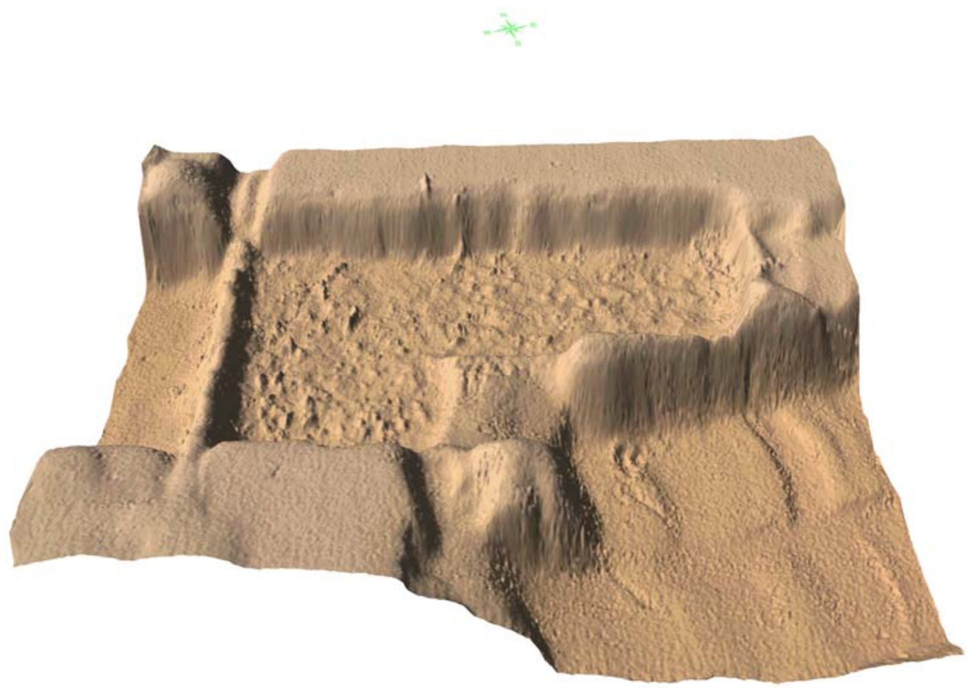
The Los Angeles Contaminated Task Force

Confined Aquatic Disposal Site Long-Term Monitoring Program 2002 - 2003



Presented to:

The Los Angeles Contaminated Task Force

November, 2004

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Los Angeles Region Contaminated Sediments Task Force

Los Angeles Contaminated Task Force
Confined Aquatic Disposal Site
Long Term Monitoring Program
2002 – 2003

Submitted to:

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Executive Summary

In early 2001, the Los Angeles District of the U.S. Army Corps of Engineers (USACE) initiated Los Angeles County Regional Sediment Management Plan Pilot Studies (DMMP Pilot Studies) to evaluate the feasibility for treating and/or disposing of contaminated sediments located within the Los Angeles County Region. The four alternatives evaluated were identified in the Los Angeles County Regional Dredged Sediment Management Plan (DMMP) 905(b) Reconnaissance Report (USACE 2000) and included cement stabilization, sediment washing, sediment blending, and aquatic capping. This report covers the findings for the aquatic capping option, referred to as the Confined Aquatic Disposal Site Long Term Monitoring Project.

In August 2001, approximately 100,000 cubic meters of contaminated sediment were mechanically dredged from the mouth of the Los Angeles River Estuary (LARE) in the City of Long Beach. The dredge material was transported via bottom-dump barge to a large borrow pit located in the Long Beach Harbor where it was deposited into a test cell termed the North Energy Island Borrow Pit (NEIBP). After allowing the approximately 2.5 meter layer of LARE material to consolidate in the disposal pit for three months, clean cap material was dredged from a second borrow pit, the South Energy Island Borrow Pit (SEIBP), and used to cover the LARE material with a 1.0 to 1.5 meter cap layer. Capping operations were initiated in mid-December 2001 and completed in early January 2002.

This report includes the findings for the monitoring effort that was begun ten months following the completion of capping operations on the NEIBP Confined Aquatic Disposal site (CAD site). Surveys were conducted in October 2002 and August of 2003 and included video and bathymetric surveys of the CAD surface, the physical and chemical analysis of sediment cores taken through cap to the underlying LARE material, and the evaluation of the benthic infauna community in and surrounding the NEIBP CAD site.

The key elements addressed by the monitoring program included:

- Determining if the CAD site cap had maintained its integrity, ensuring that fractures, erosion or deposition had not compromised the cap's ability to sequester underlying contaminants.

- Determining if burrowing organisms (bioturbators) were compromising the integrity of the cap.
- Determining if, during the two years following capping operations, contaminants were migrating through the cap at an unacceptable rate.
- Evaluating the re-colonization of the CAD site by benthic infauna and comparing this community to the surrounding harbor habitats.

The major findings of this report are summarized according to monitoring element below.

Physical Integrity of the Cap

Bathymetry results from both the 2002 and 2003 surveys of the NEIBP CAD site indicated both that the engineering goals of the project had been met and that the integrity of the cap had been maintained. The surface of the CAD site ranged from -14 to -15 m. Isopach thicknesses comparing pre and post placement of LARE dredge and SEIBP cap material indicated that the depth of the LARE material ranged from 1 to 2.5 m and that the cap ranged from just under 1 to 2 m. Comparison of surface isopachs between 2002 and 2003 showed that the surface of the cap was unchanged and that no sloughing had occurred, and fractures and depressions were absent. During the dredging operation in March 2001**,** there was concern that dredge material might have "splashed" over the walls off the borrow pit. This was not in evidence during the two post dredging bathymetric surveys.

The video transects across the NEIBP during 2002 and 2003 showed that there were no visible fractures or large depressions in the CAD surface and also that there were more burrow mounds present than were expected. This was a subject of concern, since these burrows may have been created by organisms capable of penetrating the LARE material and transporting contaminants to the surface. Therefore in 2003, another video transect was added on the SEIBP to provide a comparison with the NEIBP. During both years, surface sediments were grey-brown and were composed of a very fine layer of flocculent material. The estimated number of burrows for the entire NEIBP was calculated to range from 92,000 ± 18,400 in 2002 to 40,000 ± 8,000 in 2003. The average diameter of the burrow mounds for both years was 3.6 cm and ranged from 2.0 to 7.0 cm. The survey of the SEIBP yielded an estimated 1.3 burrows m^2 or 24,700 $\pm$ 4,940 for the entire site. The surface of this site appeared to be very similar to the NEIBP except that there was less surface flocculent material present due, probably, to strong currents in evidence during the operation.

It is unknown whether or not these burrow mounds were created by organisms capable of burrowing to the depths of the LARE material. In some cases, enumerated burrow mounds may only have been small depressions in the CAD surface. However, the enumeration of burrows was conducted from a video rather than being counted in situ, so the estimated numbers of burrows were probably a fairly accurate approximation. In addition, depositional material falling on the CAD site between 2002 and 2003 may have filled in the surface depressions that could have been misidentified as burrows in 2002, thus lowering the total count during the subsequent year.

Chemical Migration in the NEIBP CAD site

During the first two years of monitoring the NEIBP CAD site, evidence of contaminant migration into or through the cap from the LARE dredge material was not measured. Core samples revealed a clear boundary layer between the LARE and cap materials. The LARE material was fine, black, and smelled of petroleum, and the cap material was dark grey, odorless and sandy. Neither burrows created by bioturbators nor surface depositional materials from outside the CAD site were observed in any of the cores. Of the 15 metals and total PAHs measured, none were elevated in the cap material relative to concentrations found in the LARE. Total PAH concentrations, considered to be the best marker for the LARE material, were orders of magnitude lower in the cap material than in the LARE. Further, in 2003, core layer samples taken from three centimeters above the LARE material showed no evidence of either metals or PAH migration into the cap. Additionally, the concentrations of contaminants in the core layers were similar between the 2002 and 2003 surveys.

Metal and PAH concentrations measured in the NEIBP CAD site cap and LARE material were compared to concentrations measured in their corresponding source sediments during a pre-capping survey (Chambers 2001). Concentrations of metals and total PAHs measured in the CAD LARE material and the Los Angeles River Estuary were similar. Concentrations of metals were similar between the NEIBP capping material and SEIBP. Concentrations of PAHs were below detection in the SEIBP, but were slightly elevated during both years in the NEIBP cap material.

The Effects Range Low (ERL) threshold level was exceeded for several metals and PAHs in both the CAD site LARE material and Los Angeles River Estuary pre cap sediments during both surveys. The maximum concentrations of several metals exceeded the Effects Range Medium

(ERM) levels. None of the constituents measured from either the NEIBP cap or SEIBP sediments exceeded the ERL limits.

Benthic Infauna - Re-Colonization of the CAD Site

The re-colonization of the NEIBP CAD site by benthic infauna proceeded at a rapid pace during the ten-month period between October 2002 and August 2003. Although total abundances of infauna at the CAD site decreased slightly during this time, the numbers of species, diversity, and dominance (number of species comprising 75% of the abundance) had each increased dramatically. During this period, almost twice as many species were collected, diversity was 30% greater and the dominance had tripled. This contrasted with areas in the non-capped portions of the borrow pit and Harbor where numbers of species declined slightly, while diversity and dominance remained relatively unchanged between 2002 and 2003. At all CAD site locations, BRI index values (a measure of benthic community health) indicated that the infauna community on the CAD site was similar or approaching the values measured in communities found at other uncontaminated harbor sites in southern California.

Between October 2002 and August 2003, the infauna population on the CAD site began shifting toward a taxa composition that was similar to that found on the surrounding harbor sediments. The dominance on the CAD site increased from five in 2002 to twenty in 2003, which included eight species common to the Harbor sites. In 2002, the CAD site could be defined as “disturbed” since 64% of the most abundant species found there were characteristic of sediments from areas of low to moderate organic enrichment. By 2003 there was a 50% reduction in the numbers of these characteristic species, indicating that an ecologically “healthier” community had been established.

Immediately following capping, re-colonization occurred at a rapid pace on the CAD site. Two mechanisms could have been involved. Firstly, the composition of the infauna populations at the CAD site and SEIBP were very similar in terms of abundance, numbers of species, dominance, BRI and shared species. Therefore, inoculation of species from the SEIBP to the CAD site during the capping process may have been a source of potential re-colonization. Secondly, in light of the numbers of dominant species shared by the CAD site, SEIBP and Harbor sites, recruitment of infauna from the nearby Harbor sediments to the CAD site was probably occurring.

Bioturbators

Of the eight organisms collected in the survey that were potential bioturbators, only the ghost shrimp (*Neotrypaea sp*.) has been reported to burrow to depths that could potentially penetrate the LARE material. Members of this group have been reported to create burrows ranging from >50 to 90 cm in depth. During both years, a total of 46 individuals were collected from the survey area, with the majority found at CAD site stations. The impact of these burrowers is difficult to assess. The individuals collected during both 2002 and 2003 were small (<3 cm) and were most likely incapable of burrowing to great depths. However, the depth of penetration of the van veen grab used to collect the infauna samples did not exceed 15 cm. Thus, it is possible that the larger, adult ghost shrimp could have been present at depths below 15 cm, thus avoiding capture altogether.

Bioturbators were not observed in the sediment core samples during either 2002 or 2003, but during video surveys across the CAD site, burrow mounds were clearly evident and abundant. Sediment samples from these mounds in 2002 revealed elevated concentrations of several target metals, and, in several cases, above those measured in the LARE material. Further investigations in 2003 included the collection of both burrow mound and surface samples from the CAD site and surrounding Harbor sediments. These samples showed that while, in some cases, metals concentrations were elevated in the burrow mounds, they were likewise elevated in surface sediment samples without burrows. It appeared that the elevated metals concentrations in the burrow and surface sediment samples were the result of deposition from the surrounding harbor. Similarly, PAH concentrations were over an order of magnitude higher in the LARE than in the burrow mounds, strongly suggesting that sediments from burrow mounds did not originate from the LARE material.

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1.0 Introduction

In early 2001, the Los Angeles District of the U.S. Army Corps of Engineers (USACE) initiated Los Angeles County Regional Sediment Management Plan Pilot Studies (DMMP Pilot Studies) to evaluate the feasibility for treating and/or disposing of contaminated sediments located within the Los Angeles County Region. The four alternatives evaluated were identified in the Los Angeles County Regional Dredged Sediment Management Plan (DMMP) 905(b) Reconnaissance Report (USACE 2000) and included:

- Cement Stabilization – dredging and re-handling contaminated sediments to an upland staging area where dredged sediments are mixed with a cement-based product to create structurally stable soil sediment.
- Sediment Washing – dredging and re-handling contaminated sediments to an upland staging area where the dredged sediments are washed to remove chloride, allowing disposal at an upland landfill.
- Sediment Blending – dredging and re-handling contaminated sediments to an upland staging area and blending the sediments with various additives to create structurally stable sediment.
- Aquatic Capping – dredging and placing contaminated sediments into an inner Los Angeles/Long Beach Harbor borrow pit and capping with clean sediments.

This report covers the findings for the aquatic capping option, referred to as the Confined Aquatic Disposal Site Long Term Monitoring Project.

In August 2001, approximately 100,000 cubic meters of contaminated sediment were mechanically dredged from the mouth of the Los Angeles River Estuary (LARE) in the City of Long Beach (Figure 1). The dredge material was transported via bottom-dump barge to a large borrow pit located in the Long Beach harbor where it was deposited into a test cell termed the North Energy Island Borrow Pit (NEIBP). After allowing the approximately 2.5 meter layer of LARE material to consolidate in the disposal pit for three months, clean cap material was dredged from a second borrow pit, the South Energy Island Borrow Pit (SEIBP), and used to cover the LARE material with a 1.0 to 1.5 meter cap layer. Capping operations were initiated in mid-December 2001 and completed in early January 2002.

The NEIBP is an “L” shaped depression, one of a group of depressions created in the 1960’s by excavating large borrow pits for constructing a series of islands to house oil and gas production facilities (Figure 1). The surrounding area varies from –7 to –8 meters MLLW. Prior to disposal of the LARE material, the NEIBP had an average elevation of about –17.5 meters MLLW, with some lower areas at the southern edges of the site dropping down to –19.3 meters MLLW. The sides along most of the NEIBP have slope ratios of about 1 part vertical to 2 parts horizontal (1V:2H); the slope at the north end was about 1V:4H.

After depositing approximately 100,000 cubic meters (~2.5 meter thick layer) of LARE material into the NEIBP, the final surface elevation within the pit were raised to approximately –15.5 meters MLLW. With the addition of a 1.0 to 1.5 meter cap over the surface (approximately 60,000 cubic meters in volume), the final surface elevation at the completion of the project was approximately -14.5 to -15.5 meters MLLW.

The dredging, placement, and capping activities at the LARE, NEIBP and SEIBP were extensively monitored (USACOE 2002, MEC 2002). Monitoring activities included chemical characterization of the dredged and cap sediments, water quality surveys, bathymetric surveys (pre- and post-capping), and chemical analysis of the cap.

This report includes the findings for the monitoring effort that was begun ten months following the completion of capping operations on the NEIBP Confined Aquatic Disposal site (CAD site). Surveys were conducted in October 2002 and August of 2003 and included video and bathymetric surveys of the CAD surface, the physical and chemical analysis of sediment cores taken through cap to the underlying LARE material, and the evaluation of the benthic infauna community in and surrounding the NEIBP CAD site.

The key elements addressed by the monitoring program included:

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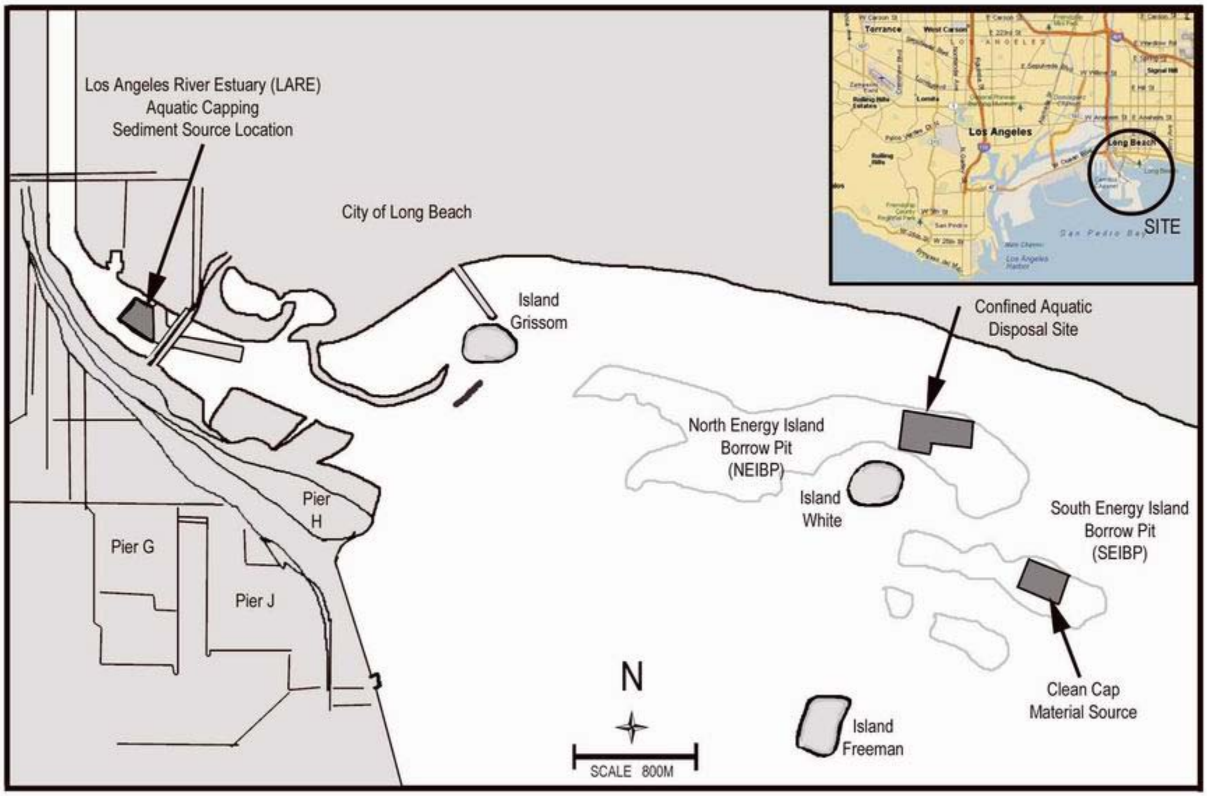
- Evaluating the re-colonization of the CAD site by benthic infauna and comparing this community to the surrounding harbor habitats.

The findings for the 2002 and 2003 CAD Site Long Term Monitoring Project are grouped and presented based on the objectives of the project. Chapter 2 includes detailed methods for each of the survey programs; Chapter 3 (Physical Integrity of the Cap) is concerned with the physical integrity of the CAD site as investigated using bathymetry and video. The physical and chemical composition of the CAD site and the burrow mounds found there are presented in Chapter 4 (Chemical Migration in the NEIBP CAD site). The findings of the infauna survey are presented in Chapter 5 (Benthic Infauna Re-colonization of the CAD Site). All figures and tables pertaining to each subject follow at the end of the chapter. References, acknowledgements, raw and summarized data are presented in the Appendices.



1-1 Map of the Long Beach Harbor vicinity and confined aquatic disposal site study area.

2.0 Materials and Methods

Sample collection for the first two year's of the CAD Long Term Monitoring Program was conducted during October 2002 and August 2003. The sampling programs for each of the two years included the collection of bathymetry data, video transects, sediment cores, benthic infauna grabs and samples of burrow mound sediments. The sampling design for each of the programs (except the bathymetry program) were modified for the August 2003 survey after the 2002 survey data had been evaluated. These modifications are explained in each section below. More detailed sampling and analysis procedures for this project are contained in the Quality Assurance Project Plan (Aquatic Bioassay 2002).

A total of 20 stations were visited in 2002; Stations 1 thru 10 located on the CAD, Stations 11, 12, 13, 18, 19 and 20 in non-capped portions of the NEIBP, and Stations 14, 15, 16 and 17 located adjacent to the NEIBP on natural harbor sediments (Figure 2-1). During 2003, two additional sites (Station 21 and 22) were added on the SEIBP. During both years bathymetric and video surveys were conducted over the NEIBP CAD site. In 2003 a video survey was also conducted over the SEIBP. Burrow mound sediments were randomly collected from the surface of the CAD site in 2002 and from both the CAD site and natural Harbor surfaces in 2003.

2.1 Navigation and Positioning

The CAD site boundaries and all sampling stations were located using a Lowrance Global Map 2000 differential global positioning system (DGPS) in accordance with *Evaluation of Survey Positioning Methods for Near Shore Marine and Estuarine Waters* EPA Contract No. 68-01-6938 (USEPA 1987).

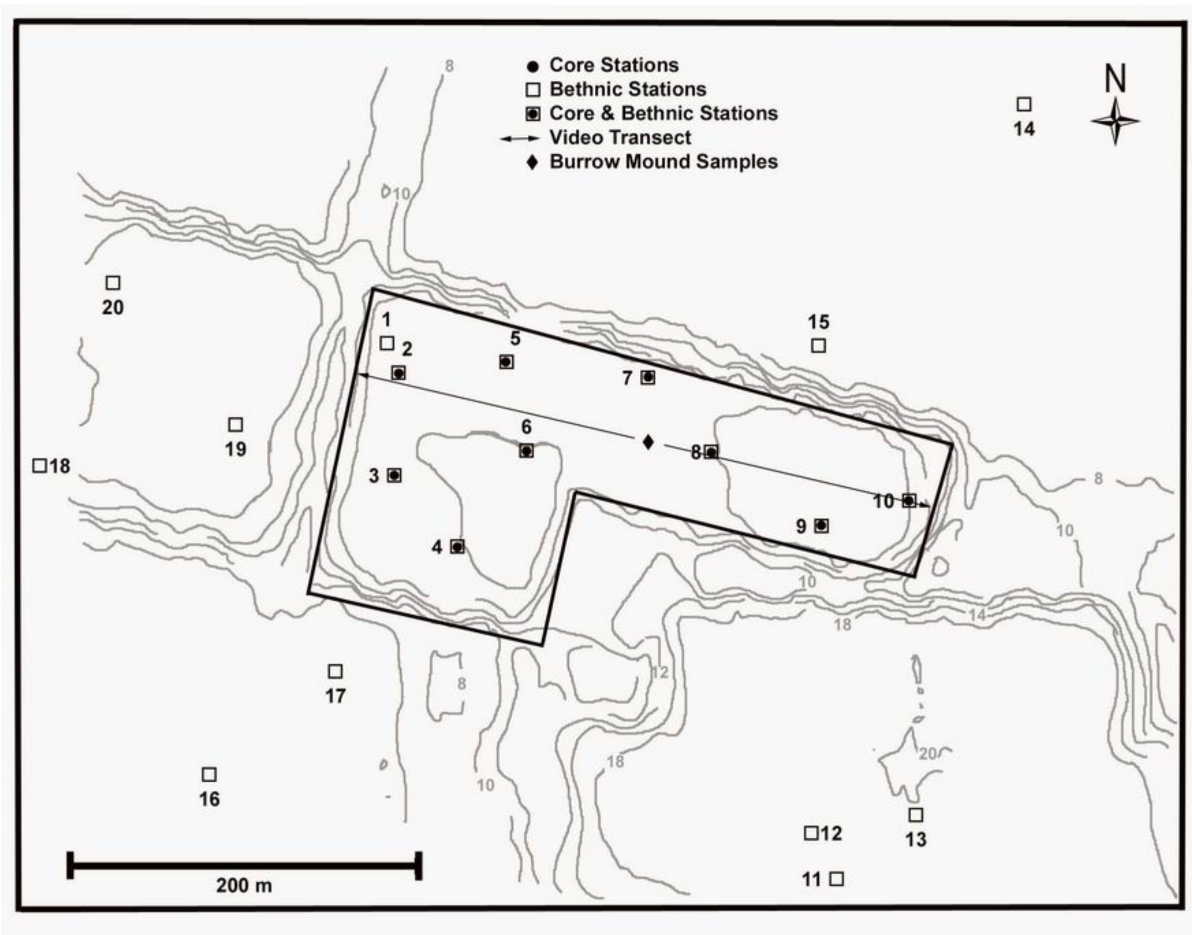
2.2 Bathymetry Surveys

On October 17th, 2002, and August 6th, 2003 bathymetric surveys were conducted over the NEIBP CAD site and surrounding area (to a minimum of 50 meters beyond the top edge in all directions) using a multi-beam sonar device with a maximum 0.1 meter vertical resolution. Station and horizontal positioning were based on State Plane Coordinates referenced to NAD 83 California Zone 5 in meters. All soundings were measured in meters and referred to MLLW

1993 as determined from BM “Tide Gage”, elevation 4.15m MLLW 1993. The following equipment was used to conduct the survey: a Reson Seabat 8101 Multibeam Sonar, TSS POS/MV 320 GPS/Intertial Motion Reference, Reson 6042 Multibeam Data Acquisition System and an Applied Microsystems SV Plus Sound.

The data collected from this survey are presented in both 2 and 3 dimensional images. The October, 2002 data were combined with bathymetry data collected in August and September of 2001 to create isopach thicknesses of the LARE and cap material. The data from both the 2002 and 2003 surveys were used to create an isopach, the purpose of which was to determine if fractures or erosion of the CAD surface were in evidence.

Figure 2-1. Station location map for all monitoring samples including the video transect, cores, benthic infauna and burrow mounds.



2.3 Video Surveys

Video surveys were conducted across the NEIBP CAD site in 2002 and both the NEIBP and SEIBP in 2003. The SEIBP transect was added in response to the observation of a large number of burrows counted on the NEIBP in 2002. The goal of the SEIBP survey was to determine whether or not burrow counts were similar between the two sites.

During both years, divers conducted an east to west, 300 meter swimming transect along the bottom of the NEIBP CAD site. Burrow counts were recorded using a hand-held Sony TRV900 digital camcorder encased in an Underseas underwater housing with an attached bank of fluorescent underwater lights. The video camera captured 30 digitized frames per second along the transect, which allowed for detailed analysis of the bottom. The line transect (yellow nylon line) was anchored at each end with a surface buoy. An additional buoy was located at the half way point. The transect line was marked with tape at 10 meter intervals so that the position of the video camera could be determined. The SEIBP pit survey was conducted in the same manner.

Divers entered the water at the east end of each transect and swam the entire length of the cap, exiting the water at the western buoy array. In the laboratory the film was captured from the camcorder to a computer by IEEE 1394 fire wire. Editing was accomplished by Adobe Premiere 6.5. Although the divers moved the camcorder very slowly across the bottom during the survey, the proximity of the camcorder lens to the bottom caused the speed of transit to appear very fast. To correct for this, the video speed in the editing program was reduced by 50%. In addition, the contrast was increased slightly to accentuate the burrows. The final project was then converted to DVD.

The DVD was reviewed and all burrows seen on the video 2 cm or larger were counted. Staff biologists estimated that a ghost shrimp or other animal~~s~~ smaller in diameter than 2 cm would unlikely be large enough to burrow deeper than the thickness of the cap (1 meter). In addition, the diameters of 50 burrows greater than 2 cm were measured to provide an estimate of average size.

The underwater visibility dictated the distance the camera lens needed to be positioned above the surface. This, in turn, determined the width of the video image when viewed on screen. For the NEIBP the visibility was less than 15 cm during the dives in both 2002 and 2003 and the lens of the housing had to be held about 7 cm above the bottom during transit. Based on the known sizes of images observed in the video (such as the transect line and duct tape), the transect width captured by the video was determined to be 0.28 m. Using this dimension plus the length of each transect, the quadrat created by the video transect could be calculated. For example, the 300 meter transect on the NEIBP was estimated to be 84 square meters (0.28 X 300).

For the SEIBP, the visibility during the 2003 dive was 5 cm and the lens of the video housing was held at 2 cm above the bottom, making the transect width 0.15 m wide. The length of the transect was approximately 190 m, but it was determined that about 15% of the bottom on this video could not be seen, so the length of the transect was reduced to 160 m. Therefore, the total quadrat size was calculated to be about 24 square meters (0.15 X 160).

The number of burrows per square meter was determined by dividing the total number of burrows counted by the size of the quadrat. Based upon maps of the CAD site and SEIBP, their total areas were calculated to be about 40,000 and 24,700 m^2, respectively. The total number of burrows (larger than 2 cm) for each site was estimated by multiplying the number counted per square meter by the area. The maximum, average, standard deviation, and ranges of the size measurements were also calculated.

2.4 Sediment Coring

Sediment core samples were collected on October 25th, 2002 and August 11th, 2003 at the original nine CAD stations established during the March 2002 pilot survey (Figure 2-1, Stations 2 through 10) (USACE 2002). All coring activities were conducted in accordance with the following protocols:

- *QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations - Chemical Evaluations (EPA-B-95-001).* (USEPA 1995)
- *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA Office of Water, EPA-823-B-01-002, October 2001.* (USEPA 2001)

A hand held coring device was used by US Navy Divers to collect a single core at each of the nine stations during both surveys. At each station the coring device was fitted with a new, clear, 6 foot liner (ID = 2½", OD = 2 5/8") made of butyrate. Two divers entered the water at each station to position the core, insert it through the sediment and pull it back out. Care was taken to not disturb the bottom while the core was being taken. Caps were placed on each end of the core as it was retrieved from the sediment.

Station information was entered onto the CSTF Core Sampling Data Sheet as each core was recovered. General station information included the station ID, date, time, sea state, weather conditions, station depth, latitude and longitude. Information regarding the core sample included:

- Total core depth (cm)
- Depth of LARE penetration (cm)
- Presence or absence and depth (cm) of newly deposited material at the core surface
- Visual sediment composition
- Odor
- The presence, number and depth (measured from the surface) of tubes created by bioturbators
- The depth of the boundary between the cap and LARE material as well as the depth of the mid-core sample

Once a core was brought onboard, it was labeled with the station ID, digitally photographed, and then placed horizontally in a holder made of a half PVC pipe that was covered with a sheet of non-contaminated clear plastic. The plastic sheet was discarded between each sample and replaced with a new sheet.

Each core was inspected to ensure it met the following acceptability criteria:

- The core was not inserted into the bottom at an angle.
- The core penetrated to at least 15 cm into the LARE material.
- The surface of the core had not escaped from the top of the liner.

Each acceptable core was then measured from its surface and marked in 10 cm intervals from surface to the bottom. The interval that coincided with the boundary layer between the grey cap material and black LARE material was identified and marked as the bottom sample. In 2002 the middle sample was designated as the halfway point between the bottom and surface of the core (Figure 2-2). In 2003 the mid sample was moved to 6 cm above the bottom sample in an attempt to detect migration of chemicals from the LARE material. Additionally, in 2003 a high resolution core study was conducted at Station 2, in which each 10 cm core layer from surface to bottom was analyzed.

The core was then cut horizontally from the top using a pneumatic saw. Cutting stopped at each 10 cm interval where visual observations (for bioturbation and new sediment deposition) and chemistry samples were collected.

2002	Core Layer Depth (cm)	2003
Surface	0-10	Surface
	10-20	
	20-30	
	30-40	
Mid	40-50	
	50-60	
	60-70	
	70-80	
	80-88	Mid
Bottom	90-100	Bottom

Figure 2-2. Core layer sample depth (cm). Middepth samples collected at 40-50 cm in 2002 and at 80-88 cm in 2003.

Chemistry samples were collected from the surface, middle and bottom core layers using one, 16 oz. I-Chem glass container (EPA certified for both metals and organics analysis). All containers were marked with the Program (CSTF), station ID and date. Additionally, the core depth (e.g surface, middle or bottom) from which the sample was collected was designated with its upper and lower boundaries recorded in centimeters. Each layer was sampled using a plastic scoop that had been pre-cleaned. Information from each sample was logged onto the chain of custody sheet as each was collected. The chemistry samples were capped and placed on dry ice before transport back to the laboratory where they were placed in –20° C storage before shipment to the chemistry laboratory.

The remains of each 10 cm core layer were archived by placing them in I-Chem glass containers (EPA certified for both metals and organics analysis) and labeled as above with their core depth ranges. Information from these samples was entered onto the chain of custody forms. These samples were placed on dry ice, transported to the laboratory and stored at –20° C for future analysis.

2.5 Burrow Mound Chemistry Samples

2002

Six samples of the sediments from surface mounds created by burrowing organisms were collected by divers using 8 oz EPA certified glass containers. The divers entered the water near the center of the NEIBP CAD site and randomly selected six burrow mounds associated with burrows greater than 2 cm in diameter. Due to poor visibility the sample containers were labeled before the dive with the transect ID, date, and sample number (1, 2, 3, etc.).

The sample containers were opened underwater, filled with water over the burrow mound, scooped through the material until it was ¾ full of mound material, then re-capped. After the divers returned to the boat, the sample data were recorded onto a chain of custody and samples were placed on dry ice. Following the return to the laboratory, the samples were stored at –20° C. Samples were analyzed for metals, PAH’s, grain size, density and TOC (see Chemistry Methods below).

2003

The concentrations of several metals were elevated in sediments from burrow mounds collected during the 2002 survey. To further investigate, the monitoring program was redesigned. Burrow mound, as well as non-burrow mound surface sediments, were collected from both the NEIBP CAD site and surrounding harbor sediments. A total of six CAD site burrow mounds, six CAD site non-burrow surface sediments, three Harbor burrow mounds, and six Harbor non-burrow surface sediments were sampled. To ensure the accuracy of sampling, these later samples were collected using modified 60 mL plastic syringes. The ends of these syringes were cut off to create a small suction sampler. The syringes were acid washed, rinsed and sealed before use.

2.6 Sediment Chemistry

Chemical analyses were conducted according to the follow protocols:

- Trace metals were prepared using EPA Method 3015 and analyzed using a Hewlett Packard 4500 Inductively Coupled Plasma Mass Spectrometry (ICPMS) by EPA Method 6020
- Samples for PAH's were extracted using EPA Method 3545 and analyzed using a Hewlett Packard 6980/5972 Gas Chromatograph/Mass Spectrometer by EPA Method 8270C in the full scan mode.
- Particle size was analyzed by laser diffraction in 2002 using a MicroTrac II analyzer and in 2003 a Horiba LA-920, laser scattering particle size distribution analyzer. In both cases the methods followed Standard Methods 20th ed., Section 2560-c and Plumb 1981.
- Total Organic Carbon was determined by EPA Method 415.1 using a Carlo Erba Elemental Analyzer.

Sediment chemistry results were normalized to % fine sediments by dividing each value by the percent particle size fraction ranging from 33 µm to <2µm at each station.

2.7 Benthic Infauna Grabs

During 2002, a total of 20 benthic infauna samples were collected from the survey area (Figure 2-1): Stations 1 thru 10 located on the CAD, Stations 11, 12, 13, 18, 19 and 20 located on non-capped portions of the NEIBP, and Stations 14, 15, 16 and 17 located adjacent to the NEIBP on natural harbor sediments. Results of the 2002 sampling indicated that infauna had rapidly re-colonized the CAD site. To determine whether or not this was due to inoculation of organisms from the SEIBP (where the cap material was taken), the 2003 survey included two additional sites (Station 21 and 22) on the SEIBP.

Samples for benthic infauna were collected on October 22, 2002 and August 12th, 2003. Benthic grabs were collected according the procedures established in:

- *Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods, EPA Contract No. 68-01-6938*

- *The Southern California Bight Regional Monitoring Program, 1998 Survey* (SCCWRP 1998)

Samples were collected using a modified 0.1 m^2, Van Veen grab. Once on board, each grab was visually inspected for penetration depth, color, sediment composition and odor. All samples were screened using a 1.0 mm sieve, while a sub-set of 5 samples (Stations 1, 7, 8, 17 and 19) were also screened through a 0.5 mm sieve. Samples were relaxed in $MgSO_4$ for a half hour then transferred to 10% buffered formalin.

In the laboratory samples were sorted into major taxonomic groups (annelids, crustaceans, mollusks, echinoderms and other phyla). Two of the samples were re-sorted by the laboratory supervisor to verify sorting completeness. Vials containing polychaetes were packaged and shipped by Federal Express to Mr. Tom Gerlinger, a private taxonomic consultant, and crustaceans and miscellaneous organisms were sent to C.A. (Tony) Phillips of the City of Los Angeles' Bureau of Sanitation. The taxa list and problem organisms were reviewed by C.A Phillips and presented to members of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) as necessary to ensure proper identification.

2.8 Statistical Analyses

Infauna Community Metrics

Five biological metrics were used to compare the benthic infauna assemblages that were collected from both on and near the NEIBP CAD site (Table 2-1). Abundance, numbers of species, Shannon Diversity, the Infaunal Trophic Index (ITI) and the Benthic Response Index (BRI) were calculated for the benthic infauna data.

Total Abundance – is the abundance of infauna collected per sampling effort. Abundance included all of the non-colonial animals collected from one replicate Van Veen grab (0.1 square meter surface area) and retained on either a 1.0 or 0.5 mm screen.

Numbers of Species – is the number of separate infaunal species collected per sampling effort (i.e. one Van Veen grab). In general, stations with higher numbers of species per grab tend to be in areas of healthier communities.

Shannon Diversity (H') – is a diversity index whose calculation includes both numbers of species and the relative abundance of each species. For example, two samples may have the same numbers of species and the same numbers of individuals. However, one station may have most of its numbers concentrated into only a few species while a second station may have its numbers evenly distributed among its species. The diversity index would be higher for the latter station.

The Shannon Diversity Index (H') (Shannon and Weaver 1963) is defined as:

$$H' = -\sum^{s} \{(n_j/N)\ Ln(n_j/N)\}$$

where: n_j = number of individuals of the jth species
N = total indiv. of all species in the sample
s = number of species in the sample.

Schwartz' Dominance. The Schwartz' dominance index is:

$$D = \text{\# species composing 75\% of population} = 1 - (y_1 + y_2 + \ldots\ldots\ y_n / N)$$

where: y_1 = number of most abundant species
y_2 = number of second most abundant species
N = total number of all species.

Infaunal Trophic Index (ITI) - was developed to compare the populations of benthic organisms at different sites based on feeding strategies. Higher values denote species assemblages dominated by suspension feeders, which are more characteristic of unpolluted environments. Lower index values denote assemblages dominated by deposit feeders more characteristic of sediments high in organic pollutants (e.g. near major ocean outfalls). Values greater than 60 indicate an undisturbed benthic population. Values between 30 and 60 indicate a population that is changed, while values below 30 indicate degradation. The infaunal trophic index is based on a 60-meter depth profile of open ocean coastline in southern California. Its results should be interpreted with some caution when applied to shallower stations.

$$ITI = 100 - 33.33\{n_2+(2)(n_3)+(3)(n_4)/n_1+n_2+n_3+n_4\}$$

where: n_1 = number of individuals of group 1 species
n_2 = number of individuals of group 2 species
n_3 = number of individuals of group 3 species
n_4 = number of individuals of group 4 species.

Benthic Response Index (BRI) – measures the condition of a benthic assemblage, with defined thresholds for levels of environmental disturbance (Smith et al. 2001). The pollution tolerance of each species was determined based upon its distribution of abundance along the gradient. The BRI is the abundance-weighted average pollution tolerance of species occurring in a sample (Smith *et al.* 2001). The general index formula is:

$$BRI_s = \frac{\sum_{i=1}^{n} a_{si}^{f} p_i}{\sum_{i=1}^{n} a_{si}^{f}} \qquad (1)$$

where BRI_s is the BRI value for sampling unit s, n is the number of species in s, p_i is the pollution tolerance of species i, a_{si} is the abundance of species i in s, and f is an exponent used to transform the abundance values. The index was calculated using a two step process in which ordination analysis was employed to quantify a pollution gradient within a data set assembled from four projects distributed throughout southern California. The Northern bays index was applied to the NEIBP CAD site data.

To give index values an ecological context and facilitate their interpretation and use for evaluation of benthic community condition, four thresholds of biological response to pollution were identified. The thresholds were based on changes in biodiversity along the pollution gradient. A reference threshold, below which natural benthic assemblages normally occur, was identified at an index value of 31, the point on the pollution vector where pollution effects first resulted in a net loss of species. Three additional thresholds of response to disturbance were defined at index values of 42, 53 and 73, representing points at which 25%, 50%, and 80% of the species present at the reference threshold were lost. The thresholds were equivalent to the thresholds developed for the southern California mainland shelf BRI.

Table 2-1. Community population metrics and their expected response to an impact.

Indicator	Reference	Expected Pattern with Increasing Disturbance
Total abundance	Pearson and Rosenberg (1978)	Increases, then decreases with increasing outfall effects
Number of species	Pearson and Rosenberg (1978)	Initial increase, then decrease with increasing impact
H' - Shannon information diversity	Pielou (1969)	Initial increase, then decrease with increasing impact
ITI - Infaunal Trophic Index	Word (1979, 1980a, 1980b)	Decreases in value
BRI - Benthic Response Index	Smith et al. (2001)	Increases in value

NOAA Effects Range Thresholds

Sediment chemistry results were compared to the limits presented in two NOAA studies (NOAA 1990 and Long, et. al. 1995). In these studies, researchers compiled published information regarding the toxicity of chemicals to benthic organisms. The data for each compound were sorted, and the lower 10th percentile and median (50th) percentile were identified. The lower 10th percentile in the data was identified as an Effects Range-Low (ER-L) and the median was identified as an Effects Range-Median (ER-M). The ER-L value represents a concentration below which adverse biological conditions should rarely be observed. The ER-M represents a concentration above which adverse biological effects may frequently be observed.

3.0 Physical Integrity of the Cap

The CAD site was designed to maintain a barrier between the contaminants associated with the LARE material and the surface sediments. The cap barrier of clean sediments could potentially be breached by forces such as currents, earthquakes and settling of the surface sediments. Additionally, organisms (bioturbators) capable of burrowing through the cap to the LARE material could potentially carry contaminants to the surface through their burrows. A large number of bioturbators could provide a significant mechanism for the transport and deposition of contaminants to the CAD surface.

The cap's integrity was investigated using bathymetry contours of the CAD surface, isopach's of the CAD surface and underlying layers, video surveys of the cap surface and observations for bioturbators in sediment cores.

3.1 Bathymetric Survey

On October 16th, 2002 and August 6th, 2003 bathymetry surveys of the CAD site and surrounding area were conducted by Fugro West, Inc. using multi-beam side scan sonar. The data were processed and converted into both 2 and 3 dimensional images for analysis (Figures 3-1 to 3-7). The depth contours showed that the CAD site surface depth was nearly identical for both 2002 and 2003, ranging from approximately -12 to -14 meters. The harbor surface surrounding the CAD site ranged between -4 to -8 meters. The deepest portion of the site (-20 meters) occurs in a non-capped portion of the borrow pit southeast of the CAD site. The height of the borrow pit walls were deeper (-10 meters) on the north and southwest sides of the CAD site. The walls on the southeast side of the CAD site were even deeper and appear to be considerably eroded. This condition existed before the capping project had been initiated. The berm on the west end of the CAD site was shallower (ranging from -8 to -5 meters) and was originally created to cover a now unused pipeline.

The surface of the CAD site is at the same approximate depth throughout, although areas of unevenness are present, especially toward the west end. This may be the result of differing disposal techniques. On the west end, the barge remained stationary during the dumping process causing the material to mound up. This procedure was changed for the east end of the pit where the barge moved continuously while dumping, thus smoothing the deposition of material on the bottom.

During the dredging operation in March, 2001, it was reported that some dredge material “splashed” over the walls of the borrow pit (USACE 2002). This splash was not evident in either of the bathymetry profiles collected during the subsequent surveys.

3.2 Isopach Thicknesses

To assess if the engineering objectives of the capping portion of the project were met, isopach thicknesses were created to determine the depths of the LARE material, the combined depth of the cap and LARE material, and the depth of the cap material alone. The isopach thicknesses were created using data from the bathymetry surveys of the NEIBP CAD site before dredging operations had begun in August, 2001; after the LARE material was placed in September, 2001; and, in October 2001 after the SEIBP capping material was placed over the LARE material. Figure 3-3 shows how the isopach thicknesses were derived. Figure 3-4 represents the depth of the LARE material, Figure 3-5 represents the depth of the CAD site capping material and Figure 3-6 represents the combined depth of the LARE and capping material. Figure 3-7 is an overlay of the CAD site surface elevation from 2002 and 2003 surveys.

The LARE material varied between slightly less than 1 to nearly 2.5 meters in thickness across the CAD site (Figure 3-4). The thickest portions of the LARE material were in the east end of the CAD site. The steep walls of the CAD site are represented in red and are especially prevalent in the southwestern portion. The thickness of the cap material averaged between slightly less than 1 (yellow) and up to just over 2 (blue) meters (Figure 3-5). The isopach shows several areas in the west end of the CAD where mounds, slightly exceeding 2 meters, occurred. The combined depth of the LARE and cap material was 2 meters or greater throughout the site (green and blue) (Figure 3-6). The surface elevation of the CAD surface was nearly identical between years (Figure 3-7). The largest difference between years was a small -0.35 cm depression in the north western corner of the CAD site.

3.3 Video Survey

Video surveys were conducted across the NEIBP CAD site in October 2002 and August 2003. Since numerous burrow mounds were counted on the CAD site during the 2002 survey, an additional video survey was conducted for comparison purposes across the SEIBP in 2003. Each video was reviewed looking for CAD site erosion, fracture and burrow mounds created by bioturbators. Burrow mounds were quantified, and estimates of the total numbers and sizes of burrow mounds were calculated for each survey. Still frame pictures captured from the video footage are presented below.

October 2002

In October 2002, underwater visibility during the NEIBP video transect was less than a foot (30 cm). Burrows, recorded by hand-held video, were still readily visible by divers (Figure 3-8 to 3-11). Surface color was gray-brown and surface sediments were composed of an extremely fine, flocculent material that was dispersed with the slightest disturbance. This flocculent ranged from between 1 and 3 centimeters in thickness. Beneath the flocculent, sediments were considerably more dense, indicating that the flocculent material may have been the product of new deposition onto the cap. This fine surface layer was not observed in either the core or grab samples and may have been dispersed by the bow wake created by these devices as they neared the sediment surface.

The video transect covered an area equivalent to 84 m^2 and yielded a total of 190 burrows. This was converted to an average of 2.3 burrows per m^2. Thus, for the whole 40,000 m^2 CAD site, the total number of burrows could be estimated at 92,000 ± 18,400. (Since interpretation of what was a burrow and what was not a burrow could be questioned, it was estimated that a $\pm$ 20% error was probably not unreasonable.)

The smallest burrow diameter (by definition) observed was 2.0 cm and the largest was 7.0 cm. The average diameter of all burrows was 3.6 cm (standard deviation = 1.1 cm). Most burrows ranged from 3.0-3.9 cm (35%), followed by 4.0-4.9 cm (28%), and 2.0-2.9% (22%). The least number of burrows was in the largest group, $\geq$ 5.0 cm (15%).

August 2003

During the August 2003 video transect, visibility on the NEIBP was again poor (10 cm). Burrows were readily observed by divers and recorded by hand held video. The surface of the CAD appeared the same as in 2002 and no fractures or erosion were observed. The surface color of the CAD sediment was grey-brown and the light flocculent material observed in 2002 covered the surface. The video transect covered an area equivalent to 81 m^2 and yielded a total of 88 burrows. This was converted to an average of 1 burrow per m^2. Thus, for the whole 40,000 m^2 CAD site, the total number of burrows was estimated at 40,000 ± 8,000. Burrow sizes were similar to the 2002 survey.

The video survey on the SEIBP was conducted during extremely poor visibility (5 cm) and strong tidal current. Burrows were visible to divers during portions of the dive and were recorded on the hand held video. The surface of the SEIBP was similar to NEIBP CAD site, but the light flocculent found on the CAD site was not as prevalent, probably due to the strong current. The surface was grey-brown and was composed of dense sand. The 24 m^2 SEIBP quadrat yielded 32 burrows or 1.3 burrows per m^2. Thus, for the 19,000 m^2 SEIBP site, the total number of burrows was estimated to be 24,700 ± 4,940. Burrow sizes were similar to the NEIBP.

3.4 Summary

Bathymetry results from both the 2002 and 2003 surveys of the NEIBP CAD site indicated both that the engineering goals of the project had been met and that the integrity of the cap had been maintained. The surface of the CAD site ranged from -12 to -14 m. Isopach thicknesses comparing pre and post placement of LARE dredge and SEIBP cap materials showed that the thickness of the LARE material ranged from 1 to 2.5 m and that the cap ranged from just under 1 to 2 meters. Comparison of surface isopachs between 2002 and 2003 showed that the surface of the cap was unchanged and that no sloughing had occurred, and fractures and depressions were not in evidence. During the dredging operation in March 2001, there was concern that dredge material had “splashed” over the walls off the borrow pit. This was not evident in the two post dredging bathymetric surveys.

Surface mounding was evident on the east end of the CAD site in both the 2002 and 2003 side scan sonar images. These mounds ranged in height from 0.5 to 0.75 meters above the surrounding sediment and were created when the dredge scow remained stationary while dumping the cap material into the borrow pit. The engineering team noted this during operations and changed procedures on the west end of the CAD site where the scow was moved as the dredge material was being dumped. As a result, the surface on the west end of the CAD site lacks mounds and is thus smoother.

The video transects across the NEIBP during both the 2002 and 2003 surveys indicated that there were no visible fractures or large depressions in the CAD surface and that there were more burrow mounds present than were expected. As a result, in 2003 a transect was added to the SEIBP to provide a comparison with the NEIBP. During both years, surface sediments were grey-brown and were composed of a very fine layer of flocculent material on the surface. This fine material was 1 to 3 cm thick, very light, dispersed with little disturbance and was probably deposited from the surrounding harbor sediments. The estimated average number of burrow mounds observed ranged from 2.3 m^2 in 2002 to 1.0 m^2 in 2003 on the NEIBP. The estimated number of burrows for the entire NEIBP was calculated to range from 40,000 ± 8,000 in 2003 to 92,000 ± 18,400 in 2002. The average diameter of the burrow mounds for both years was 3.6 cm and ranged from 2.0 to 7.0 cm. The greatest concentration of burrows was in the 3.0 to 3.9 cm (35%) diameter range.

The video survey of the SEIBP in 2003 yielded an estimated 1.3 burrows m^2 or 24,700 ± 4,940 for the entire site. The sizes of burrows were similar to the NEIBP. The visibility during the video transect across the SEIBP was extremely poor making the estimated numbers of burrows found there probably less accurate. The surface of this site appeared very similar to the NEIBP except that there was less surface flocculent material present. This is probably due to strong currents that were evident during the dive operation.

Whether or not these burrows mounds were created by organisms capable of burrowing to the depths of the LARE material is unknown. In many cases what may have been recorded as burrow mounds, may have just been small depressions in the CAD surface. However, since the enumeration of burrows was conducted from the DVD and not in situ, the estimated numbers of burrows are probably fairly accurate. Counts were generally higher in 2002 over 2003, indicating that depositional material falling on the CAD site between 2002 and 2003 may have filled in any surface depressions that were potentially misidentified as burrows in 2002.

Figure 3-1. Multibeam side-scan sonar bathymetry of the Long Beach Harbor, CSTF CAD site in October 2002. The color depth scale is in meters from MLLW. Depths range from -4 m (blue) to -20 m (red).

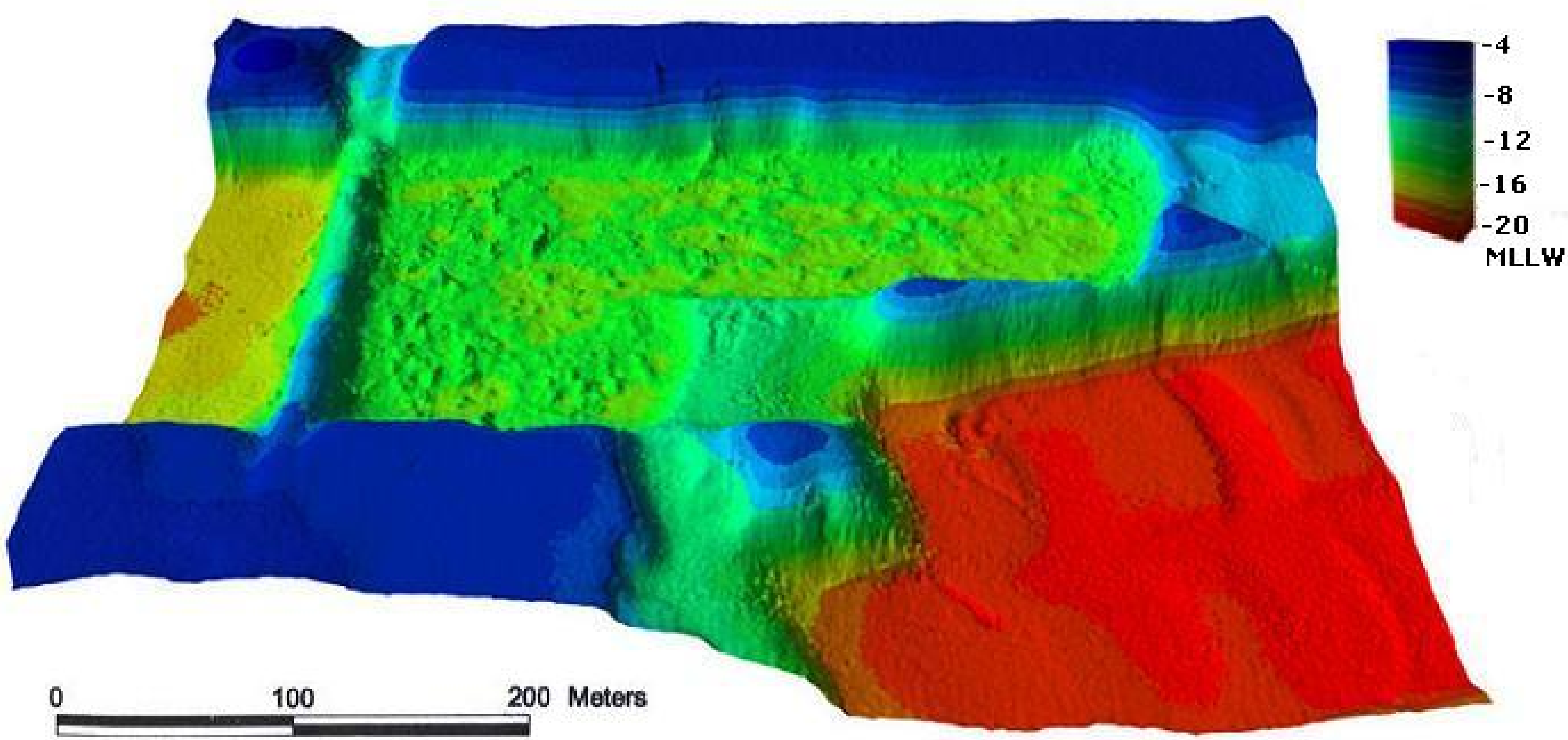


Figure 3-2. Multibeam side-scan sonar bathymetry of the Long Beach Harbor, CSTF CAD site in August 2003. The color depth scale is in meters from MLLW. Depths range from -4 m (red) to -20 m (blue).

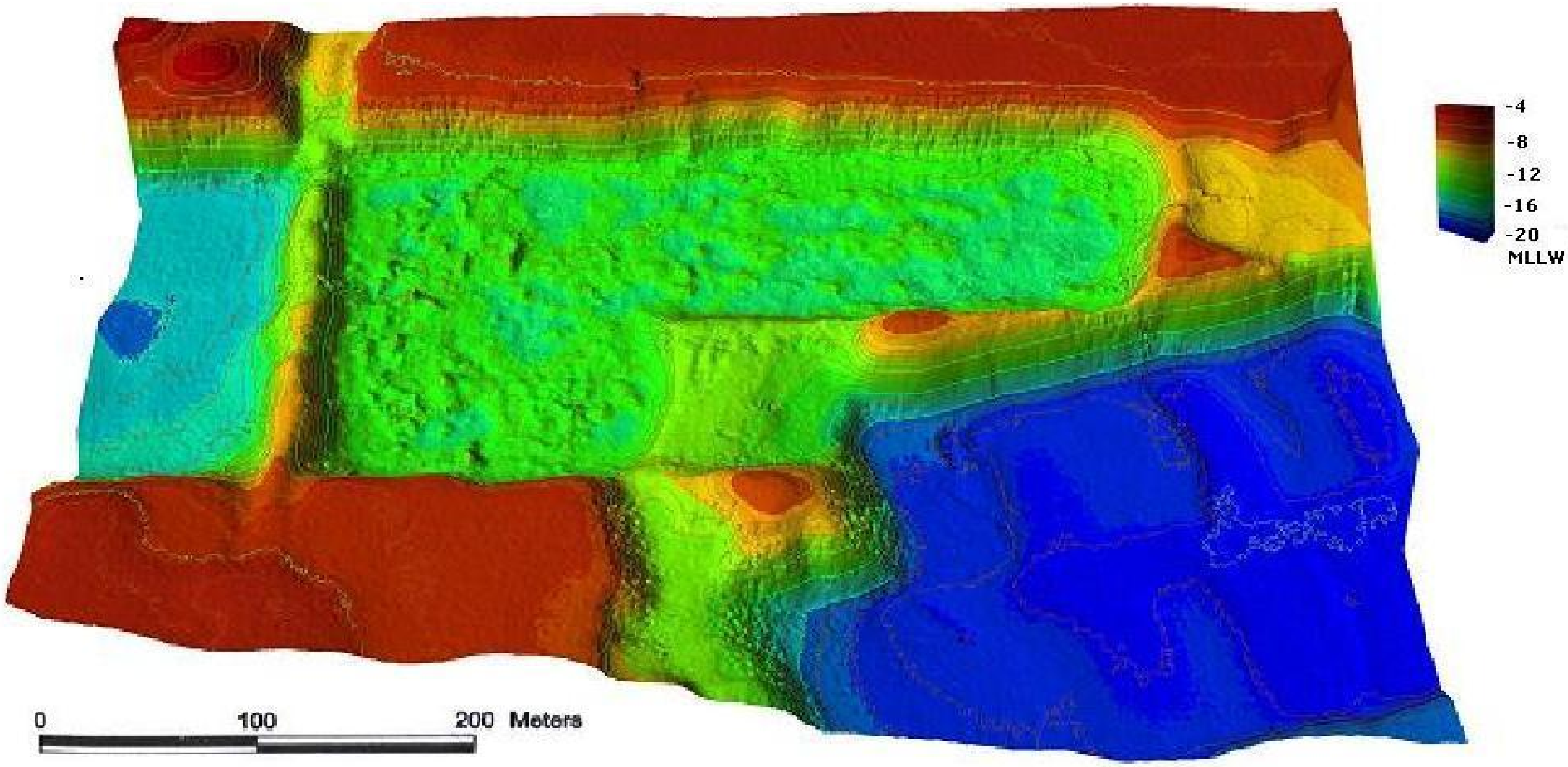


Figure 3-3. Illustration of the depth layers represented in the isopach thicknesses of the NEIBP CAD site.

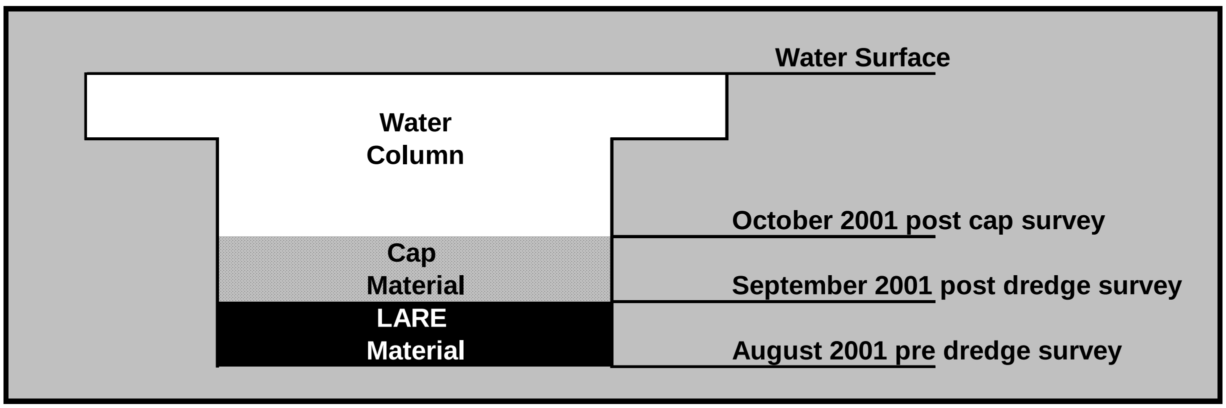


Figure 3-4. Isopach depicting the total thickness of the NEIBP LARE dredge material comparing the August to September 2001 bathymetry data.

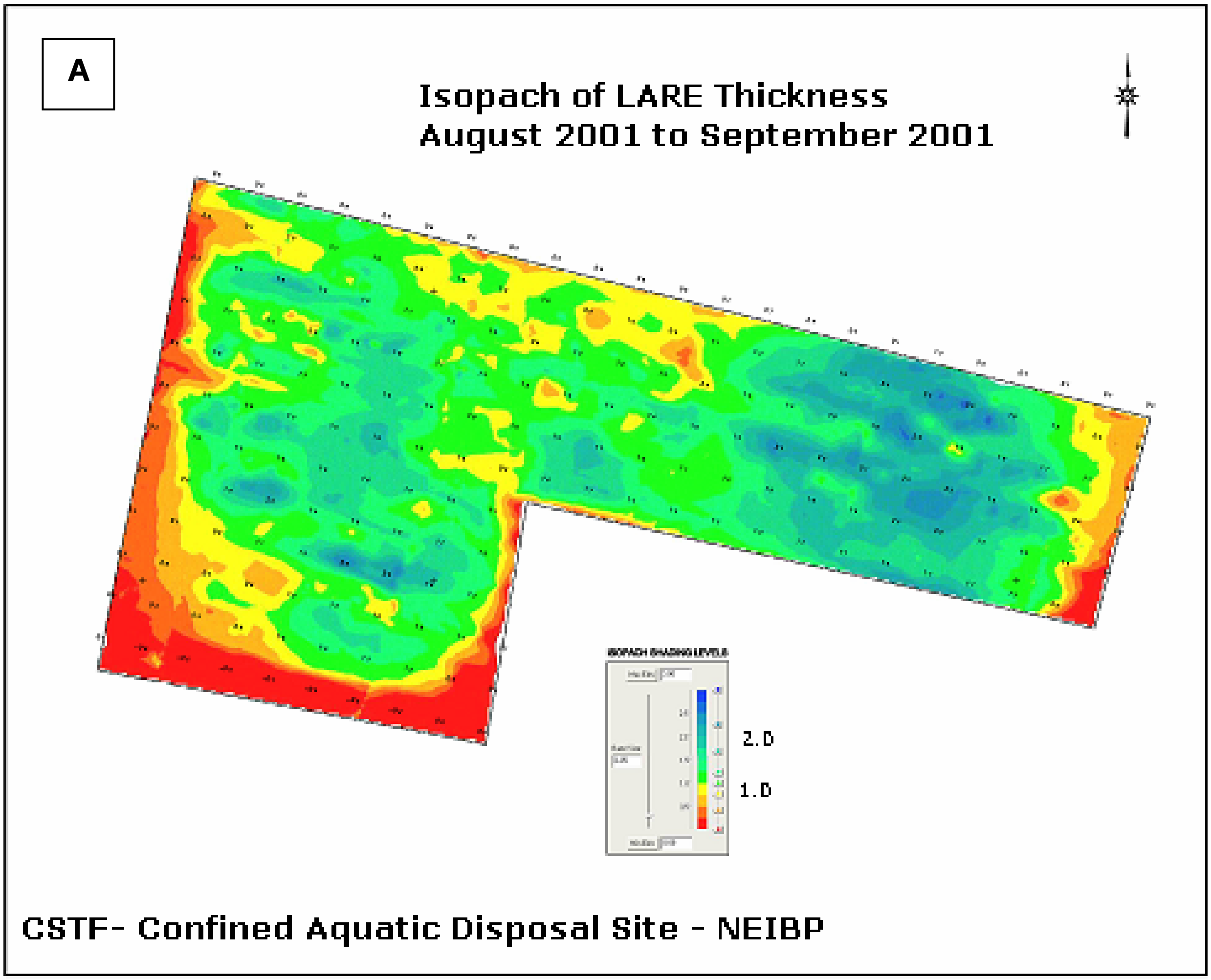


Figure 3-5. Isopach depicting the total thickness of the NEIBP cap material comparing the September 2001 to October 2002 bathymetry data.

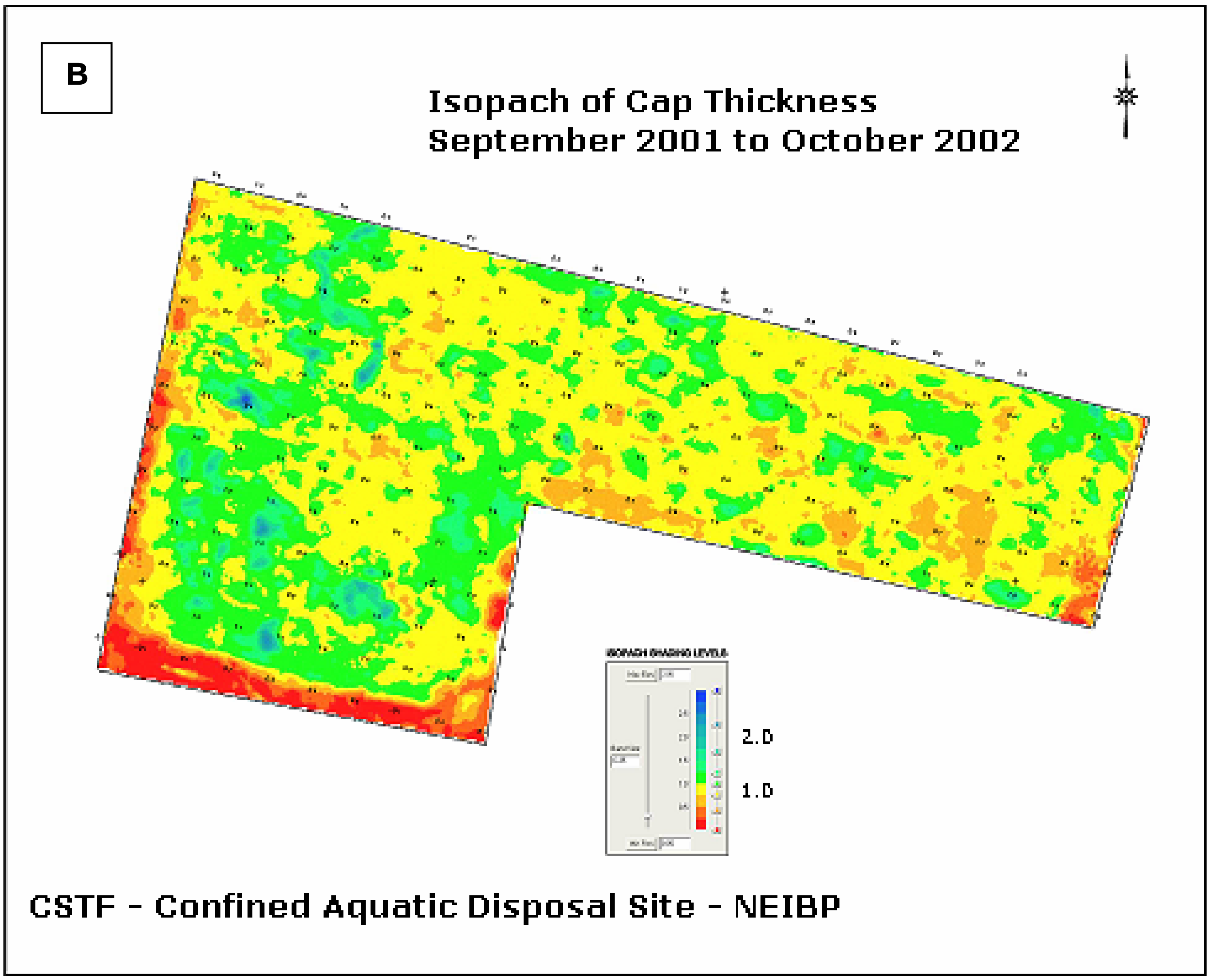


Figure 3-6. Isopach depicting the combined thickness of the NEIBP cap and LARE material comparing the August 2001 to October 2002 bathymetry data.

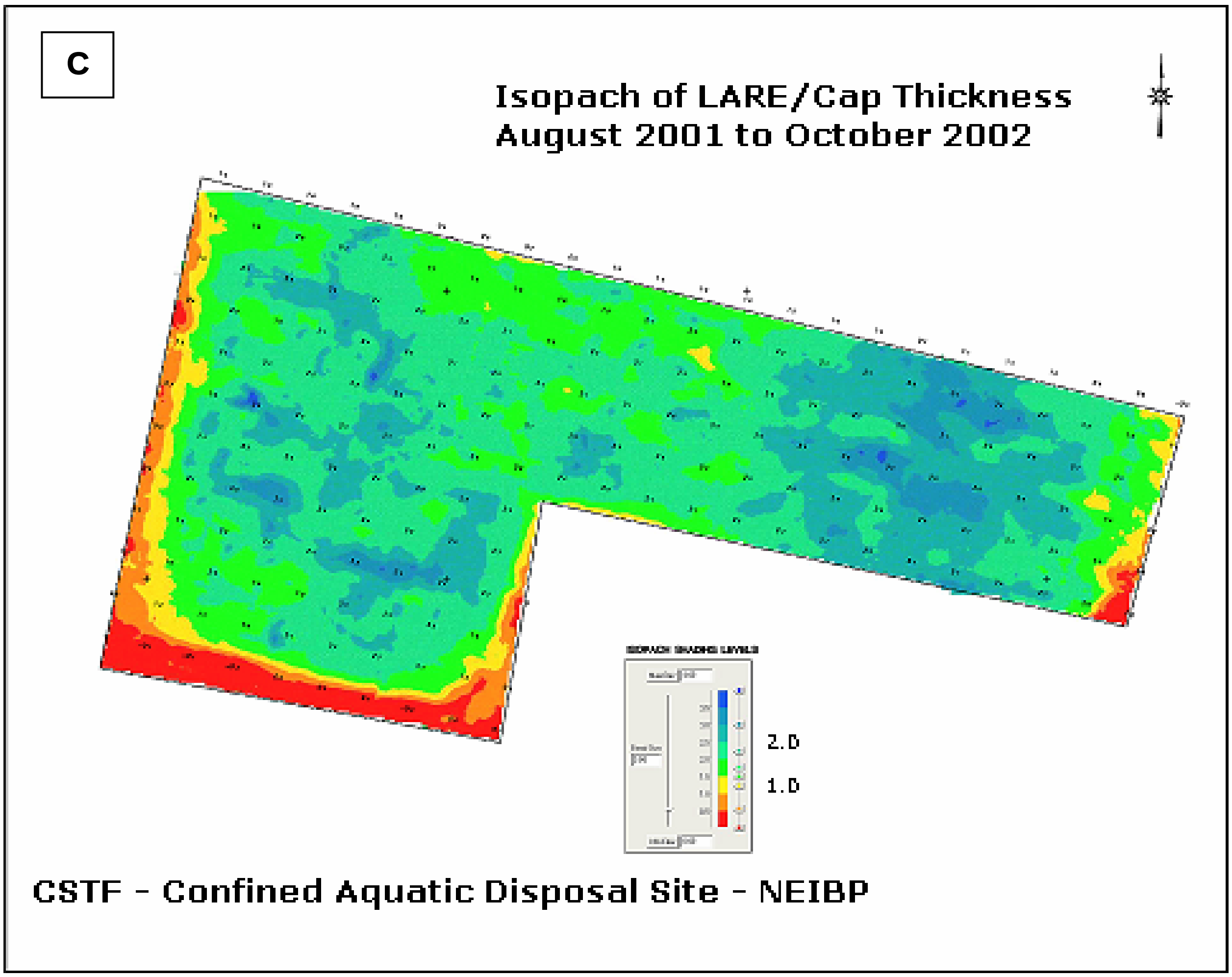


Figure 3-7. Isopach depicting the difference in CAD site surface elevations between October 2002 and August 2003. Grey area indicates no difference in elevation.

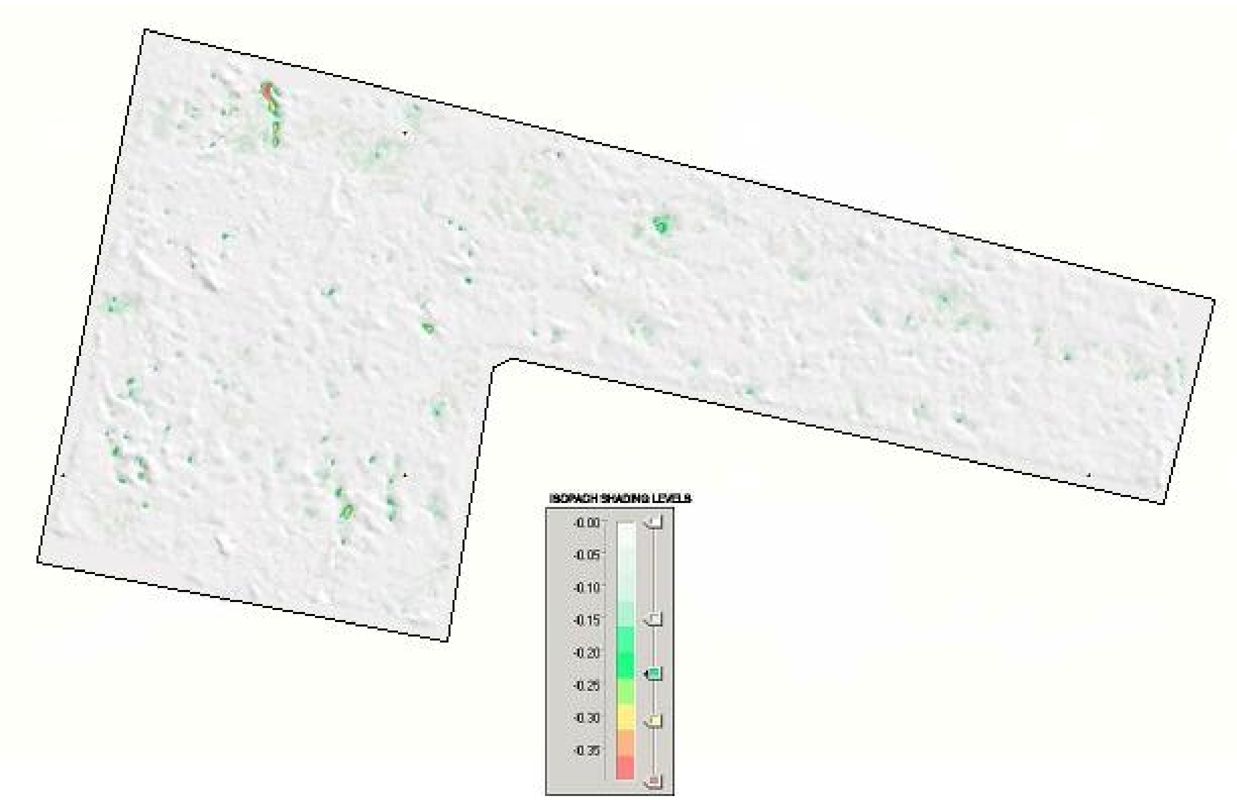


Figure 3-8. Still frames from the NEIBP CAD site video survey. Image width represents 0.28 m.

Figure 3-9. Still frames from the NEIBP CAD site video survey. Image width represents 0.28 m.

Figure 3-10. Still frames from the NEIBP CAD site video survey. Image width represents 0.28 m.

Figure 3-11. Still frames from the NEIBP CAD site video survey. Image width represents 0.28 m.

4.0 Chemical Migration in the NEIBP CAD site

The migration of contaminants through the capping material to the surface is dependent on several factors including the physical characteristics of the sediments, the partition coefficients of each contaminant, erosion or fractures in the cap material caused by currents or earthquakes, and the actions of bioturbators capable of penetrating the LARE material. The possible flux of contaminants to the surface through these processes is the major focus of this study. To investigate these processes, core samples were collected at nine sites on the NEIBP CAD site during October 2002 and August 2003. The core findings are presented below and are divided into visual observations, physical characteristics, and contaminant concentrations.

In 2002, samples were collected for analyses from the top 15 cm (surface), at the boundary between the LARE material and the cap (bottom), and at the middle point between the two (middle). In 2003 the samples were collected as in 2002, except that the middle sample was collected 3 cm above the bottom sample. This was done in an effort to make the most conservative estimate of contaminant migration into the cap material. In 2003, each of the 10 cm core layers at Station 2 were analyzed to provide a high resolution profile of contaminant concentrations through the cap. All chemistry samples were analyzed for particle size, total organic carbon, density, total solids, metals and PAH's. To investigate the possibility that organisms were transporting contaminants from the LARE to the surface sediments through bioturbation, burrow mound samples were collected and analyzed as above.

4.1 Visual Core Observations

2002

In 2002 the average total penetration of the nine core samples was 197 cm (Table 4-1). The minimum required core penetration into the LARE material (15 cm) was met in all cases and averaged 88 cm (min = 50, max = 130 cm). Samples from all layers included 15 cm of core material. All core surface samples were collected from zero to 15 cm. The transition zone from the cap material to the LARE material (bottom) exceeded one meter at all stations except for at Stations 8 (60 to 75 cm) and 9 (75 to 90 cm). Middle core samples ranged in depth from 35 to 50 cm (Station 8) to 45 to 60 cm (Stations 7 and 9, respectively).

Neither new depositional material nor evidence of bioturbation was observed in any of the core samples. All surface and middle core sediments were dark grey, composed of sand, contained large amounts of shell hash and were odorless. The LARE material was black, composed of course silt and had an odor of petroleum. The demarcation between the cap and LARE material was easily visible. Digital photos of the Station 9 core are shown in Figure 4-1 and are representative of all CAD site core samples taken during the survey.

2003

In 2003 the average total penetration of the nine core samples was 201 cm (Table 4-2). The minimum required core penetration into the LARE material (15 cm) was met in all cases and averaged 100 cm (min = 52, max = 181 cm). Core samples from all layers included 10 cm of core material. All core surface samples were collected from zero to 10 cm. The transition zone from the cap material to the LARE material (bottom) exceeded one meter at all stations except for at Stations 2 (88 to 98 cm) and 7 (88 to 98 cm).

Neither new depositional material nor evidence of bioturbation was observed in any of the core samples. All surface and middle core sediments were dark grey, composed of sand and contained large amounts of shell hash. Each of these was odorless except at Stations 7 and 8 where H_2S was detected in both the surface and middle layer and Station 10 in the middle layer. The LARE material was black, composed of fine silt and had an odor of petroleum. The demarcation between the cap and LARE material was easily visible. Digital photos of Station 9 are shown in Figure 4-2 and are representative of all CAD site core samples.

4.2 Physical and Chemical Characteristics of Core and Burrow Mound Sediments

Analyses for particle size, density, total organic carbon (TOC), total solids (TS), metals and PAH's were conducted on 27 (9 stations x 3 layers each) core layer samples collected during the October 2002 and August 2003 surveys. In 2002 six burrow mound samples were collected from the NEIBP CAD site. Since metals concentrations were elevated in these samples, additional burrow mound and non-burrow mound surface sediment samples were collected in 2003. Sampling included six burrow mound and six non-burrow mound surface samples from the NEIBP CAD site, plus three burrow mound and three non-burrow mound surface samples from harbor sediments outside the borrow pit.

So that comparisons could be made between the concentrations of each constituent in the surface, middle and bottom core layers, results were averaged together by core layer for all stations combined. Additionally, burrow mound sample results from the NEIBP CAD site were averaged for each constituent and presented with the core layer results. Averaged results of all core and burrow mound samples are presented in Figures 4-3 to 4-17 and Tables 4-3 and 4-6. Raw particle size and chemistry results for core and burrow mound samples can be found in Appendix C - Core and Burrow Mound Particle Size and Chemistry, Table C-1 to C-10.

4.2.1 Particle Size

Particle size measurements taken of the capping, LARE and burrow mound material were used to detect any mixing or movement of sediments within or through the cap. The physical characteristics and distribution of particles in the burrow mounds and nine core stations are summarized in Tables 4-3 and 4-4 and Figures 4-3 and 4-4. Raw results are presented in Appendix C, Tables C-1 to C-3.

2002

The CAD site surface and middle core layers were composed of sand (91 and 85%, respectively) and the bottom LARE material, while still high in sand, contained a much higher percentage of fines (45%) (Table 4-3). The surface and middle core layers were characterized as fine sand while the bottom LARE material was composed of very fine sand. Burrow mound sediments were similar in composition to the core bottom samples, contained 45% fines and 55% sand, and were characterized as very fine sand. The dispersion of particle sizes for all of the core layers and burrow mounds were relatively heterogeneous, being either poorly or very poorly sorted. However, the difference between the cap material and the burrow and LARE material was evident as index values in both the burrow mound and bottom samples were greater (1.80 and 2.10, respectively) than the surface and middle core layers (1.08 and 1.25, respectively).

Figure 4-3 shows the distribution of particles in the core layers and burrow mound samples. The burrow mound and bottom core sediments were more widely distributed or heterogeneous, while the surface and middle core samples were more narrowly distributed or homogeneous. Three of the six burrow mound samples contained a greater proportion of larger sand particles indicating that the cap material probably mixed with these predominantly finer particles. Three of the nine bottom core samples also contained greater proportions of larger sand particles. This could be the result of cap material mixing with the finer LARE material at the transition zone. In each case this mixing was most likely an artifact of sampling.

2003

As in 2002 the surface and middle core layers were composed of sand (76 and 75%, respectively) compared to the bottom LARE material (54% sand) (Table 4-4, Figure 4-4). Conversely, the bottom layers contained a higher percentage of fines (41%) than either the surface (20%) or middle layers (21%). Each layer was characterized as fine sand and, as in 2002, were slightly more heterogeneous (very poorly sorted) in the bottom LARE material compared to the surface and middle layers (poorly sorted).

The particle size distribution of burrow mound and surface sediments were similar to one another on the CAD site and one another on the Harbor, but differed between the two locations (Table 4-4, Figure 4-5). The composition of CAD site burrows and surface sediments were more balanced between fines (61 and 55%, respectively) and sand (39 and 45%, respectively), while the Harbor burrows and surface sediments were characterized by much greater percentages of sand (77 and 76%, respectively) than fines (23 and 23%, respectively). Both CAD site burrows and surface sediments were characterized as medium to course silt, while the Harbor burrows and surface sediments were characterized as fine sand. The distributions of particles from all Harbor samples were uni-modal with a sharp peak at 125 µm (Figure 4-5). This is in contrast to the CAD site burrow samples which were, except for one sample, composed of uniformly finer particles with a mode at 16 µm. The CAD site surface sediments were somewhat bi-modally distributed (125 and 16 µm).

4.2.2 Density, Total Organic Carbon (TOC), Total Solids (TS) & Median Particle Size

2002

Average sediment density for all stations combined was highest in the surface and middle cap samples (average = 2.64 and 2.62 g/cm^3) and was lowest in the LARE material (average = 1.83 g/cm^3) (Figure 4-6, Appendix C, Tables C-4 and C-8). Density ranged from 1.32 to 2.74 g/cm^3 for all samples. Burrow mound sediment density was similar to the surface and middle core layers (2.47 ± 0.13 g/cm^3).

TOC concentrations were highest in the LARE material (average = 1.38%) compared to the surface (average = 0.62%) and middle core samples (average = 0.47%). TOC ranged from 0.29% to 2.50%. Average burrow mound TOC concentrations was slightly higher than the surface and middle core samples (0.73%).

Total solids were similar among core depths and were only slightly lower, on average, in the LARE material (average = 67.8%) compared to the surface (average = 75.0%) and middle core samples (average = 80.3%). Burrow mound total solids were much lower than in the core layers (average = 29.8%). Total solids for all samples ranged from 23.0 to 81.8%.

Percent fine sediments were greatest in the bottom LARE material (45.26%) and burrow mound sediments (44.86%) and lowest in the surface and middle core layers (average = 8.46 and 14.34%, respectively). Percent fine grain size for all samples ranged from 2.20 to 68.13%.

2003

Average sediment density was similar in the surface, middle and bottom samples (average = 1.72, 1.58 and 1.43 g/cm^3, respectively) and lowest in the CAD site burrow mound samples (0.78 g/cm^3) (Figure 4-7, Appendix C, Tables C-5 and C-10). Density ranged from 0.78 to 1.97 g/cm^3 for all samples.

TOC concentrations were greatest in the bottom LARE material (2.37%) and similar in the surface, middle and burrow mound samples (average = 0.36, 0.49 and 0.82%, respectively). TOC ranged from 0.01% to 3.74%.

Total solids were similar among core depths and were only slightly lower, on average, in the LARE material (65.1%) compared to the surface (73.79%) and middle core samples (77.4%). Burrow mound total solids were lower than in the core layers (36.48%). Total solids for all samples ranged from 36.48 to 82.3%.

Percent fine sediments were greatest in the bottom LARE material (41.5%) and burrow mound sediments (61.0%) and smallest in the surface and middle core layers (average = 19.9 and 21.2%, respectively). Percent fine grain size for all samples ranged from 2.20 to 68.13%.

4.2.3 Metals & PAH's

Metal and PAH concentrations in the surface, middle and bottom core layers, as well as burrow mound samples are presented separately for the October 2002 and August 2003 surveys. Results were averaged within each depth zone among all NEIBP stations (± 95% CI) (Figures 4-8 and 4-10). Core data normalized to % fine sediment are presented in Figures 4-9 and 4-11. Results for the 2003 high resolution (every 10 cm) core study conducted on multiple layers from Station 2 are presented in Figure 4-12. Burrow mound and surface studies are presented in Figures 4-12 to 4-14. Temporal and historical comparisons are presented in Figures 4-15 to 4-17 and Tables 4-5 and 4-6.

2002

Of the 15 metals measured in each core layer, the average concentrations of 12 (Al, Sb, Be, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Zn) were higher in the bottom LARE material than in either the surface or middle core layers (Figure 4-8). Antimony (Sb) and mercury (Hg) were below detection limits in the surface and middle core layers, while selenium (Se) was the only metal that was below detection in the LARE material. Total PAH concentrations were an order of magnitude higher in the bottom core material (average = 2278 µg/Kg) than in either the surface or middle core layer samples (56 and 142 µg/Kg, respectively).

Burrow Mound Comparison with the Core Layers

The average concentration**s** of six of the 15 metals (Al, Sb, As, Be, Fe, Se) measured in the six burrow mound samples exceeded concentrations in the surface, middle and bottom core material (Figure 4-8). The concentrations of seven metals (Cd, Cr, Cu, Pb, Ni, Ag, Zn) were greater in the burrow mound sediments than in either the surface or middle core layers, but were less than the concentrations found in the bottom material. The concentration of barium measured in the burrow mound sediments was similar to both the middle layer and bottom material, and was greater than the surface core layer. Total PAH concentrations in the burrow mound sediments (176 ug/Kg) were similar to those measured in the surface and middle core layers, and far below those measured in the LARE material.

Data Normalization

To determine if physical sediment characteristics were a major factor contributing to contaminant concentrations in the cap and burrow mound samples, all 2002 chemistry results were normalized to the percent of fine sediments (Figures 4-9). The percentage of fine sediments was greatest in the burrow mound and LARE material. Of the 15 metals normalized, the burrow mound and LARE material concentrations of eight (Al, As, Ba, Be, Cr, Fe, Ni, Se) declined more between non-normalized and normalized results when compared to the surface and middle core layers. This would be expected if the metal concentrations were more dependent upon particle size rather than upon input from the LARE layer. The relative concentrations of antimony, mercury and silver each remained unchanged by normalization. Cadmium, copper, lead and zinc, and, in particular, total PAH concentrations were low in the burrow mound sediments, but remained elevated in the LARE material, indicating that the sources of these compounds are different between the burrow mounds and LARE material.

2003

Of the 15 metals measured in each core layer, the average concentrations of 12 (Sb, Ba, Be, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn) were higher in the bottom LARE material either than in the surface or middle core layers (Figure 4-10). Aluminum and silver concentrations were not much higher in the LARE material compared to the cap layers. None of the metals measured were below detection limits in any core layer. Total PAH concentrations were an order of magnitude higher in the bottom core material (average = 3161 µg/Kg) than in either the surface or middle core layer samples (23 and 166 µg/Kg, respectively).

Burrow Mound Comparison with the Core Layers

The average concentration of five (Al, As, Be, Fe and Ag) of the 15 metals measured in the six burrow mound samples exceeded concentrations in the surface, middle and bottom core material (Figure 4-10). The concentrations of five other metals (Sb, Cd, Cu, Pb and Zn) were greater in the burrow mound sediments than in either the surface or middle core layers, but were less than the concentrations found in the bottom material. The concentrations of four metals (Ba, Cr, Ni, Se) were similar in the burrow mound samples and the bottom LARE material. Total PAH concentrations in the burrow mound sediments (564 µg/Kg) were slightly higher than those measured in the surface and middle core layers, but far below those measured in the LARE material (3161 ug/Kg).

Data Normalization

To determine if physical sediment characteristics were a major factor contributing to contaminant concentrations in the cap and burrow mound samples, all 2003 chemistry results were normalized to % fine sediments (Figures 4-11). The percentage of fine sediments was greatest in the burrow mound samples, followed closely by the LARE material. Of the 15 metals normalized, the burrow mound and LARE material concentrations of nine (Al, Sb, Ar, Ba, Be, Cr, Fe, Ni, Se) decreased in comparison to the surface and middle core layers. This would be expected if the metals concentrations were more dependent on particle size rather than input from the LARE layer. The relative concentrations of cadmium, mercury and silver each remained unchanged by normalization. Cadmium, copper, lead and zinc concentrations were lower in the burrow mound sediments, but remained elevated in the LARE material, indicating that the sources of these metals were different between the burrow mounds and LARE material.

4.3 2003 Core Resolution Study

Results of the high resolution core study conducted at Station 2 during 2003 are presented in Figure 4-12. The density for all core layers were greatest at the surface and just above the LARE/cap interface, and lower at all other depths. TOC was above 2% in the bottom LARE material and below 1% in each of the cap layers. Total solids were similar at all depths (80%) though slightly lower in the bottom LARE material (<70%). Percent fine sediments were greatest in the bottom LARE material (63%), followed by the 60-70 cm cap layer (42%). Percent fines at all other core layers were below 20%.

Except for silver, the concentrations of each of the 15 metals measured were lower in the cap material than in the bottom LARE layers. Of note are the metals concentrations measured in the layer collected only 3 cm above the LARE/cap interface. In no case were metals concentrations elevated above that found in the bottom LARE sample which indicated that, as yet, the migration of contaminants up into the cap had not occurred.

Silver concentrations were elevated in the middle of the cap and were undetected in the lower portion of the cap and bottom material. This might indicate the transport of silver to the CAD site from the SEIBP during capping operations. However, all concentrations were very low and near to the method detection limit (MDL = 0.01 mg/Kg).

4.4 2003 Burrow Mound Study

The concentrations of metals and PAH's collected in sediments from NEIBP CAD site burrow mounds and the associated surface sediments were not greatly different from one another, but were, on average, slightly higher in the burrow mound samples (Figure 4-13). Metals concentrations from Harbor burrow mounds and the associated surface sediments were also nearly the same. In every case, metals concentrations from either the CAD site burrows or surface sediments were the same or slightly greater than those measured from the Harbor burrows or surface sediments.

A clear cut pattern was not evident when surface and burrow mound metal results were compared to core measurements. Several metal results (Al, As, Be, and Fe) were higher in burrow mound and surface sediments, than in either the surface and bottom core samples. For the rest, concentrations were higher in the burrow mound and surface sediments than in the surface core samples, but equal to or below the concentrations measured in the LARE.

Data Normalization

To determine if physical sediment characteristics were a major factor contributing to contaminant concentrations in the burrow mound and surface sediment samples, all results were normalized to % fine sediments (Figures 4-14). In most cases, normalized CAD site, burrow mound and surface sediment concentrations were almost identical indicating that the slight differences between them were likely the result of sediment particle size. The results from the Harbor burrow and surface sediments were very different however. In nearly every case, the normalized concentrations measured in the Harbor burrows and surface sediments were greater than the normalized concentration in the CAD site burrows and surface sediments. Since the burrow mounds and surface sediments from the Harbor are coarser than those from the CAD site, normalization tends to greatly elevate contaminant concentrations there.

4.5 Temporal Comparison of Coring Results

Comparison of coring results for both the 2002 and 2003 surveys by core layer are presented in Figure 4-15. There was no indication that major changes in contaminant concentrations were occurring for any of the three core layer depths between years. Of the 14 metals measured, the concentrations of eight (Al, Ar, Ba, Be, Cd, Cr, Pb, Zn) were not greatly different for any of the three core depths between 2002 and 2003. Three metals, antimony, mercury and selenium, were either not detected or only detected in one core layer in 2002, but were detected in all three core layers in 2003. Copper concentrations were higher in the surface and middle core layers in 2003 compared to 2002, while nickel was higher in the mid core layer in 2003. Silver concentrations were near detection in all layers during both years, except in the bottom LARE material in 2002 when it was measured in concentrations several orders of magnitude higher.

4.6 Comparison to Pre-Capping Survey & Biological Screening Thresholds

Percent fine sediments, total organic carbon, total solids, metals and total PAH concentrations measured in the NEIBP CAD site were compared to concentrations measured during a pre-capping survey conducted in February 2001 (Chambers 2001) (Figure 4-16 and 4-17, Tables 4-5 and 4-6). During the pre-capping survey, sediments were collected from three sources: the Los Angeles River Estuary (dredge sediments, n = 8); the SEIBP (cap sediments, n = 4); and, the NEIBP before the Los Angeles River dredge and cap materials were distributed (NEIBP pre-cap, n = 4). Bottom LARE material collected during both the 2002 and 2003 surveys were compared against the LA River dredge sediments and NEIBP pre-cap sediments. The surface and middle core layers (cap material) collected during the 2002 and 2003 surveys were averaged together for comparison against the 2001 SEIBP cap sediments. Additionally, these data were compared to two screening level thresholds of biological concern developed by Long *et. al.* (1995). These thresholds are the effects range low (ERL), which represents a concentration below which adverse biological effects should rarely be observed, and the effects range median (ERM), which represents a concentration above which adverse biological effects may frequently be observed.

Post Capping NEIBP LARE Sediments vs. Pre Capping LA River Dredge & NEIBP Sediments

During both 2002 and 2003 the percent fines sediments measured in the bottom LARE material were half that measured in the LA River dredge and NEIBP pre-cap sediments (Figure 4-16, Tables 4-5 and 4-6). Since the cap material was composed of a high percentage of sand, the lower percentage of fines in the bottom LARE material may be the result of mixing that occurred at the boundary between the LARE and cap during sampling. TOC measured in the LARE material during 2002 was slightly lower than for all other surveys. Total solids were similar for the bottom LARE material in 2002 and 2003 and LARE dredge material, but NEIBP pre capping sediments had only about half as much.

Of the ten chemical constituents that could be compared, concentrations were similar between the CAD LARE in both 2002 and 2003 and the LARE dredge material for eight compounds (arsenic, cadmium, chromium, copper, lead, nickel, zinc and total PAHs). Sediments from the pre-cap NEIBP survey in 2001 were elevated above the CAD LARE and LARE dredge material for arsenic, chromium and nickel, and were lower in cadmium and PAHs. Mercury concentrations were just above detection in CAD LARE sediments collected in 2002 and much higher in each of the other surveys. Similarly, concentrations of silver neared detection limits in CAD LARE sediments in 2003, but were much higher in sediments from the other surveys.

NEIBP Surface and Middle Core Layers vs. SEIBP Capping Sediments

The concentration of percent fines, TOC and total solids were similar in both the NEIBP cap material and SEIBP sediments (Figure 4-11 and Tables 4-5 and 4-6). Of the ten chemical constituents that could be compared, sediment concentrations of four were similar in all three surveys (arsenic, cadmium, chromium and silver). The concentrations of five metals (Cu, Pb, Hg, Ni and Zn) were lower in NEIBP cap sediments in 2002 compared to the other surveys. PAHs were not detected in sediments collected from the SEIBP in 2001 but were detected and similar in concentration during both the 2002 and 2003 NEIBP surveys.

ERL/ERM Threshold limits

Ten metals and total PAHs were compared against the ERL/ERM threshold limits (Tables 4-5 and 4-6). For the bottom LARE material collected in 2002, the average concentration of five metals exceeded the ERL threshold limit (cadmium, copper, lead, nickel and zinc). Additionally, the maximum concentrations of five constituents exceeded the ERL (cadmium, chromium, copper, silver and PAHs) and two exceeded the ERM (nickel and zinc). During 2003, the same five metals exceeded the ERL for the bottom LARE material (cadmium, copper, lead, nickel and zinc), in addition to mercury. The maximum concentrations of six constituents exceeded the ERL (cadmium, chromium, copper, mercury, nickel and PAHs). Only zinc exceeded the ERM threshold value in 2003.

Average metal concentrations measured in sediments from the LA River dredge material exceeded the ERL for five of the nine metals (cadmium, copper, lead, mercury and zinc). The maximum concentrations of arsenic, nickel and silver exceeded the ERL and the maximum concentration of zinc exceeded the ERM. Total PAH's in the LA River pre-dredge sediments were below the threshold limits.

Six of the NEIBP pre-cap sediment metals concentrations exceeded the ERL (arsenic, copper, lead, mercury, nickel and zinc). For each of these, even their minimum concentrations exceeded the ERL threshold level. The ERM was not exceeded by any of these metals and the total PAH concentrations were well below the threshold limits.

None of the constituents measured from either the NEIBP cap or SEIBP sediments exceeded the ERL limits.

4.7 Summary

During the first two years of monitoring the NEIBP CAD site, evidence of contaminant migration into or through the cap from the LARE dredge material was not observed. Core samples revealed a clear boundary layer between the LARE material, which was fine, black, and smelled of petroleum and the capping material which was dark grey, odorless sand. The depth of the overlying cap material met the one meter depth design criteria for the study based on penetration depths of the cores collected during both surveys. Neither burrows created by bioturbators nor surface depositional materials from outside the CAD site were observed in any of the cores. Lack of deposition on the surface of the cores was probably related to the dispersion of these fine particles by the bow wake created by the sampling device. During both video surveys, divers noted that the CAD site was covered by a fine layer of depositional material up to 3 cm in depth (Chapter 3).

The composition of the CAD site cap was primarily of sand (>70%). This was expected since the capping material was derived from the SEIBP which has a high sand content. Large amounts of shell hash were also present in the cap material. The LARE material was also mostly sand, but had a higher content of finer particles than the overlying capping material. Because the samples for particle size and chemistry were collected at the boundary of the cap and LARE material, it is probable that mixing occurred during sampling, thus increasing the sand content of the LARE material.

Of the 15 metals and total PAHs measured, none were elevated in the cap material compared to concentrations found in the LARE. During each survey, the concentrations of two metals (arsenic and barium in 2002, aluminum and silver in 2003) were not significantly different in the cap versus the LARE. Total PAH concentrations, considered to be the best marker for the LARE material, were orders of magnitude lower in the cap material than in the LARE. Between the 2002 and 2003 surveys, two procedural changes were made so that contaminant migration at the interface between the cap and LARE material could be investigated further. First, the middle core layer sample was collected just 3 cm above the LARE material instead of at the half way point between the surface and LARE material. Second, a high resolution core study was conducted at a single station in which core layer samples were analyzed in 10 cm increments through the core and to a depth of 20 cm into the LARE material. Neither of these approaches showed any evidence that contaminants were migrating into the cap material. Additionally, when the concentrations of metals and PAHs were compared between years by core layer, no differences were observed. This indicated that the concentrations of contaminants in the cap material were not changing over time.

Metal and PAH concentrations measured in the NEIBP CAD site were compared to concentrations measured during a pre-capping survey conducted in February 2001 (Chambers 2001). The contaminant concentrations measured in the LARE material from the CAD site were compared against their source material, Los Angeles River Estuary sediments, and the pre-capped NEIBP sediments. Concentrations of metals and total PAHs measured in the CAD LARE material and the Los Angeles River Estuary was very similar between surveys. The concentration of two metals (arsenic and chromium) in the pre-capped NEIBP were higher compared to both the LARE material and Los Angeles River Estuary, but was lower in total PAHs. Concentrations of metals were similar between the NEIBP capping material and SEIBP. Concentrations of PAHs were below detection in the SEIBP, but were slightly elevated during both years in the NEIBP cap material.

The Effects Range Low (ERL) threshold level was exceeded for several metals and PAHs in both the CAD site LARE material and Los Angeles River Estuary pre cap sediments during both surveys. In addition the maximum concentrations of several metals exceeded the Effects Range Medium (ERM) levels. None of the constituents measured from either the NEIBP cap or SEIBP sediments exceeded the ERL limits.

Bioturbators were not observed in the core samples during either year, but during video surveys across the CAD site, burrow mounds were clearly evident and abundant. Sediment samples from these mounds in 2002 revealed elevated concentrations of several of target metals, in several cases above those measured in the LARE material. Further investigation in 2003 led to the collection of both burrow mound and surface samples from the CAD site and surrounding Harbor sediments. These samples showed that while in some cases metals concentrations were elevated in the burrow mounds, they were likewise elevated in surface sediment samples without burrows. It appears that the elevated metals concentrations in the burrow and surface sediment samples were the result of deposition from the surrounding harbor. Similarly, PAH concentrations in the LARE were nearly an order of magnitude higher than in the burrow mounds, supporting the supposition that the burrow mounds are not composed of LARE material.

Table 4-1. October 2002 general observations and measurements for nine cores collected in from the NEIBP CAD site.

	Station								
	2	3	4	5	6	7	8	9	10
Total Penetration Depth (cm)	163	193	196	235	214	235	168	194	178
LARE Penetration Depth (cm)	50	77	84	85	78	130	103	114	78
Mid Sample Depth (cm)	60-75	60-75	60-75	75-90	75-90	45-60	30-45	45-60	75-90
Bottom Sample Depth (cm)	105-120	105-120	105-120	135-150	135-150	105-120	60-75	75-90	135-150
New Surface Deposition	N	N	N	N	N	N	N	N	N
Bioturbation Present	N	N	N	N	N	N	N	N	N
Surface Composition	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash
Mid Composition	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash
Bottom Composition	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt
Surface Color	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey
Mid Color	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey
Bottom Color	Black	Black	Black	Black	Black	Black	Black	Black	Black
Surface Odor	None	None	None	None	None	None	None	None	None
Mid Odor	None	None	None	None	None	None	None	None	None
Bottom Odor	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum

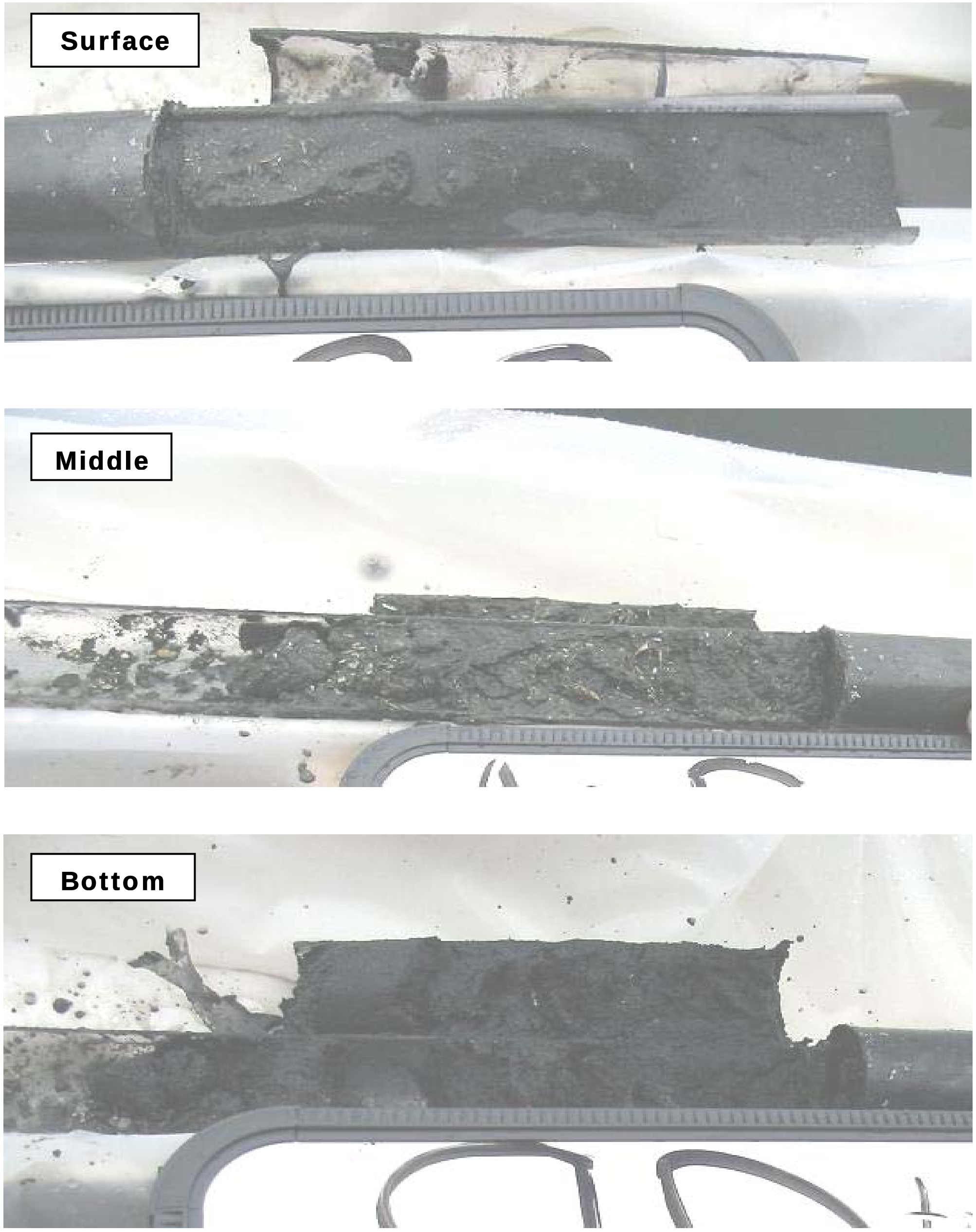


Figure 4-1. 2002 digital photos of Station 9 core layers from the NEIBP CAD site at the Surface (0-15 cm) Middle (45-60 cm), and Bottom (75-90 cm).

Table 4-2. August 2003 general observations and measurements for nine cores collected from the NEIBP CAD site.

	NEIBP Core Stations								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total Penetration Depth (cm)	140	171	207	280	194	210	217	185	211
LARE Penetration Depth (cm)	52	71	140	181	63	122	79	85	105
Mid Sample Depth (cm)	76-84	78-88	121-130	85-96	119-129	75-85	126-136	87-97	93-103
Bottom Sample Depth (cm)	88-98	90-100	140-150	99-114	131-141	88-98	138-150	100-110	106-116
New Surface Deposition	N	N	N	N	N	N	N	N	N
Bioturbation Present	N	N	N	N	N	N	N	N	N
Surface Composition	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash
Mid Composition	Sand/Shell Hash	Sand/Shell Hash	Sand/Clay/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash	Sand/Shell Hash
Bottom Composition	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt	Fine silt
Surface Color	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey
Mid Color	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey	Drk Grey
Bottom Color	Black	Black	Black	Black	Black	Black	Black	Black	Black
Surface Odor	None	None	None	None	None	H_2S	H_2S	None	None
Mid Odor	None	None	None	None	None	H_2S	H_2S	None	H_2S
Bottom Odor	Petroleum	Petroleum	None	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum

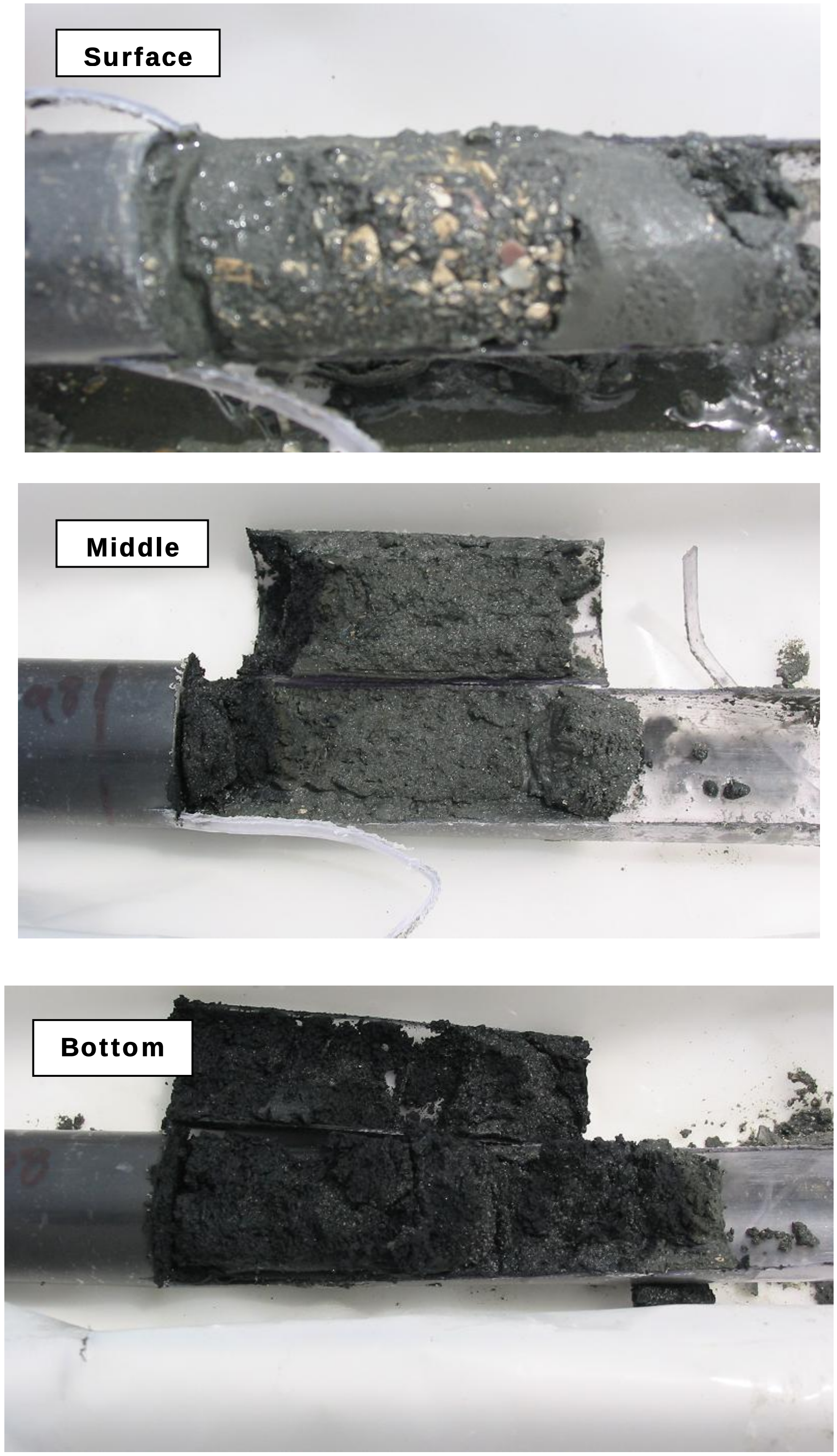


Figure 4-2. 2003 digital photos of Station 9 core layers from the NEIBP CAD site at the Surface (0-10 cm) Middle (76-84 cm), and Bottom (88-98 cm).

Table 4-3. Averaged particle sizes (µm and phi) measured in core and burrow mound samples collected in October 2002 from the NEIBP CAD site.

	Partitioned Fractions (%)				Percentile (microns)			Percentile (phi)			Dispersion or Sorting Index [2.]	Category [1.]	Sorting [2.]
Sample ID	Sand	Silt	Clay	Fines	16%	median [1.] 50%	84%	16%	median 50%	84%			
Burrow Mounds	55.1	40.8	4.0	44.9	19.0	68.8	170.8	6.4	4.4	2.8	1.80	very fine sand	poorly sorted
Surface	91.6	8.1	0.4	8.5	66.5	145.6	287.6	4.0	2.8	1.8	1.08	fine sand	poorly sorted
Mid	85.6	13.4	0.9	14.3	55.6	132.3	267.8	4.4	3.0	1.9	1.25	fine sand	poorly sorted
Bottom	54.7	42.4	2.9	45.3	14.5	65.7	222.4	6.5	4.2	2.3	2.10	very fine sand	very poorly sorted

[1.] Median: 0-4 = clay, 4-8 = very fine silt, 8-16 = fine silt, 16-31 = medium silt, 31-63 = coarse silt, 63-125 = very fine sand, 125-250 = fine sand, 250-500 = medium sand, 500-1000 = coarse sand.

[2.] Sorting Index: <0.35 = very well sorted, 0.35-0.50 = well sorted, 0.50-0.71 = moderately well sorted, 0.71-1.00 = moderately sorted, 1.0-2.0 = poorly sorted, 2.0-4.0 = very poorly sorted, >4.0 = extremely poorly sorted.

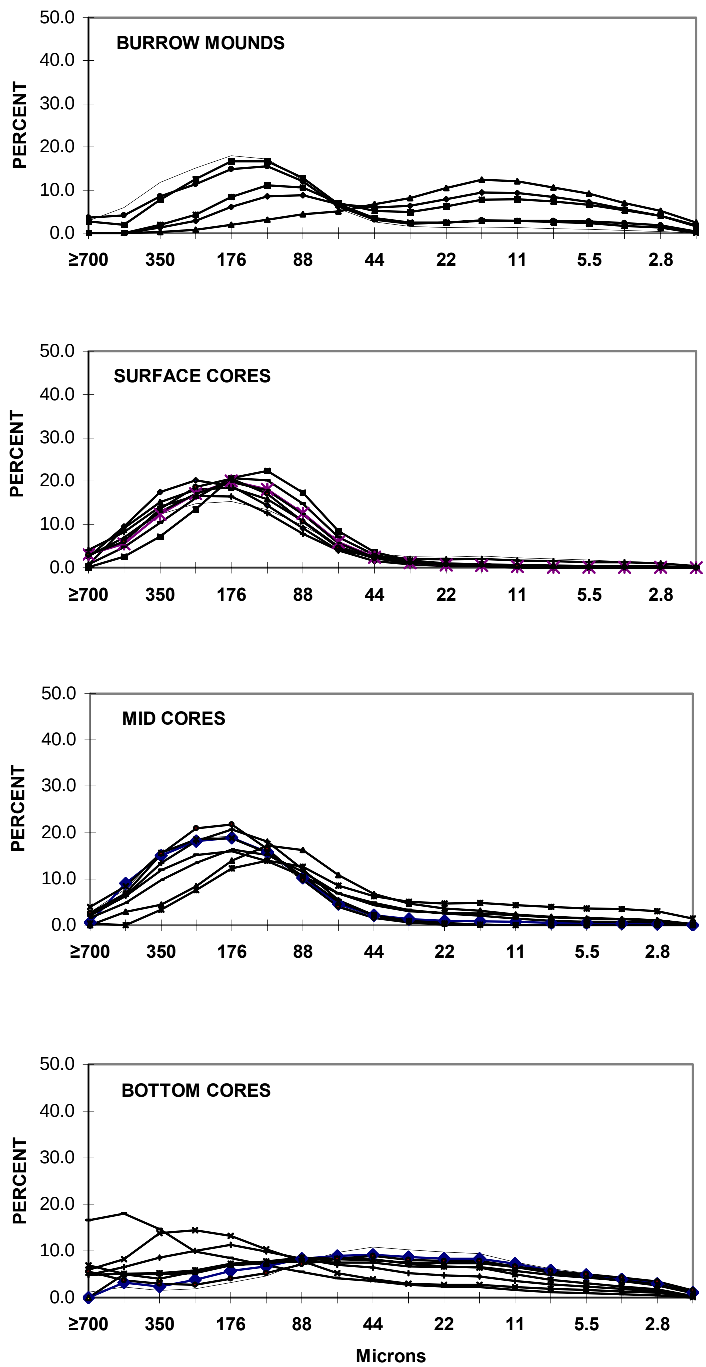


Figure 4-3. Particle sizes (µm and phi) measured in burrow mound and core samples collected from the NEIBP CAD site in October 2002.

Table 4-4. Averaged particle sizes (µm and phi) measured in core and burrow mound samples collected in August 2003 from the NEIBP CAD site.

Sample Type	Partitioned Fractions (%) Sand	Silt	Clay	Fines	Percentile (microns) 16%	median [1.] 50%	84%	Percentile (phi) 16%	median 50%	84%	Dispersion or Sorting Index [2.]	Category [1.]	Sorting [2.]
Burrow Mounds													
CAD Burrows	39.0	54.9	6.1	61.0	4.9	26.9	83.8	7.7	5.6	3.6	2.0	Medium Silt	poorly sorted
CAD Surface	45.0	49.0	6.1	55.0	5.1	35.4	113.2	7.7	5.0	3.2	2.2	Course Silt	very poorly sorted
Harbor Burrows	77.1	20.3	2.5	22.9	17.0	81.2	124.8	5.9	3.6	3.0	1.5	Very Fine Sand	poorly sorted
Harbor Surface	76.1	21.3	2.7	23.9	15.9	78.3	123.8	6.0	3.7	3.0	1.5	Very Fine Sand	poorly sorted
CAD Cores													
Surface	76.7	19.6	0.3	19.9	51.5	135.8	304.5	4.8	2.9	1.8	1.5	fine sand	poorly sorted
Mid	75.1	21.1	0.4	21.5	48.6	152.9	454.1	5.1	2.8	1.2	1.9	fine sand	poorly sorted
Bottom	54.0	41.4	0.1	41.5	21.0	133.4	429.1	6.0	3.6	1.6	2.2	fine sand	very poorly sorted

[1.] Median (µ): 0-4 = clay, 4-8 = very fine silt, 8-16 = fine silt, 16-31 = medium silt, 31-63 = coarse silt, 63-125 = very fine sand, 125-250 = fine sand, 250-500 = medium sand, 500-1000 = coarse sand.

[2.] Sorting Index: <0.35 = very well sorted, 0.35-0.50 = well sorted, 0.50-0.71 = moderately well sorted, 0.71-1.00 = moderately sorted, 1.0-2.0 = poorly sorted, 2.0-4.0 = very poorly sorted, >4.0 = extremely poorly sorted.

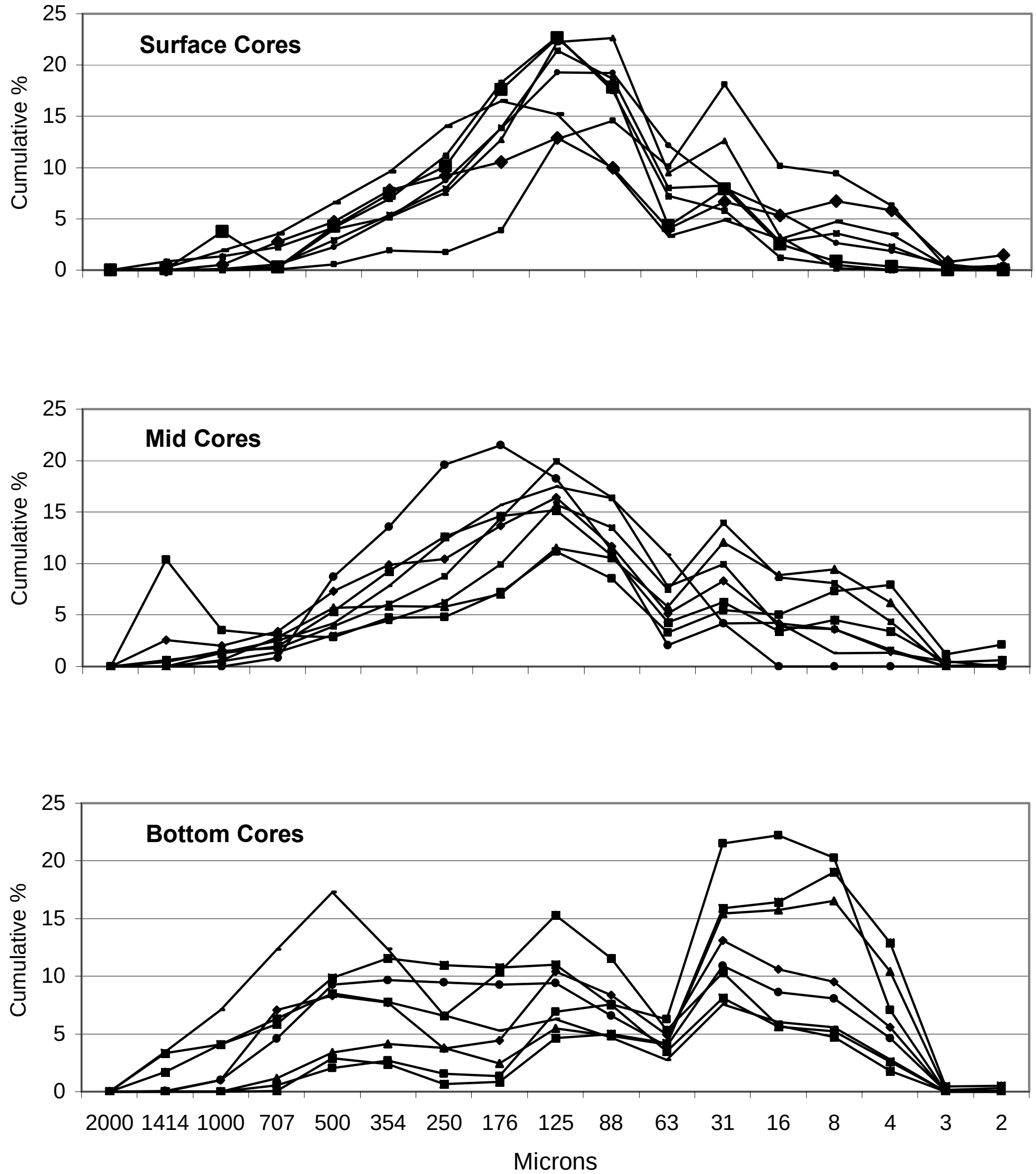


Figure 4-4. Particle sizes (µm and phi) measured in core samples collected from the NEIBP CAD site in August 2003.

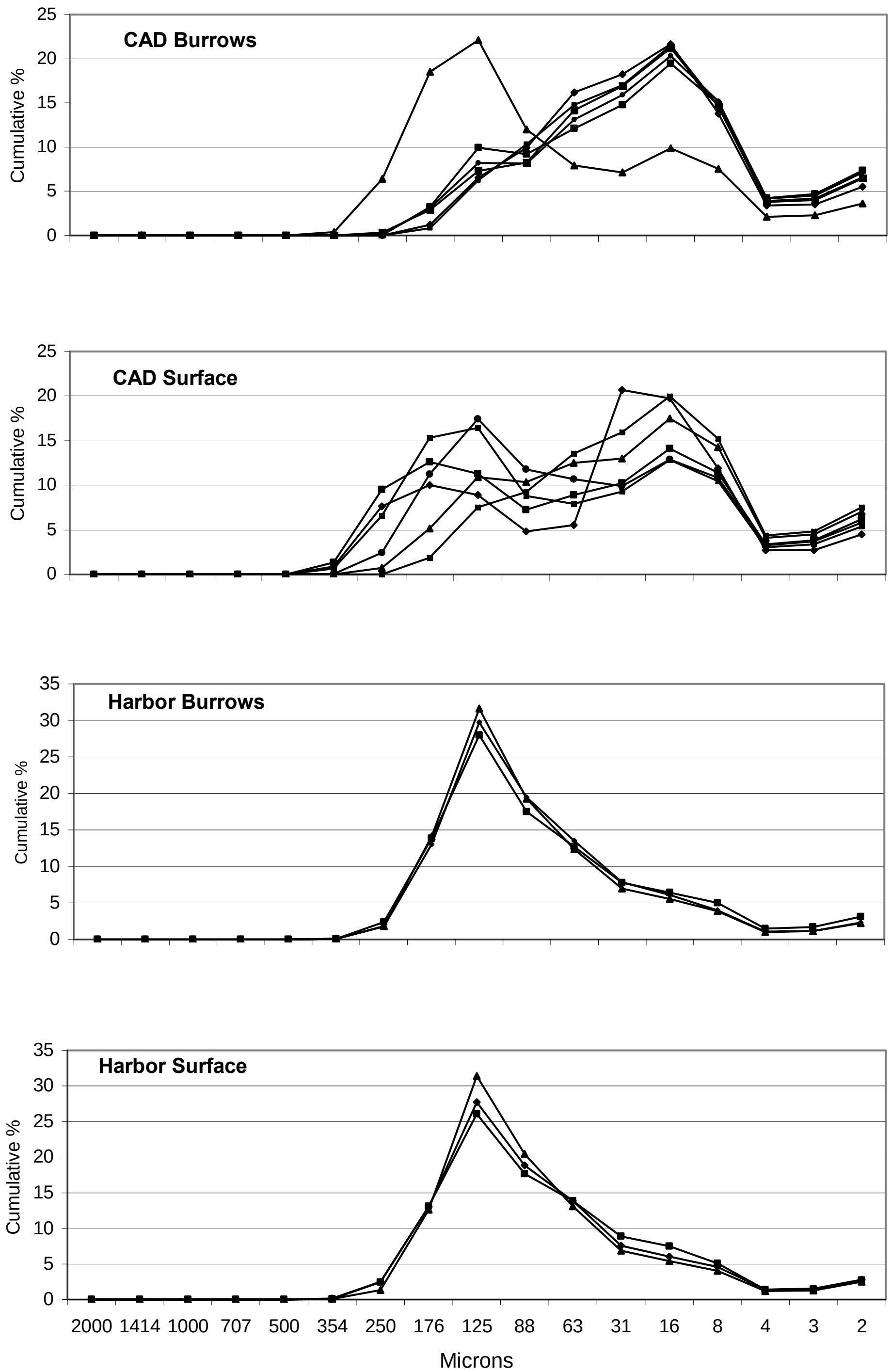


Figure 4-5. Particle sizes (µm and phi) measured in burrow mound and surface sediment samples collected from the NEIBP CAD site and surrounding harbor in August 2003.

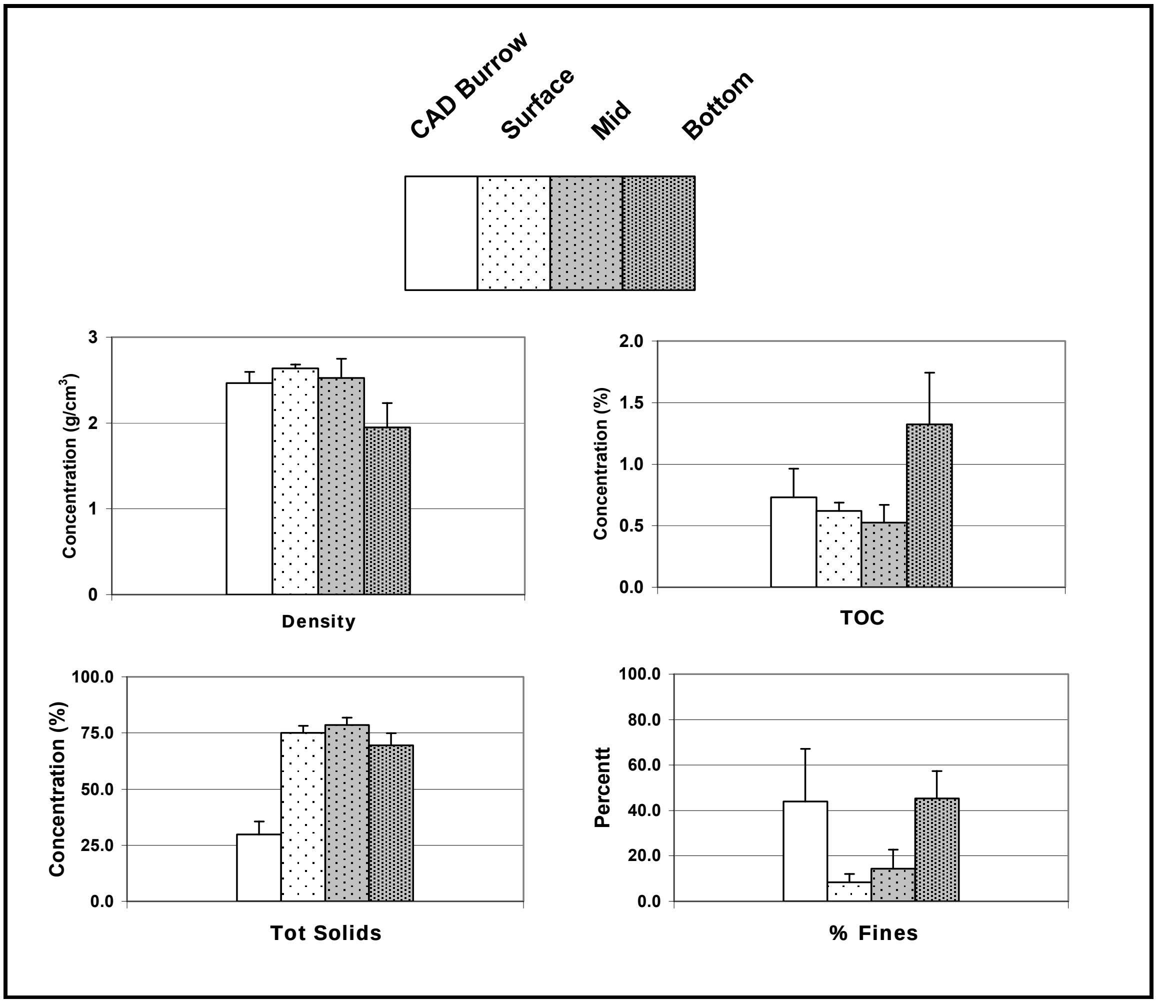


Figure 4-6. October 2002 NEIBP CAD site core chemistry. Combined average concentrations by core depth (surface, middle, bottom) (n=9) and burrow mound samples (n=6) for density, total organic carbon, total solids and median grain size. Error bars represent 95% confidence intervals.

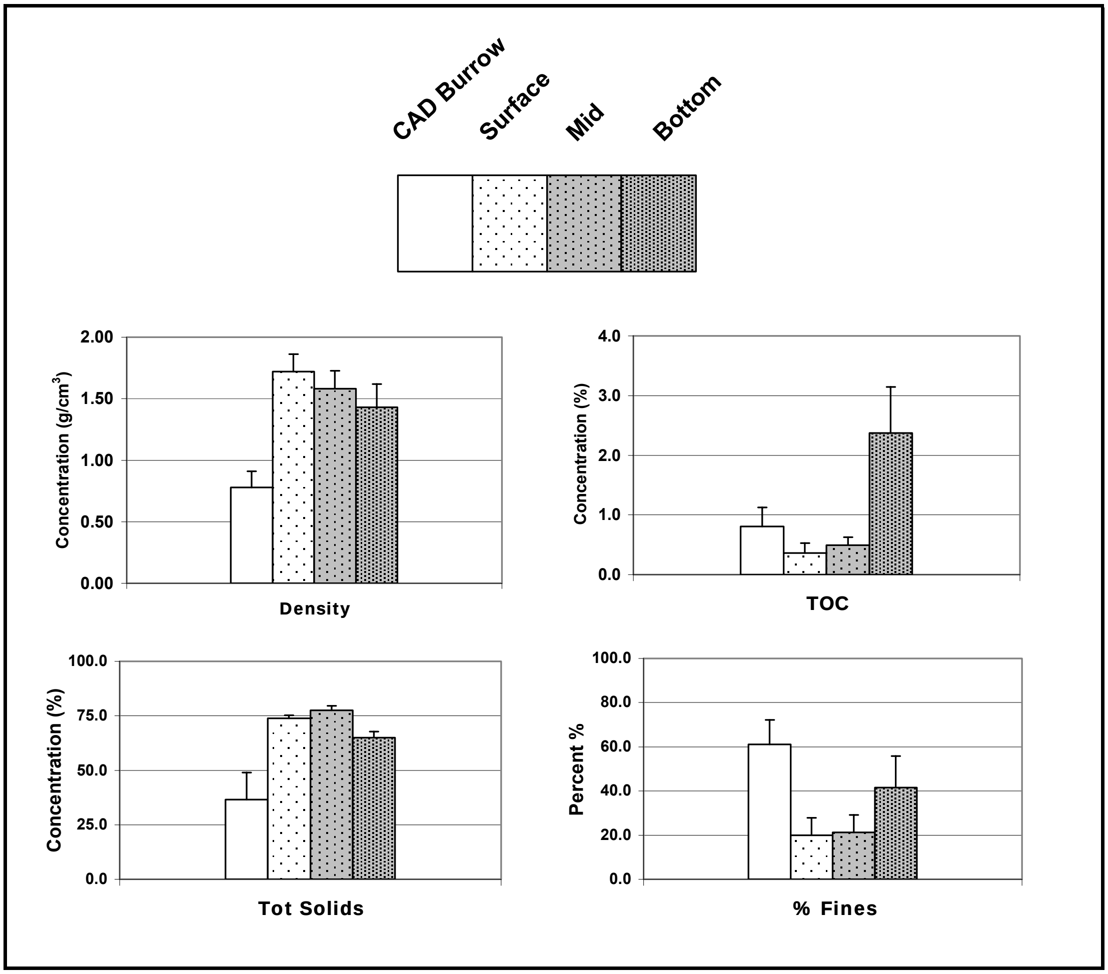


Figure 4-7. August 2003 NEIBP CAD site core chemistry. Combined average concentrations by core depth (surface, middle, bottom) (n=9) and burrow mound samples (n=6) for density, total organic carbon, total solids and median grain size. Error bars represent 95% confidence intervals.

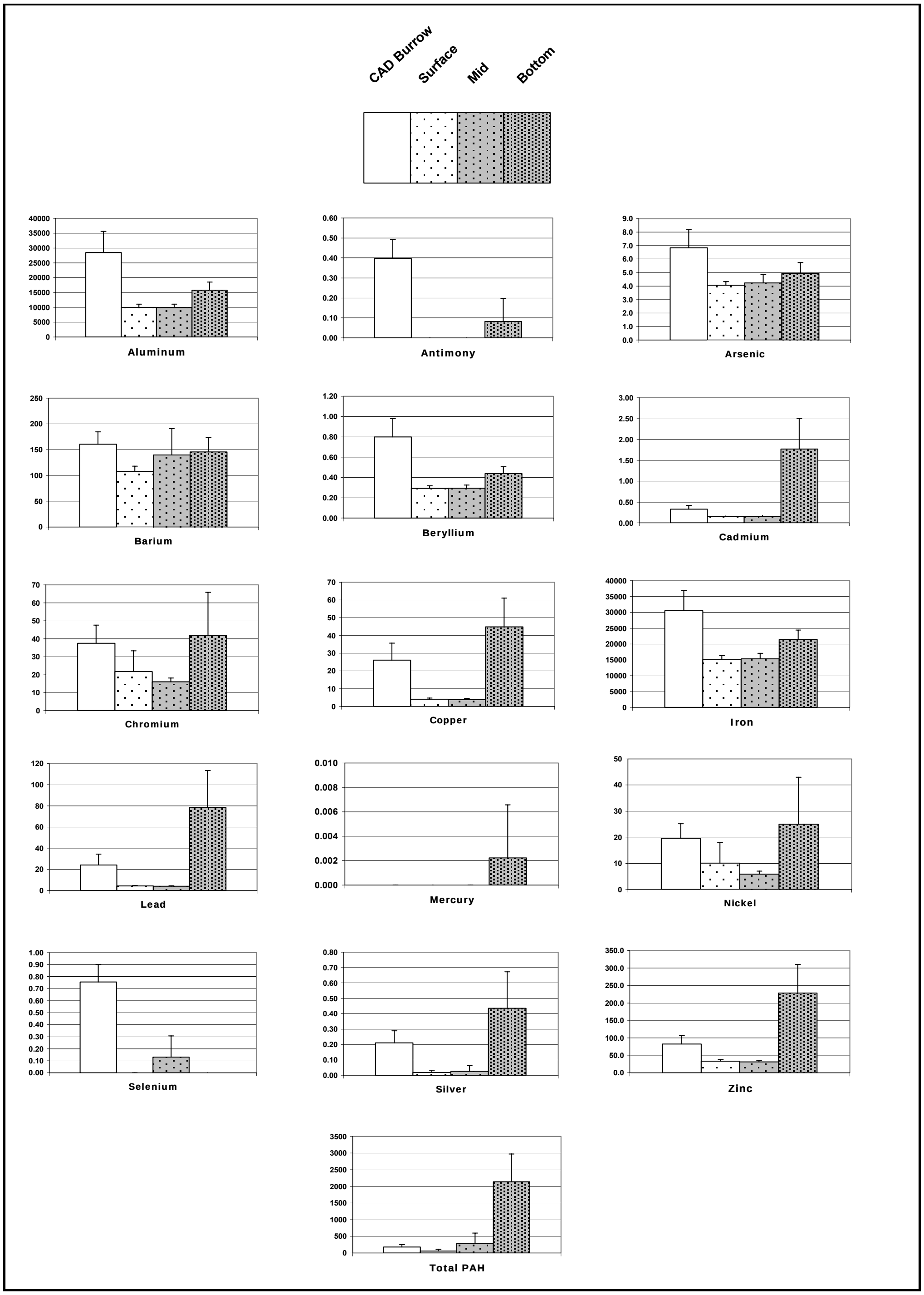


Figure 4-8. October 2002 NEIBP CAD site average metals (mg/Kg dry weight) and total PAH (µg/Kg dry weight) concentrations for each core sample depth (n = 9) and burrow mound (n = 6) samples combined. Error bars represent 95% confidence intervals.

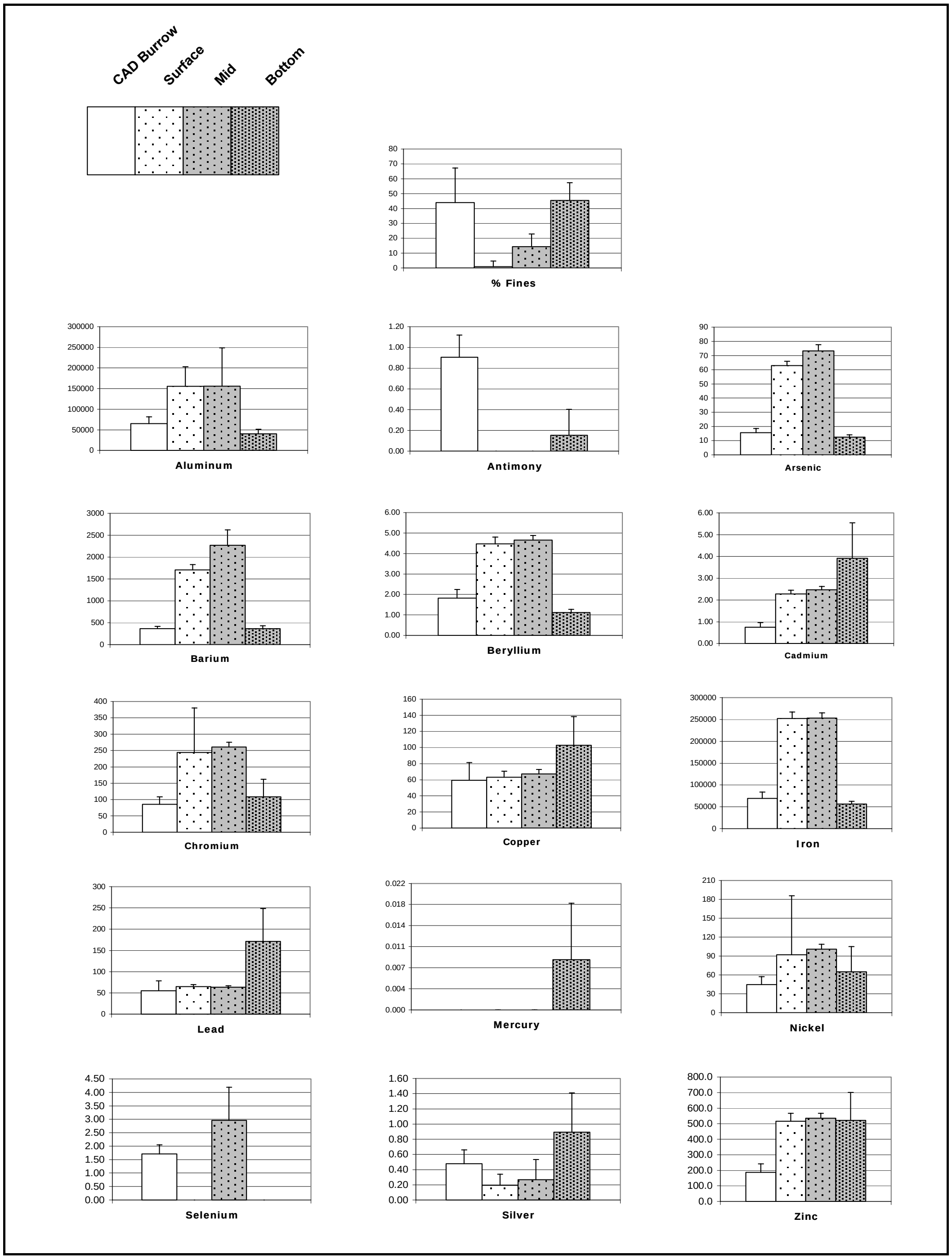


Figure 4-9. 2002 average core (n = 9) and burrow mound (n = 6) metal concentrations (mg/Kg dry weight) by core sample depth **normalized to % fine sediments**. Error bars represent 95% confidence intervals.

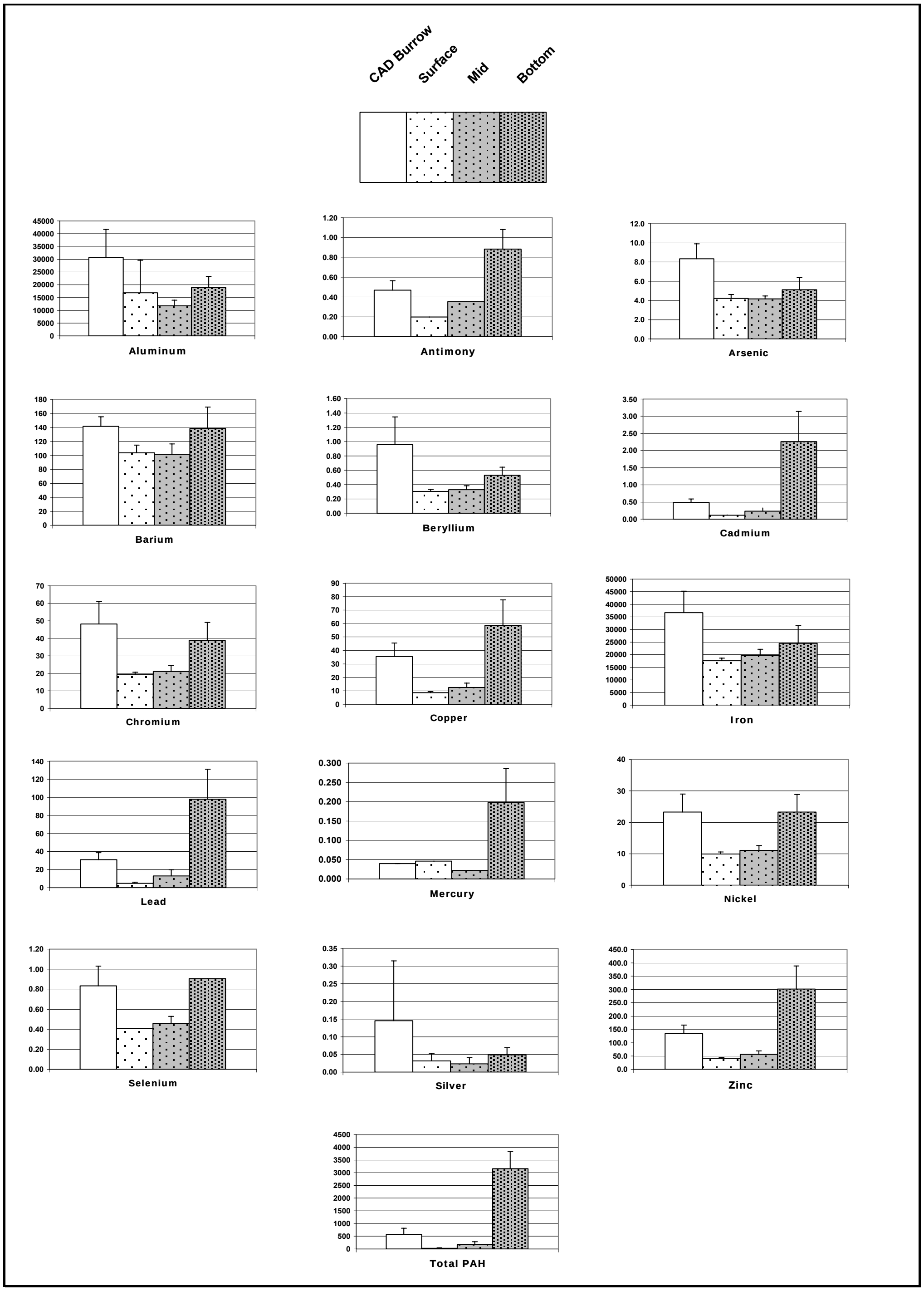


Figure 4-10. August 2003 NEIBP CAD site average metals (mg/Kg dry weight) and total PAH (µg/Kg dry weight) concentrations for each core sample depth (n = 9) and burrow mound (n = 6) samples combined. Error bars represent 95% confidence intervals.

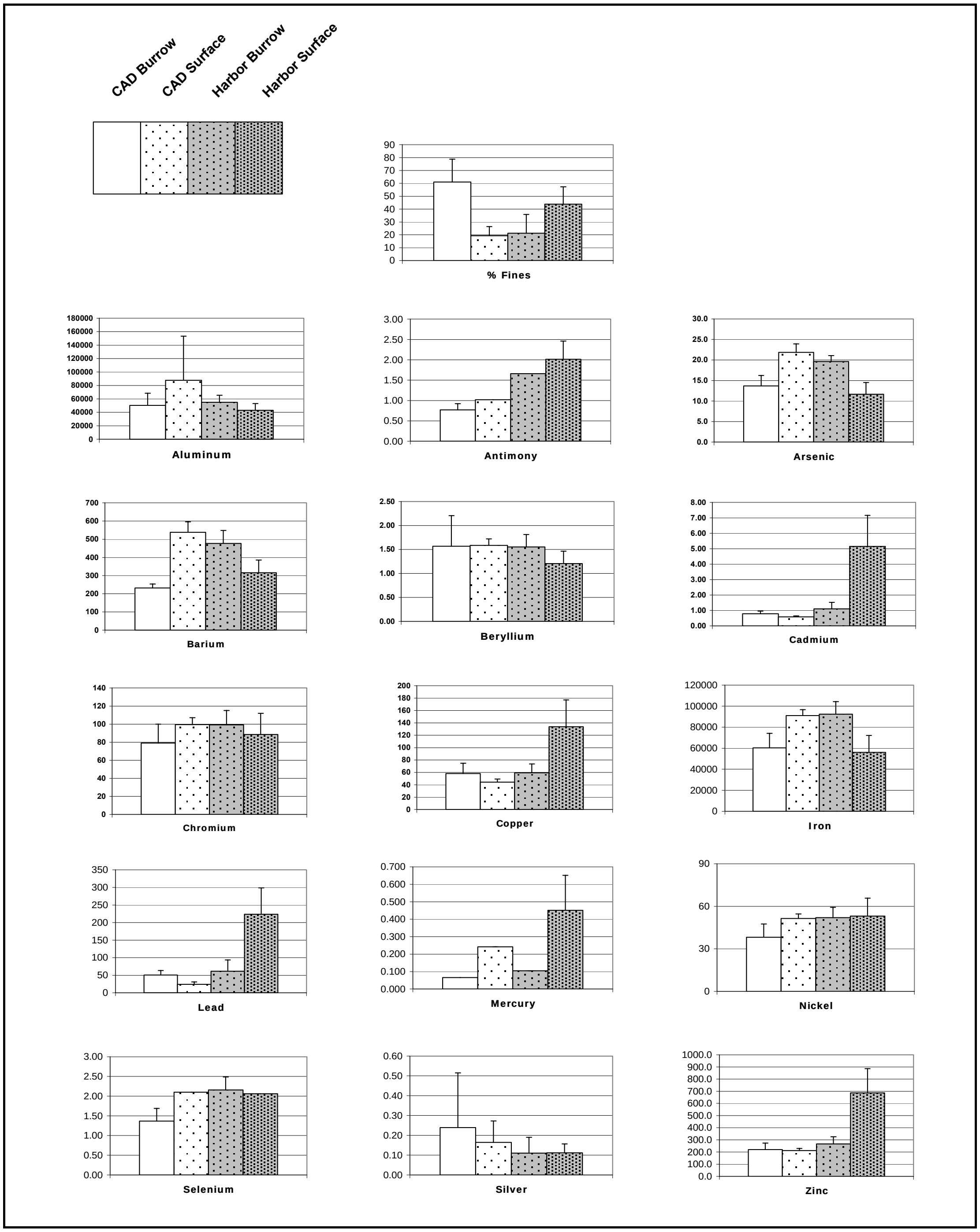


Figure 4-11. 2003 average core (n = 9) and burrow mound (n = 6) metal concentrations (mg/Kg dry weight) by core sample depth **normalized to % fine sediments**. Error bars represent 95% confidence intervals.

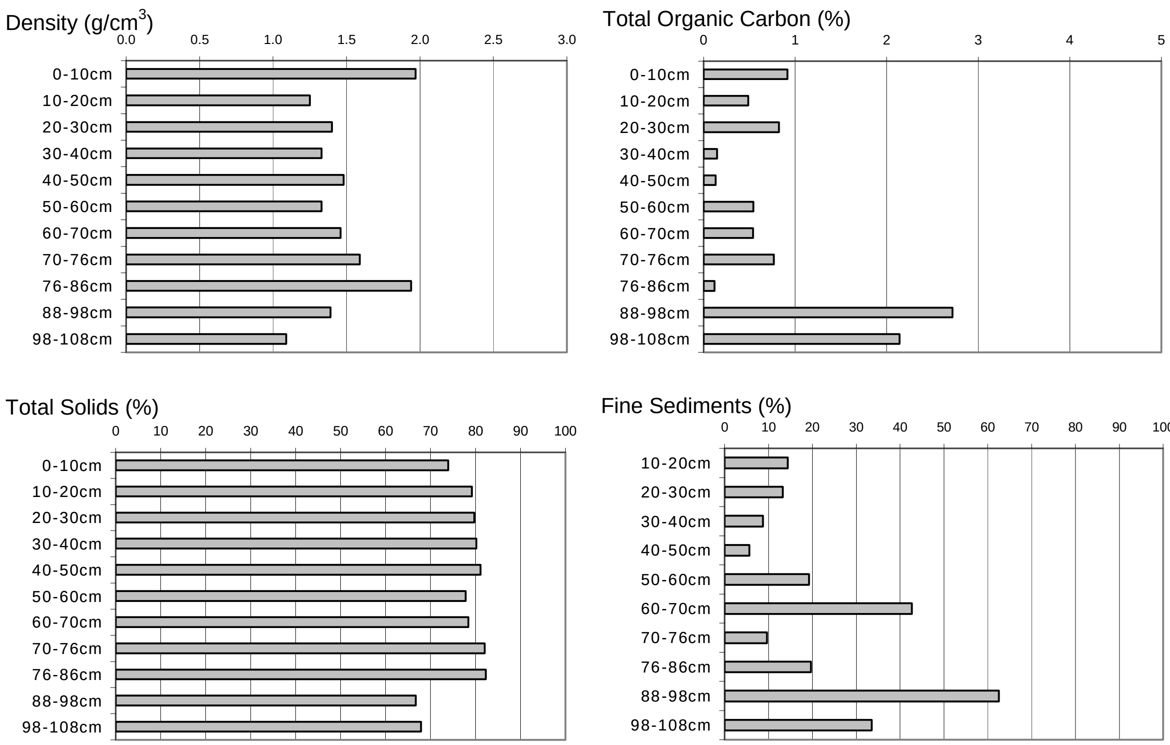


Figure 4-12. 2003 high resolution core study. Results for each 10 cm sediment core layer collected at Station 2. Concentrations for each constituent are presented at the top of each x axis and depth (cm) is plotted on the y axis. The cap material includes layers 0-10 cm to 76-86 cm. The LARE material begins at the 88-98 cm layer. Blue vertical lines on the mercury and silver graphs represent the method detection limits (MDLs).

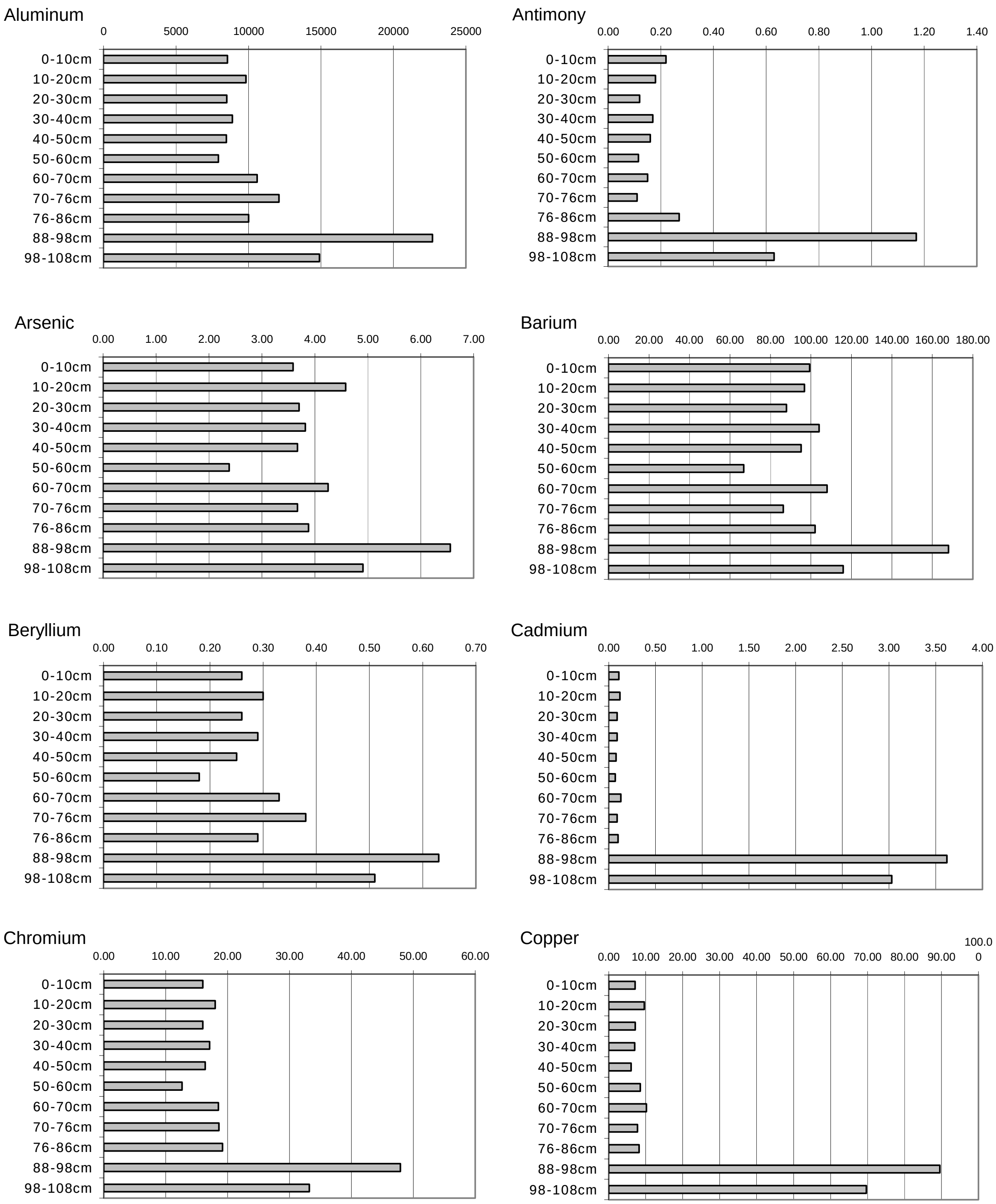


Figure 4-12. Continued

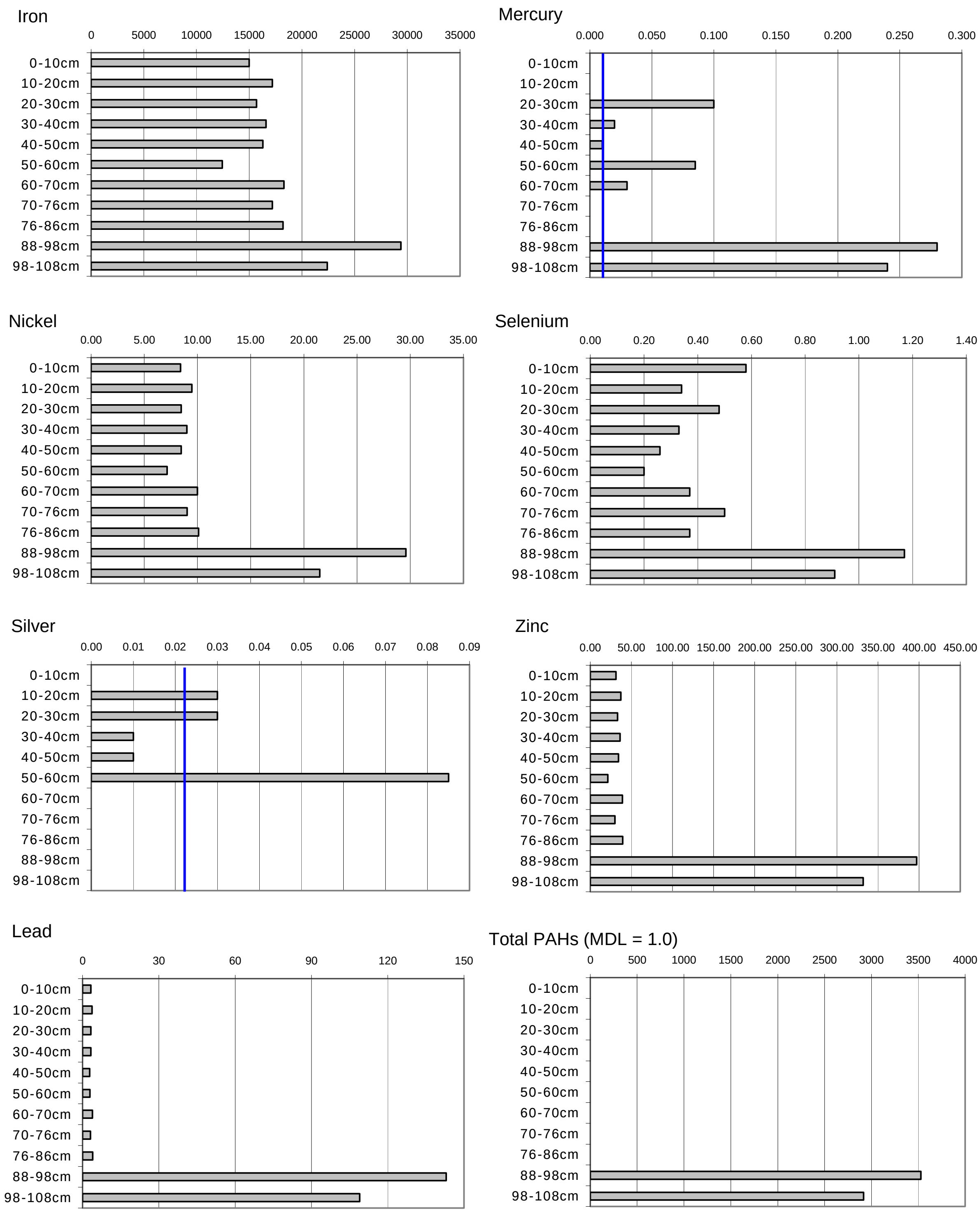


Figure 4-12. Continued

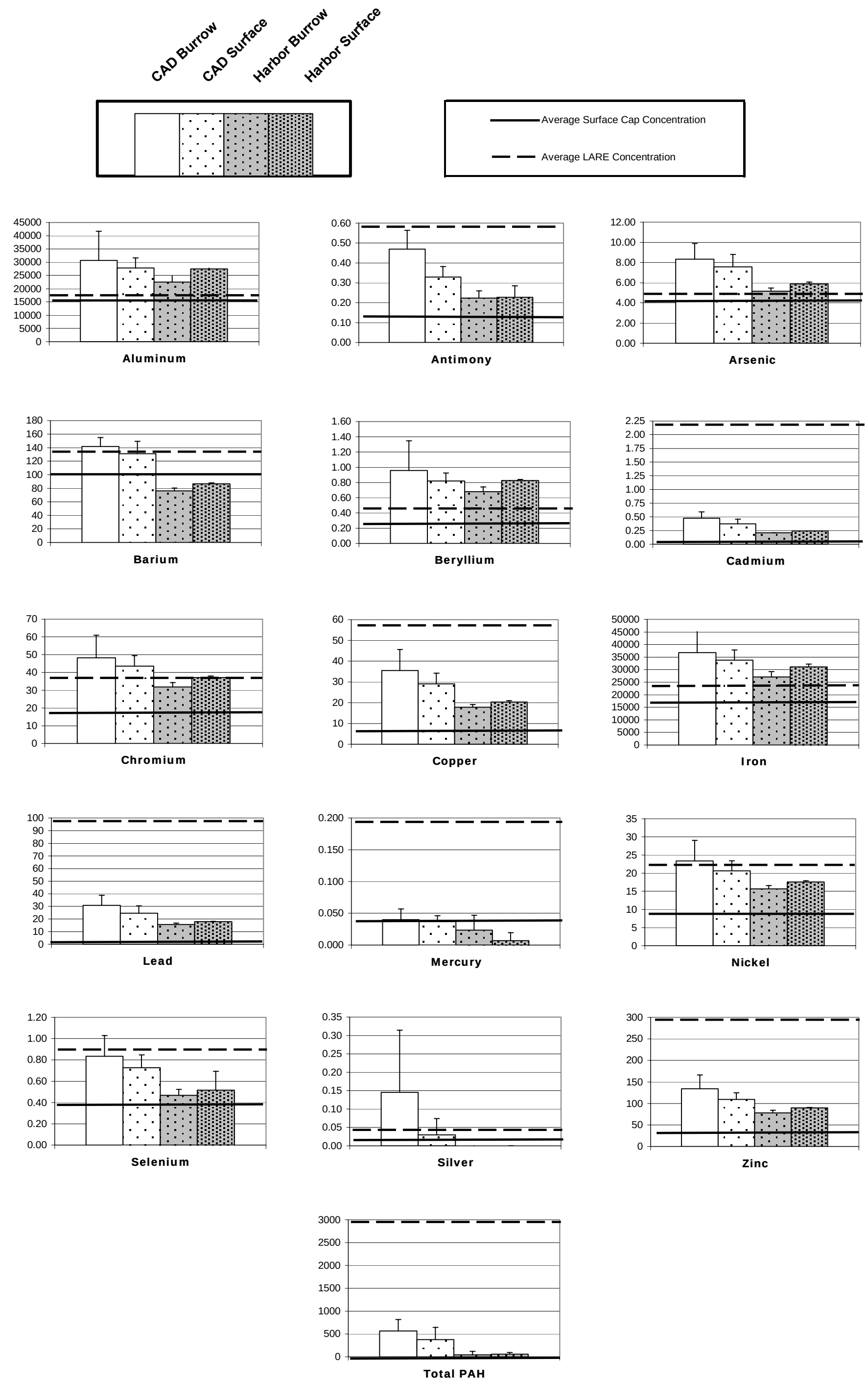


Figure 4-13. 2003 average burrow mound metal concentrations (mg/Kg dry weight) for CAD site burrow (n = 6) and surface sediments (n = 6) and Harbor burrow (n = 3) and surface sediments (n = 3). These concentrations are compared to the average surface (solid line) and LARE (dashed line) material from the core samples. Error bars represent 95% confidence intervals.

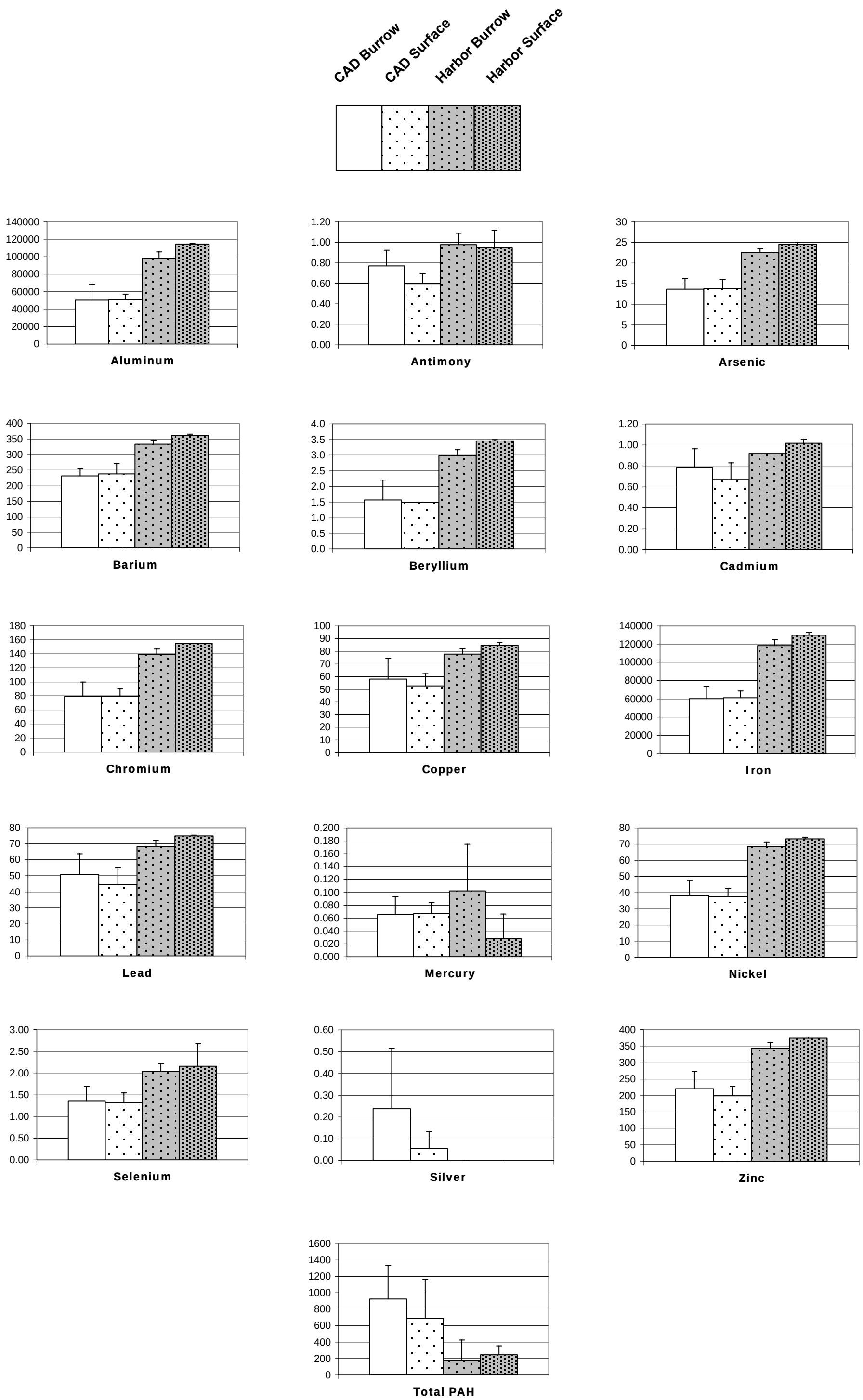


Figure 4-14. 2003 average burrow mound metal concentrations (mg/Kg dry weight) **normalized to % fine sediments** for CAD site burrow (n = 6) and surface sediments (n = 6) and Harbor burrow (n = 3) and surface sediments (n = 3). Error bars represent 95% confidence intervals.

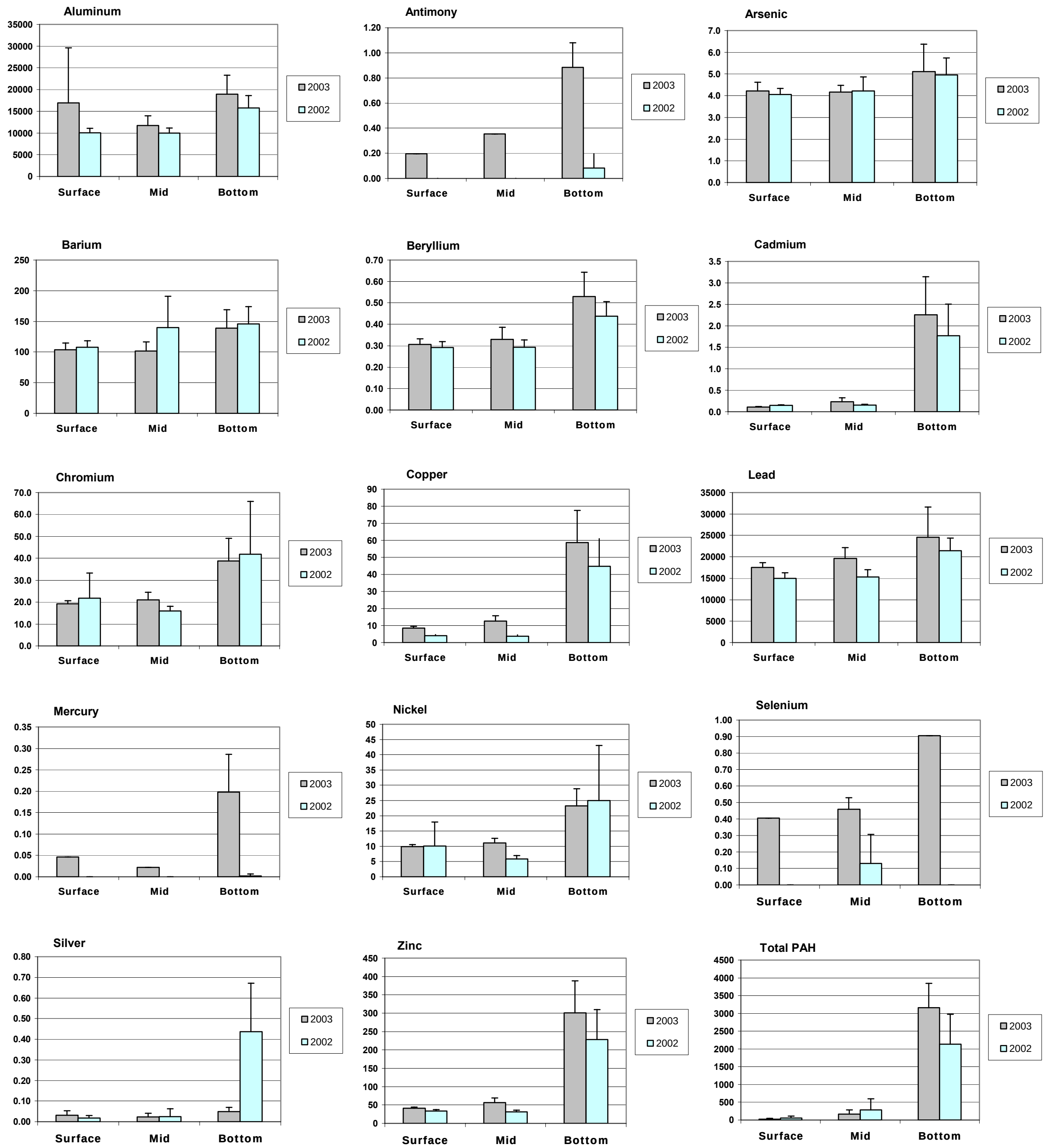


Figure 4-15. Comparison of 2002 and 2003 average metals (mg/Kg dry weight) and PAH's (ug/Kg dry weight) concentrations at surface, middle and bottom core layers. 2002 middle core samples were collected at the middle point between the core surface and LARE material. 2003 middle core samples were collected 3 cm above the LARE/cap interface.

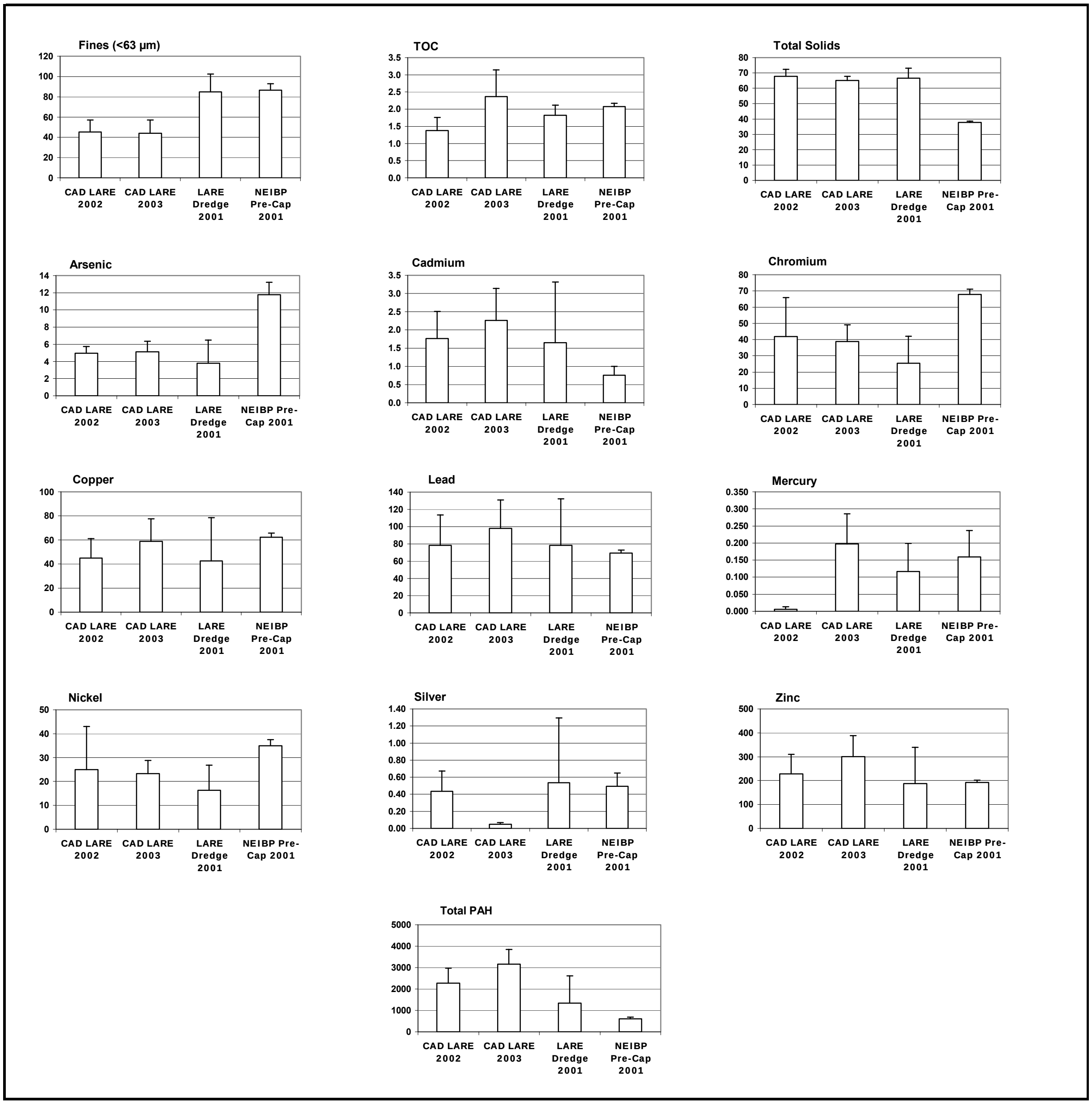


Figure 4-16. Average concentrations (± 95% CI) of constituents measured from the bottom LARE material collected in the NEIBP CAD Site during both the 2002 and 2003 post capping surveys (n=9) vs. sediments collected in core samples from the Los Angeles River Estuary (n=8) and box core samples from the NEIBP (n = 4) prior to dredge disposal (Chambers 2001).

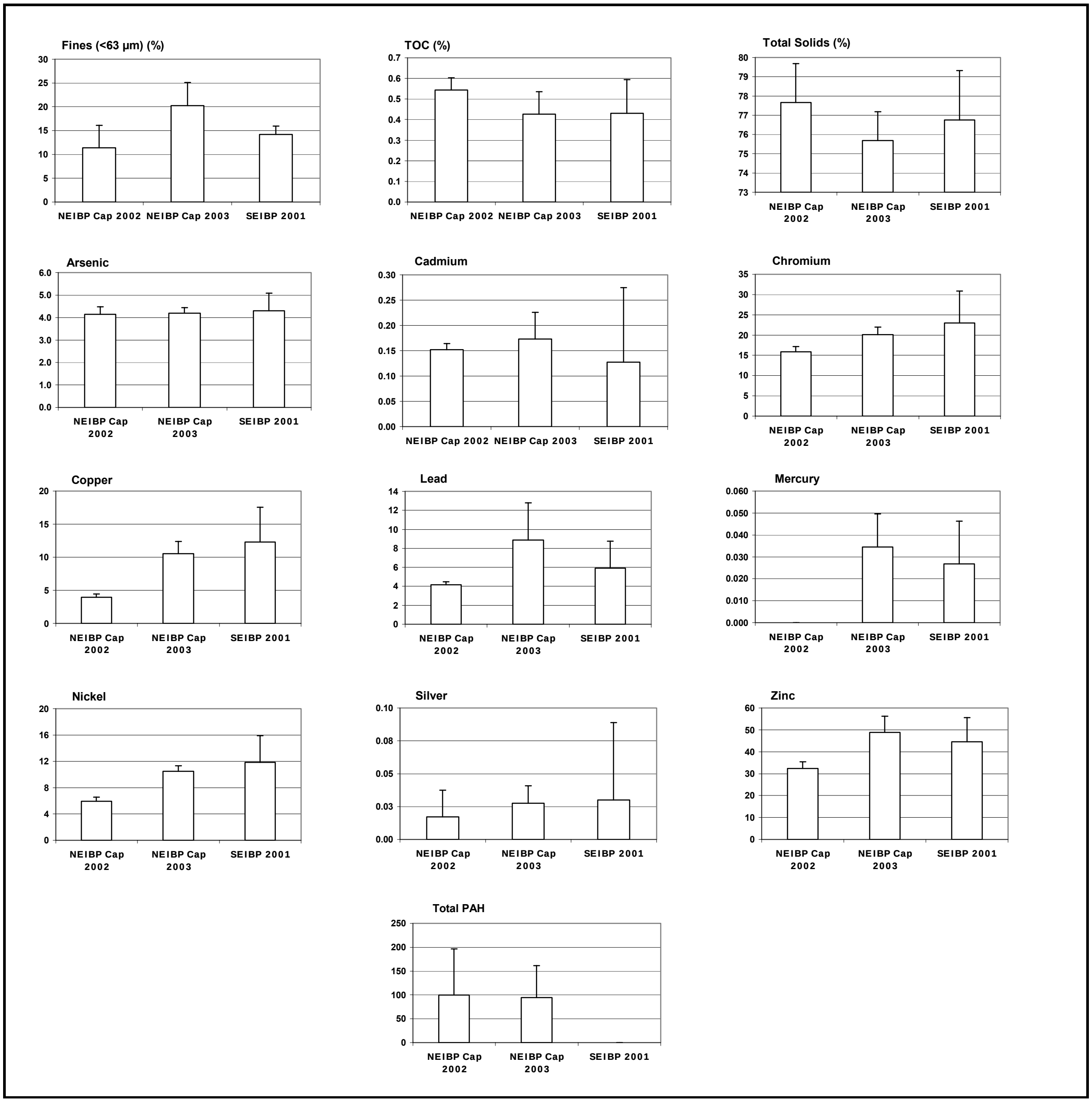


Figure 4-17. Average concentrations (± 95% CI) of constituents measured from the surface and middle core layer material collected in the NEIBP CAD site during both the 2002 and 2003 post capping surveys (n = 18) vs. sediments collected in core samples from the SEIBP (n=4) prior to capping (Chambers 2001).

Table 4-5. Average concentrations (± 95% CI) of constituents measured from the bottom LARE material collected in the NEIBP CAD Site during both the 2002 and 2003 post capping surveys (n=9) vs. sediments collected in core samples from the Los Angeles River Estuary (n=8) and box core samples from the NEIBP (n = 4) prior to dredge disposal (Chambers 2001). Screening level thresholds (ERL = effects range low, ERM = effects range medium) are used for assessing the potential of adverse biological effects (Long *et al.* 1995). Bold values exceed ERL levels and bold highlighted values exceed ERM levels.

	NEIBP 2002 Bottom LARE Material (n = 9)				NEIBP 2003 Bottom LARE Material (n = 9)				LARE Dredge Material 2001 (n = 8)				NEIBP 2001 Pre-Cap (n = 4)				ERL[1]	ERM
	Avg	95% CI	Min	Max	Avg	95% CI	Min	Max	Avg[1]	95% CI	Min	Max	Avg	95% CI	Min	Max		
Percent (%) dry wt.																		
Fines (<63 µm)	45.3	11.9	15.8	68.1	43.9	13.4	21.6	71.1	84.85	17.60	58.00	95.80	86.60	6.15	80.90	95.20		
TOC	1.38	0.38	0.64	2.50	2.37	0.78	0.00	3.74	1.83	0.29	1.50	2.20	2.08	0.09	2.00	2.20		
Total Solids	67.81	4.52	55.30	69.70	65.09	2.73	58.80	#VALUE!	66.50	6.67	60.00	76.00	37.75	0.94	37.00	39.00		
mg/Kg (ppm) dry wt.																		
Antimony	0.08	0.11	0.00	0.49	0.88	0.20	0.47	1.41	NM				NM				2	25
Arsenic	4.95	0.79	2.96	7.09	5.11	1.25	2.04	7.92	3.78	2.71	1.10	**8.60**	**11.75**	1.47	**10.00**	**13.00**	8.1	70
Cadmium	**1.77**	0.74	0.38	**3.78**	2.26	0.88	0.74	**4.49**	**1.65**	1.67	0.29	**5.00**	0.76	0.25	0.50	1.10	1.2	9.6
Chromium	41.88	24.06	18.40	**136.00**	38.82	10.30	14.50	**62.20**	25.45	16.55	7.50	56.00	67.75	3.24	64.00	72.00	81	370
Copper	**44.81**	16.22	11.10	**92.70**	**58.69**	18.89	23.50	**108.00**	**42.61**	35.77	7.90	**120.00**	**62.25**	3.52	**57.00**	**65.00**	34	270
Lead	**78.32**	35.10	16.10	179.00	**98.07**	33.00	37.40	170.00	**78.30**	53.82	12.00	**170.00**	**69.25**	3.52	**64.00**	**72.00**	46.7	218
Mercury	0.006	0.007	0.000	0.030	**0.198**	0.088	0.010	**0.380**	**0.116**	0.083	0.035	**0.270**	**0.159**	0.078	0.05	**0.23**	0.15	0.71
Nickel	**24.97**	18.02	8.34	**96.20**	**23.29**	5.54	10.70	**36.20**	16.31	10.48	6.20	**35.00**	**35.00**	2.53	**32.00**	**38.00**	20.9	51.6
Silver	0.44	0.24	0.02	**1.18**	0.05	0.02	0.00	0.08	0.54	0.76	0.00	**2.40**	0.49	0.16	0.27	0.63	1.0	3.7
Zinc	**228.21**	81.92	61.90	**477.00**	**301.00**	87.54	126.00	**537.00**	**187.70**	151.88	39.00	**510.00**	**192.50**	9.38	**180.00**	**200.00**	150	410
µg/Kg (ppb) dry wt.																		
Total PAH	2278.51	696.04	946.70	**4140.80**	3161.01	687.44	1759.30	**5117.70**	1340.88	1263.58	57.00	3700.00	607.50	80.96	550.00	730.00	4022	44792

1. Includes top and bottom from each of 4 cores.
2. Effects Range-Low (ERL) and Effects Range-Median (ERM) values from Long et al. 1995
NM = Not Measured

Bold Value = exceeds ERL
Bold Value = exceeds ERM

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Table 4-6. Average concentrations (± 95% CI) of constituents measured from the surface and middle core layer material collected in the NEIBP CAD Site during both the 2002 and 2003 post capping surveys (n=18) vs. sediments collected in core samples from the SEIBP (n=4) prior to capping (Chambers 2001). Screening level thresholds (ERL = effects range low, ERM = effects range medium) are used for assessing the potential of adverse biological effects (Long *et al.* 1995). Bold values exceed ERL levels and bold highlighted values exceed ERM levels.

Constituent	NEIBP 2002 Cap Material				NEIBP 2003 Cap Material				SEIBP 2001				ERL[1]	ERM[2]
	Avg[1]	95% CI	Min	Max	Avg[1]	95% CI	Min	Max	Avg	95% CI	Min	Max		
Percent (%) dry wt.														
Fines (<63 µm)	10.15	0.00	2.20	40.67	20.28	4.83	4.20	44.59	14.18	1.77	11.80	16.10		
TOC	0.54	0.00	0.29	0.81	0.43	0.11	0.00	0.92	0.43	0.16	0.24	0.58		
Total Solids	77.66	0.00	63.60	81.80	75.69	1.50	71.60	82.30	76.75	2.58	73.00	79.00		
mg/Kg (ppm) dry wt.														
Antimony	0.00	0.00	0.00	0.00	0.28	0.11	0.14	1.25					2	25
Arsenic	4.14	0.00	3.11	6.63	4.19	0.24	3.50	5.35	4.30	0.79	3.50	5.40	8.1	70
Cadmium	0.15	0.00	0.12	0.22	0.17	0.05	0.08	0.44	0.13	0.15	0.00	0.29	1.2	9.6
Chromium	15.84	0.00	11.40	23.40	20.14	1.84	14.40	30.90	23.00	7.88	15.00	34.00	81	370
Copper	3.97	0.00	1.97	6.12	10.56	1.84	6.18	20.80	12.30	5.25	6.90	19.00	34	270
Lead	4.17	0.00	3.31	5.37	8.88	3.91	1.98	34.00	5.93	2.82	3.70	10.00	46.7	218
Mercury	0.000	0.000	0.000	0.000	0.034	0.015	0.000	0.130	0.027	0.020	0.000	0.046	0.15	0.71
Nickel	5.91	0.00	3.58	9.59	10.49	0.85	7.73	15.30	11.85	4.04	7.40	17.00	20.9	51.6
Silver	0.02	0.00	0.00	0.18	0.03	0.01	0.00	0.07	0.03	0.06	0.00	0.12	1.0	3.7
Zinc	32.36	0.00	24.10	47.60	48.80	7.34	31.30	91.00	44.50	11.04	34.00	60.00	150	410
µg/Kg (ppb) dry wt.														
Total PAH	99.73	0.00	6.00	897.00	94.41	67.06	0.00	431.60	0.00	0.00	0.00	0.00	4022	44792

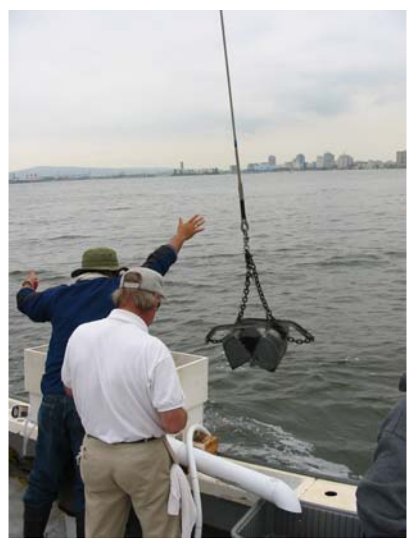
1. Includes surface and mid core layer samples from each of 9 CAD sites.
2. Effects Range-Low (ERL) and Effects Range-Median (ERM) values from Long et al. 1995

Bold Value = exceeds ERL
Bold Value = exceeds ERM

5.0 Benthic Infauna Re-Colonization of the CAD Site

The benthic community is composed of organisms that live in or on the bottom sediments (benthos). The benthic infauna is composed of those organisms that range in size from microscopic to 2 inches in diameter. These organisms are important because they oxygenate the sediments through their burrowing activities, recycle and contribute nutrients to the surface sediments, and act as a key food source for larger invertebrates and fish. Because they are relatively non-motile and their entire life cycle is spent closely associated with the sediments, they serve as good indicators of man-made disturbances.

The benthic community is normally dominated by polychaete worms, mollusks and crustaceans. In areas where sediments are frequently disturbed by natural events, such as storms, or by manmade events, such as dredging or contamination, the community will shift to one dominated by disturbance tolerant organisms. Storms or dredging can cause animals to be washed away or buried under transported sediment or they can cause changes in the preferred grain size for particular species. Some species can out-compete other organisms for disturbed space due to their rapid reproductive cycles or great fecundity. While this may lead to the rapid re-colonization of the disturbed area, competitive succession may eventually result in replacement of the original colonizers with more dominant species (Soule et al. 1996).



The re-colonization of the NEIBP CAD site by benthic infauna was investigated during the October 2002 and August 2003 surveys. This investigation included the rate of infauna re-colonization of the CAD site, their population composition and a comparison of this community with other areas of the Harbor. One replicate Van veen grab sample was collected at 20 stations located on and in the vicinity of the NEIBP CAD site (Figure 5-1). For this survey, abundance was determined to be all of the non-colonial animals collected from one replicate Van Veen Grab (0.1 m^2 surface area) and retained on a 1.0 mm screen. Stations were grouped into four topographically defined strata: the CAD site (Stations 1 thru 10), the Harbor surface (Stations 14, 15, 16, and 17), the non-capped southern portion of the NEIBP (NCADS, Stations 11, 12, 13), and the non-capped western portion of the NEIBP (NCADW, Stations 18, 19 and 20). In 2003, two additional infauna samples were added in the SEIBP to determine if the infauna community there could have inoculated the NEIBP CAD site during dredging operations (SEIBP, Stations 21 and 22).

Samples from all stations were sieved using a 1.0 mm size screen mesh. Samples from Stations 1, 7, 8, 17 and 19 were also sieved through a 0.5 mm size screen. This was to determine if small or juvenile organisms (missed by the 1.0 mm screen) constituted a significant portion of animals re-colonizing the CAD. In 2003 an additional site from the SEIBP (Station 21) was also sieved through both the 1.0 and 0.5 mm screens. An additional sample for particle size was collected from a separate grab at each site.

Detailed methods for benthic infauna sampling, particle size and statistical analyses can be found in Section 2, Material and Methods. A station map for the NEIBP infauna survey is presented in Figure 5-1. Particle size results for the 22 infauna sample locations are presented in Table 5-1 and Figure 5-2. Community metrics including abundance, numbers or species, diversity, dominance and the benthic response index (BRI) are presented in Table 5-2 and Figure 5-3. Species ranked in order of highest abundance for the entire survey area by design strata are presented in Tables 5-3 through 5-6. Two coincidence tables of cluster analysis results are presented for each year in Figures 5-4 and 5-5. Tables 5-7 through 5-11 present the results of the 1.0 vs. 0.5 mm screen size study. The types of bioturbating organisms found in the survey area and abundances of ghost shrimp (*Neotrypaea sp.*) by year are presented in Tables 5-12 to 5-14. Table 5-15 presents infauna species reported from other surveys that were associated with pristine, organically enriched and polluted habitats. Appendix D contains the complete species lists for each year by phylogeny.

5.1 Particle Size

Sediment particle size and distribution is a key factor influencing the distribution of benthic infauna organisms (Gray 1981). Particle size analysis was conducted on sediment samples collected from each of the 22 infauna sampling locations. Results summarized by stations grouped by the CAD site (Stations 1-10), Harbor (Stations 14-17), non-capped portions of the NEIBP (NCADS 11-13 and NCADW 18-20) and the SEIBP are presented in Table 5-1, Figure 5-2, with raw data presented in Appendix C.

The non-capped portions of the NEIBP (NCADS and NCADW) were similar to the SEIBP (Table 5-1 and Figure 5-2). Median particle sizes were small (10.6, 12.4, and 13.2 u, respectively) and all had a proportion of fines greater than 80%. CAD and Harbor sediments were much sandier. Median particle sizes were larger (42.8 and 81.0 u) and the proportion of fines was smaller (56% and 32%). Although more similar to each other than to the non-capped areas of the NEIBP and SEIBP, the CAD site had a larger particle size component in the 5-20 u range than did the Harbor (Figure 5-2). This likely explains their difference in median particle size. All strata were poorly or very poorly sorted (i.e. heterogeneous or widely distributed across sizes).

5.2 Community Metrics

5.2.1 Abundance

The simplest measure of population composition is the total numbers of organisms (abundance) collected per sampling effort. The total number of organisms collected from the survey area during both 2002 and 2003 were nearly identical (11,742 and 11,106 respectively) (Table 5-2 and 5-3).

Average abundances for each strata during 2002 were greatest in samples collected from the west end of the non-capped portion of the NEIBP (NCADW = 1,107), followed by the south side of the non-capped portion of the NEIBP (NCADS = 935), Harbor (654), then the CAD site (301) (Table 5-2, Figure 5-3). In 2003, average abundances were again highest in the NCADW (1,215), followed by the Harbor (682), NCADS (564), the CAD site (265), then the SEIBP (194).

5.2.2 Number of Species

A simple measure of population health is the number of separate infauna species collected per sampling effort. Because of its simplicity, numbers of species is often underrated as an index. In general, stations with higher numbers of species per grab tend to be in areas of healthier communities.

During 2002, a total of 197 unique species were collected from the entire survey area (Tables 5-2, Figure 5-3). The greatest average number of species were collected from the Harbor (85), followed by the CAD site (28), and NCADW (22). The lowest average numbers of species were collected from the NCADS (8). During 2003, a total of 232 species were collected from the entire survey area (Table 5-3). The Harbor again had the greatest average number of species collected (79), followed by the CAD site (46), then the SEIBP (36). CAD site species numbers doubled between 2002 and 2003. The non-capped portions of the NEIBP pit, NCADW and NCADS, had the lowest numbers of species (16 and 5 respectively).

5.2.3 Diversity

The Shannon-Wiener diversity index tends to emphasize the equitability of the species distribution in a community. For example, two samples may have the same numbers of species and the same numbers of individuals. However, one station may have most of its abundance concentrated into only a few species while a second station may have its numbers evenly distributed among its species. The Shannon Diversity Index would generate a higher value for the latter station.

During 2002, the highest average diversity was from the Harbor stations (3.31) (Table 5-2, Figure 5-3). The two non-capped portions of the borrow pit, NCADW and NCADS, had the lowest average diversities (0.84 and 0.25 respectively). The average diversity of CAD site stations (1.98) was intermediate between the Harbor and non-capped borrow pit stations. During 2003, the average diversity at the CAD site (3.00) was higher than all other strata, even the Harbor sites (2.77). On average, the Harbor stations were similar to the SEIBP stations (2.72). Diversity remained low at each of the non-capped borrow pit station groups (NCADW = 0.59 and NCADS = 0.30).

5.2.4 Dominance

The Schwartz Dominance Index is defined as the minimum number of species required to account for 75% of the individuals in a sample. When many, rather than few, species account for total abundance, the infaunal community tends to be healthier.

During 2002, the highest average dominance was measured at the Harbor stations (15), followed by the CAD site stations (3), then the non-capped portions of the borrow pit (NCAD and NCADW, each = 1) (Table 5-2, Figure 5-3). In 2003 the average dominance at the CAD site stations had more than tripled to 11**,** which had now equaled the Harbor stations (11). The SEIBP was somewhat lower (8), and the non-capped borrow pit stations were lowest with one species each.

5.2.5 Benthic Response Index (BRI)

The BRI measures the condition of a benthic assemblage, with defined thresholds for levels of environmental disturbance (Smith et al. 2001). The pollution tolerance of each species is assigned based upon its distribution of abundance along a pre-established environmental gradient. To give index values an ecological context and facilitate their interpretation, four thresholds of biological response to pollution were identified. The thresholds are based on changes in biodiversity along a pollution gradient. A reference threshold, below which natural benthic assemblages normally occur, was identified at an index value of 31, the point on the pollution vector where pollution effects first resulted in a net loss of species. Three additional thresholds of response to disturbance were defined at index values of 42, 53 and 73, representing points at which 25%, 50%, and 80% of the species present at the reference threshold were lost.

In 2002 the lowest average BRI values (populations most similar to reference sites) were found at the Harbor stations (11.6), followed by the NCADW (21.3) and CAD site (21.5) stations, all of which were within reference site conditions (Table 5-2, Figure 5-3). The NCADS was the only station group in which the BRI index value (31.7) fell just above the reference threshold, indicating that some contamination may have affected the composition of this community. In 2003, the lowest average BRI values were again measured from the Harbor station group (7.7), followed by the CAD site (18.1) and SEIBP (18.5). The highest BRI values were measured for the NCADW (25.0) and the NCADS (32.2), which again exceeded the reference threshold.

5.3 Species Composition

The infauna community was numerically dominated by polychaetes in 2002 (86%) (Appendix D, Tables D1 and D2). Followed by arthropods (8%), mollusks (1%) and echinoderms (<1%). All other miscellaneous phyla comprised 4% of the entire population. In 2003, polychaetes were again dominant (73%), but arthropods (17%) and mollusks (5%) comprised a larger portion of the population. Abundances of echinoderms (<1%) and other miscellaneous phyla (3%) remained relatively unchanged.

In 2002, polychaetes were the most diverse taxonomic group (92 species), followed by arthropods (42 species), mollusks (37 species), echinoderms (4 species) and other miscellaneous phyla (18 species) (Appendix D, Table D-1). Polychaetes (108 species), arthropods (51 species), mollusks (48 species) and echinoderms (5 species) all increased in 2003, while the numbers of miscellaneous phyla species declined slightly to 15 (Appendix D, Table D-2).

5.3.1 Dominant Species

The polychaete, *Cossura candida*, accounted for over 40% of the total abundance of infauna collected in the survey area during both 2002 and 2003 (Tables 5-3 and 5-4). During each year the majority of these were collected from stations located in the non-capped portions of the NEIBP (NCADW and NCADS).

During 2002, four polychaetes (*Cossura candida*, *Paraprionospio pinnata*, *Mediomastus sp*. and *Monticellina siblina)*, a crustacean (*Amphideutopus oculatus*) and a phoronid (*Phoronis sp*.) accounted for 75% of the infauna abundance in the study area (Tables 5-3 and 5-4). During 2003, eight polychaetes (*Cossura candida, Cossura sp A, Monticellina siblina, Spiophanes duplex, Sigambra tentaculata, Mediomastus sp, Chaetozone corona* and *Paraprionospio pinnata*) and two crustaceans (*Amphideutopus oculatus* and *Euphilomedes carcharodonta*) accounted for 75% of the abundance in the survey area.

Table 5-15 lists infauna reported in earlier investigations to reflect either background reference conditions or organic enrichment and pollution. Of the most abundant species collected in the survey area during both years, three polychaetes, *Paraprionospio pinnata*, *Mediomastus sp*. and *Tharyx* (= *Monticellina* in present study), and the ostracod crustacean, *Euphilomedes carcharodonta*, are all characteristic of sediments containing low to moderate organic enrichment.

To evaluate the dominance of species collected in each of the four design strata, infauna abundances were summed by species from stations located on the CAD site (Stations 1 thru 10), Harbor (Stations 14 thru 17), non-capped portions of the NEIBP (NCADS - Stations 11 thru 13, NCADW - Stations 18 thru 20), and, in 2003, the SEIBP (Stations 21 and 22) (Tables 5-5 and 5-6).

In 2002, four polychaetes (*Paraprionospio pinnata, Mediomastus sp, Monticellina siblina, Cossura candida*) and a phoronid (*Phoronis sp*), accounted for 75% of the abundance on the CAD site. In contrast, a total of 24 species, including 18 polychaetes and 6 crustaceans, accounted for 75% of the abundance at the Harbor during the same survey. The crustacean

Amphideutopus oculatus (14%) and the polychaete *Mediomastus sp.* (12%) were the most abundant species collected there. Both the west and south non-capped portions of the NEIBP (NCADS and NCADW) were numerically dominated by the polychaete *Cossura candida*, which accounted for 95 and 80% of the abundance in these strata, respectively. Additionally, far fewer taxa were collected in the NCADS (13) and NCADW (41) compared to the CAD site (89) and Harbor (165).

In 2003, while abundance on the CAD site was similar to 2002 (2617 vs. 2727), the number of species comprising the top 75% of the abundance had increased from 5 to 20 (Table 5-6). Taxa groups included 13 polychaetes, three crustaceans, two mollusks, a phoronid and a nemertean. The most abundant organisms collected included the polychaetes *Monticellina siblina, Chaetozone corona,* and *Mediomastus sp.,* and the crustacean *Amphideutopus oculatus* (the most abundant species collected from the Harbor in 2002 and 2003). The infauna population at the Harbor sites was similar between 2002 and 2003 in terms of numbers of species (170) and abundance (2727). In 2003, nineteen species accounted for 75% of the abundance at the Harbor and was represented by 11 polychaetes, five crustaceans and three mollusks. *Amphideutopus oculatus,* and *Spiophanes duplex* were the most abundant species collected and combined represented 46% of the population. The non-capped portions of the NEIBP (NCADS and NCADW) were again dominated by the polychaete *Cossura candida* (92 and 84% respectively). Ten species accounted for 75% of the abundance at the SEIBP including eight polychaetes, a mollusk and a phoronid. Like the CAD site, the most abundant species collected were the polychaetes *Monticellina siblina* and *Paraprionospio pinnata, and* a phoronid, *Phoronis sp*.

5.3.2 Cluster Analysis

Spatial patterns of species composition in and around the NEIBP CAD site were evaluated using cluster analysis separately for the 2002 and 2003 surveys (Figures 5-3 and 5-4). For the purposes of this analysis, only organisms captured on the 1.0 mm screen mesh size were used. Rare species (those occupying fewer than three sites within the survey area) were excluded from the analysis. Species with relatively high abundances within a station group characterize the species composition of the group. Symbols on the two-way coincidence tables indicate relative abundance by the size of the symbol. Cluster analysis considers relative abundance of each tested taxa across the stations it occupies and is not weighted towards dominant species and therefore provides a more complete assessment of community structure. The relatively abundant species composing each of the Station Groups reported below were compared to a list of species reported in previous studies from either reference stations or areas of low to moderate organic enrichment and/or pollution (MEC 2000, Reish 1959, Pearson and Rosenberg 1978, Word 1978, Thompson 1982, Dorsey et al. 1983) (Table 5-15). The percentage of organisms known to respond to organic enrichment is then summed for each stratum. Habitats where fewer than 35% of the relatively abundant species are known to respond to organic enrichment are considered “healthy”, those composed of 36 to 60% are considered “semi-healthy” and those composed of >60% are considered degraded (Pearson and Rosenberg 1978).

2002

In 2002**,** three station groups and six species groups were identified (Figure 5-4). Stations clustered into three groups which were delineated by strata; the CAD site (Stations 1 thru 9), Harbor (Stations 14 thru 17) and non-capped portions of the NEIBP (Stations 11, 12, 13, 18, 19 and 20). The Harbor sites were most similar to the CAD site stations, followed by sites located in the un-capped portions of the NEIBP.

Station Group 1 included nine of the ten CAD site stations. The depth of the CAD site (-14 m, MLLW) is intermediate between the Harbor (-6 to -8 m) and the un-capped portions of the NEIBP (-18 to -20 m). The CAD site was created 10 months prior to the survey. While no baseline infauna data were collected immediately following the creation of the CAD site, it is probable that infauna were absent from the surface sediments immediately following dumping.

The Station Group 1 cluster was represented by 55 taxa from a total of 110 possible taxa in the species cluster groups. The species groups that best represented the CAD site included Groups E and F represented by taxa that were present across many stations in the survey area. These included fifteen polychaetes, five arthropods, a phoronid and an anthozoan. Species in Group E included three polychaetes (*Paraprionospio pinnata*, *Mediomastus sp*, and *Sigambra tentaculata*) and the phoronid, *Phoronis sp*. These taxa were also relatively abundant at Harbor station Group 2 and station Group 3 (NCADS and NCADW). *Paraprionospio pinnata* and *Mediomastus sp*. have been reported to increase in abundance in areas of low organic enrichment, while *Phoronis sp.* has been associated with relatively uncontaminated reference sites (Table 5-15). Species in cluster Group F were also relatively abundant at the CAD site and Harbor station groups but were not common in Station Group 3. These species were represented by the amphipod crustaceans *Amphideutopus oculatus and Neotrypaea sp.,* as well as the polychaetes *Monticellina siblina, Leitoscoloplos pugettensis, Spiophanes duplex, Cossura sp. A, Spiochaetopterus costarum*, *Tharyx* (=*Monticellina siblina* in this study), *Leitoscoloplos pugettensis*, and *Spiochaetopterus costarum.* These species have all been reported to occur in areas of low to moderate organic enrichment. 64% of the most abundant species occurring at the CAD site stations during 2002 are known to respond to organic enrichment. This is expected since capping occurred only ten months prior to this survey.

Station Group 2 included the four Harbor stations (14 – 17), plus CAD site station 10. These sites were the shallowest in the survey area (-6 to -8 m). Sediments were composed mostly of sand (67%) with relatively low amounts of fines (32%). This station cluster group was represented by a diverse assemblage of 84 taxa. Species Group D was most representative of the Harbor station group with 48 taxa that were present in relatively high abundances. This species group was composed of 30 polychaetes, 10 arthropods, five mollusks, two nemerteans, one echinoderm. Taxa that best represented this group included the polychaetes *Pseudopolydora paucibranchiata, Scoletoma sp A*, and *Scoletoma sp*, five amphipod crustaceans (*Eochelidium sp A, Leptochelia dubia, Ampelisca cristata microdentata, Monocorophium acherusicum* and *Photis brevipes*) and the ostracod crustacean *Euphilomedes carcharodonta*. *Pseudopolydora, Euphilomedes* and *Photis* have each been reported to increase in abundance in areas of low to moderate organic enrichment, while *Ampelisca* is generally associated with reference conditions (Table 5-15). Station 10 was a CAD site station that clustered with the Harbor group. This station is located on the east edge of the CAD site and had higher in abundances, numbers of species, diversity and dominance than the other CAD site stations. Of the most abundant species occurring at Station Group 2 during 2002, only 31% are known to respond to organic enrichment. This indicates that the Harbor stratum is representative of a “healthy” habitat.

Station Group 3 was represented by the non-capped CAD site stations (NCADS and NCADW) which were the deepest sites (-18 to -20 m). This station group was composed of high amounts of fine sediments (>80%). Species Group A best represented this station group. Its single member, the polychaete *Cossura candida,* composed >80% of the abundance at the NCADS (2664 individuals) and NCADW (2669 individuals). In other studies *Cossura candida* has been associated with relatively uncontaminated reference areas (Table 5-15). The dominance of this species at these sites, to the apparent exclusion of other taxa, indicates that some disturbance has probably been occurring.

2003

In 2003 three station groups and five species groups were identified by cluster analysis (Figure 5-4). Stations groups clustered according to strata; Group 1 representing the CAD site (Stations 1 thru 10, except for Station 5) and SEIBP sites (Stations 21 and 22), Group 2 representing the Harbor (Stations 14 thru 17, including CAD Station 5) and Group 3 representing the non-capped portions of the NEIBP (Stations 11, 12, 13, 18, 19 and 20). As in 2002, the Harbor and CAD site stations were most similar to each other; while the non-capped borrow pit stations were dissimilar to either of these station groups. Station depths were unchanged between surveys and both the CAD site and Harbor sediments were composed of low concentrations of fine material (56 and 32% respectively) and high amounts of sand (43 to 67% respectively). The NCADS, NCADW and SEIBP each were composed of mostly fine sediments (>80%).

Station Group 1 included nine of the ten CAD site stations and both SEIBP Stations 21 and 22. The station cluster group was represented by 97 taxa from a total of 111 possible taxa in the species cluster groups. Species Group E best represented the CAD site and SEIBP. The species composing Group E were also relatively abundant at the Harbor Group 2 stations. These taxa included 20 polychaetes, three arthropods, two mollusks, a phoronid, an anthozoan and a nemertean. Representative taxa included numerous polychaetes (*Monticellina siblina, Chaetozone corona, Mediomastus sp, Paraprionospio pinnata, Cossura sp A, Aphelochaeta monilaris, Spiophanes duplex, Scoletoma sp B, Leitoscolopios pugettensis,* and *Streblosoma sp B*), the amphipod crustacean *Amphideutopus oculatus*, the ostracod *Euphilomedes carcharodonta*, *Phoronis sp*, and the nemertean *Tubulanus polymorphus*. *Aphelochaeta* and *Monticellina (=Tharyx* in past studies*)* have been associated with reference conditions by Reish (1959), but more recently have been considered an indicator of contaminated conditions (Word 1978, Thompson 1982, Dorsey et al. 1983). Four other species (*Mediomastus, Paraprionospio, Leitoscolopios*, and *Euphilomedes*) have been reported to increase in abundance in areas of low organic enrichment, while Phoronis has been associated with relatively uncontaminated reference locations (Table 5-15). Of note in the 2003 cluster result is the lack of a species transition group that was delineated in the 2002 cluster analysis. In that survey, three species (*Paraprionospio pinnata, Phoronis sp, and Mediomastus spp*) occurred in relatively high abundances across all three station groups. During 2003, these species had merged into the

CAD site and Harbor station groups. 33% the most abundant species occurring at the CAD site stations during 2003 are known to respond to organic enrichment. This represents a 50% reduction since 2002, and indicates that the CAD site had become a much healthier habitat over a one-year period. Of the most abundant species occurring at the SEIBP, 44% were indicative of organic enrichment indicating a semi-healthy habitat.

Station Group 2 included the four Harbor stations (14 – 17), plus CAD site station 5. This station cluster group was represented by a diverse assemblage of 105 taxa, representing 95% of the total of 111 species that were included in the analysis. Species Group D was most representative of Station Group 2, with 69 taxa that were present in relatively high abundances. This group was composed of 29 polychaetes, 16 arthropods, 17 mollusks, four nemerteans, and three echinoderms. Taxa representative of this group included the bivalves *Tagelus subteres*, *Cooperella subdiaphana* and *Macoma yoldiformis*, the polychaetes *Prionospio heterobranchia*, *Ampharete labrops*, and *Pista disjuncta*, and the amphipod *Ampelisca cristata cristata*. *Prionospio* is reported to increase in abundance in areas of low organic enrichment (Table 5-15). Station 5, located on the northern edge of the borrow pit, was the only CAD site station that was included with the Harbor stations. As with Station 10, which was included in the harbor group in 2002, these stations on the edge of the CAD site nearest to the Harbor sediments may be re-colonizing at a slightly more rapid rate than those sites further away. Of the most abundant species occurring at the Harbor site stations during 2003, only 10% are known to respond to organic enrichment, which is indicative of a healthy habitat.

As in 2002, Station Group 3 represented the non-capped NEIBP sites (NCADS and NCADW). The polychaete, *Cossura candida,* again dominated the population abundances at these stations (>80% of total abundance). Another polychaete, *Sigambra tentaculata*, was also present in relatively high numbers in Station Group 3.

Additional toxicity and chemistry samples were collected in 2003 from Stations 12 and 19. Sediment metals and total PAH concentrations from these samples were similar to concentrations in other areas of the outer harbors and were not toxic to the amphipod *Eohaustorius estuaries.* This suggests that some other factor other than contamination is more responsible for the infaunal population pattern noted at these sites.

5.3.3 Screen Size Comparison

In 2002, five (Stations 1, 7, 8, 17 and 19) of the twenty infauna samples were sieved through both 1.0 and 0.5 mm mesh screens (Table 5-7; Appendix D-3). In 2003, these five, plus an additional sample from the SEIBP (Station 21), were also sieved through both screen sizes (Table 5-8, Appendix D-4).

2002

In 2002, of the 4,300 organisms collected from the five stations where both 1.0 and 0.5 mm screens were used, total abundances and numbers of species were similar on both screens (Table 5-7). Of the total infauna counts found at CAD site Stations 1, 7 and 8, and harbor Station 17, approximately 50% were collected on each screen size. At Station 19, located in the non-capped portion of the NEIBP, over twice the numbers of organisms were collected on the 1.0 mm screen when compared to the 0.5 mm screen. This difference was due to an abundance of the polychaete *Cossura candida*, which accounted for 80% of the total taxa collected at the NCADW sites (Table 5-5).

The numbers of species was equal or slightly greater on the 0.5 mm screen size at the CAD sites and un-capped borrow pit stations. Conversely, at Harbor Station 17 the numbers of species collected on the 1.0 mm screen was over twice that found on the 0.5 mm screen. The numbers of unique species collected on the 0.5 mm screen was greater than on the 1.0 mm screen at CAD Stations 1 (26 vs. 16) and 7 (19 vs. 6), and Station 19 (17 vs. 13) in the non-capped portion of the borrow pit, and nearly equal at CAD Station 8 (10 vs. 11). In contrast, Harbor Station 17 had over four times as many species that were unique on the 1.0 mm (61) as was on the 0.5 mm (14) screen.

2003

In 2003, of the 4,218 organisms collected from the six stations where both 1.0 and 0.5 mm screens were used, total abundances and numbers of species captured on the 1.0 mm mesh were over twice that captured on the 0.5 mm mesh (Table 5-8). At all six locations, the total numbers of infauna collected were greater on the 1.0 mm mesh. This differed from 2002 when the numbers of organisms collected from the CAD site on both screen sizes were nearly equal. As in 2002, the number of organisms collected on the 1.0 mm mesh (1,205) at Station 19, were much greater than were collected on the 0.5 mm (360) mesh. The numbers of organisms collected on both screens were similar at SEIBP Station 21 and CAD site Station 1.

The numbers of species was nearly twice as great on the 1.0 mm mesh compared to the 0.5 mm screen at all stations in 2003, except at Station 19, in the non-capped portion of the borrow pit, where the numbers of species captured on each screen were nearly the same. The greatest difference in the number of species captured on the 1.0 mm mesh between years occurred at the CAD site stations (1, 7 and 8) where numbers of species increased in 2003. The numbers of unique species collected on the 1.0 mm screen were much greater at the CAD site stations. This differed from 2002 when there were more unique species collected on the 0.5 mm mesh. The numbers of unique species collected on the 1.0 mm mesh were greatest at Harbor Station 17 and smallest at Station 19, similar to 2002. The number of unique species on both the 1.0 and 0.5 mm mesh sizes were similar between the SEIBP and the CAD site.

5.3.4 Taxa Composition by Screen Size

The combined abundances of each of the major phyla captured on the 1.0 and 0.5 mm mesh sizes were evaluated (Table 5-9). Annelids, which were by far the most abundant phyla in the study area, were captured in highest numbers on the 1.0 mm mesh in nearly all cases. Only Stations 1 and 21 in 2003 had abundances nearly equal on the 1.0 and 0.5 mm screens. The abundance of annelids was greatest at Station 19 in both years and was composed almost entirely of *Cossura candida* or *Cossura sp A* on both mesh sizes (Tables 5-5 and 5-6). Arthropods were most abundant at Harbor Station 17, especially in 2003. Their distribution by screen size was, in general, slightly higher on the 1.0 mm screen across stations and years. Mollusks were captured in highest numbers on the 1.0 mm mesh. Echinoderms were very low in numbers and were captured exclusively on the 1.0 mm mesh during both years. Other phyla (nemerteans and phoronids in 2002 and chordates, cnidarians, nemerteans, phoronids, flat worms, and sipunculans in 2003) were mostly captured on the 1.0 mm mesh.

Dominant species captured on the 0.5 mm screen in 2002 and 2003 were similar (Tables 5-10 and 5-11). Representative species in 2002 included five polychaetes (*Cossura candida, Mediomastus sp, Leptochelia dubia, Prionospio lighti, Apoprionospio pygmaea*) and two amphipods (*Amphideutopus oculatus* and *Photis bifurcata*) and the ostracod, *Rutiderma lomae* Dominant species captured in 2003 were similar in composition to 2002 and included five polychaetes (*Cossura sp A, Cossura candida, Mediomastus sp, Nephtys cornuta,* and *Monticellina siblina*), an amphipod (*Amphideutopus oculatus*) and the ostracod, *Euphilomedes carcharodonta*.

5.3.5 Bioturbators

Eight infauna species recognized as bioturbators were collected on the 1.0 and 0.5 mm screens during the 2002 and 2003 surveys (Table 5-12) (Don Cadien, personal communication). Of these, most confine their burrowing activities to less than 18 inches beneath the sediment surface. The burrows of the nemertean, *Cerebratulus californiensis*, can reach 36 inches, but their burrows travel laterally under the sediment surface. Only *Neotrypaea sp*., the ghost shrimp, has been observed to burrow vertically to depths (>50 to 90 inches) that could reach the bottom LARE material.

In 2002 a total of 46 ghost shrimp were collected at 14 of the 20 survey stations on the 1.0 mm screen (Table 5-13). All but one (*Neotrypaea gigas*) were juveniles and could not be identified to the species level. Eight of the 14 stations where the ghost shrimp occurred were on the CAD site (Stations 1, 2, 3, 6, 7, 8, 9 and 10), with the greatest abundances of ghost shrimp found at Stations 9 (n = 10) and 10 (n = 12). In 2003 at total of 46 ghost shrimp were captured in the study area, 32 juveniles and 14 adults. Twenty nine of these occurred on the CAD site, with the greatest abundances occurring at Station 10 (n = 18). No ghost shrimp were collected at the SEIBP.

In 2002 ghost shrimp were over twice as abundant on the 0.5 mm screen (15 vs. 7) (Table 5-14). In 2003 far fewer ghost shrimp were collected at these sites and none were collected at the SEIBP.

5.4 Summary and Comparison with Historic Surveys

The re-colonization of the NEIBP CAD site by benthic infauna proceeded at a rapid pace during the ten-month period between October 2002 and August 2003. Although total abundances of infauna at the CAD site decreased slightly during this time, the numbers of species, diversity, and dominance (number of species comprising 75% of the abundance) had each increased dramatically. Almost twice the numbers of species were collected, diversity was 30% greater and the number of taxa comprising 75% of the abundance had tripled. This was in contrast to locations in the non-capped portions of the borrow pit and Harbor where numbers of species declined slightly, and diversity and dominance remained relatively unchanged between the 2002 and 2003 surveys.

2002-03 results were averaged across both years and compared against findings from the Year 2000 Baseline study conducted by the Ports of Long Beach and Los Angeles. These studies included sampling for infauna during January-February, May, August and November from 14 sites located in the basins, channels and outer harbor. Results were then combined by depth (shallow or deep) and averaged (MEC 2000) (Table 5-16). Among the five strata compared (2000 deep, 2000 shallow, 2002-03 CAD sites, 2002-03 Harbor sites, and 2003-03 Non-Capped NEIBP sites), the 2002-03 NEIBP site abundances were high (average of 955 individuals), the 2000 shallow (716) and 2002-03 Harbor sites (668) were moderate, and the 2002-03 CAD (283) and 2000 deep sites (249) were low. Average numbers of species, diversity and dominance all followed a different pattern: values were high at the 2002-03 Harbor sites, moderate at the 2002-03 CAD sites and both deep and shallow 2000 sites, and low at the non-capped NEIBP sites.

The Benthic Response Index (BRI) is another measure of infaunal community “health”. BRI scores below 31 characterize communities which are comparable to reference communities from other southern California bays and harbors (Smith et al., 2003). Index scores exceeding 31 indicate that pollution effects have caused a net loss of species. At all CAD site locations, BRI index values were below 31 during both the 2002 and 2003 surveys, and, on average, actually declined somewhat between 2002 and 2003. This indicates that by 2003, the infauna community on the CAD site had begun to approach the ecological health of communities found at other harbor reference sites. During both surveys, the average BRI index score at the Harbor sites was the lowest of among all other strata in the study area. Average BRI values from this area actually decreased slightly between years. The sites located in the western portion of the non-capped NEIBP (NCADW) were similar to the CAD site in 2002, but then increased in 2003. All values at the NCADW were still below 31, however.

The highest BRI index scores were measured at the NCADS where they exceeded threshold levels during both surveys. The scores here were just above 31, indicating that there was a net reduction in species, possibly due to some anthropogenic disturbance. Other community metrics from the NCADS concurred with these findings. Elevated total abundance, decreased numbers of species and dominance by a single species indicate that these sites were impacted, possibly to a greater degree than the BRI index indicated. Sediment chemistry from the NCADS location in 2003 revealed that sediment metals and total PAHs were similar to concentrations found in other outer harbor locations. Additionally, these same sediments were not toxic to *Eohaustorius estuaries*. These findings combined indicate that impacts to the community structure appear to be more subtle than could be detected by chemistry and toxicity alone.

The polychaete worm, *Cossura candida,* was the most dominant benthic organism found in the survey area, and comprised 40% of the entire population. Found in relatively high abundances at each of the strata during both years, it comprised over 80% of the NCADS and NCADW site populations. *Cossura candida* was reported by Reish (1959) as an indicator of relatively undisturbed reference conditions. During the Year 2000 baseline survey (MEC 2000), *Cossura candida* was abundant at locations similar in depth and sediment grain size, and was the 13th most abundant species found in both Long Beach and Los Angeles Harbors. Additionally, between 1954 and 2000, *Cossura* was a member of the top three most dominate species collected in six out of seven surveys conducted in the harbors (Reish 1959, HEP 1976, HEP 1980, MBC 1984, MEC 1988, SAIC/MEC 1997). It is not known why this species numerically dominates the infauna community at these non-capped borrow site locations.

Three distinct and similar station groups were identified by cluster analysis during both the 2002 and 2003 surveys. Not surprisingly these station clusters were defined by the pre-assigned design strata: stations located on the CAD site, stations in the Harbor and stations from the non-capped portions of the NEIBP. The infauna population on the CAD site shifted during the ten-month period between the October 2002 and August 2003 surveys toward a taxa composition that was similar to that found on the surrounding harbor sediments.

During 2002, high abundances of the polychaetes *Paraprionospio pinnata*, *Mediomastus sp*, and *Sigambra tentaculata* and the phoronid, *Phoronis sp*. formed a group that occurred at the

CAD, Harbor and non-capped NEIBP sites. Combined with *Cossura candida*, they composed 75% of the infauna population on the CAD site. At that time, the CAD site could have been considered “disturbed”, since 64% of the most abundant species found there were known to increase in abundance in areas of low to moderate organic enrichment (Reish 1959, Pearson and Rosenberg 1978, Word 1978, Thompson 1982, Dorsey et al. 1983). Since the capping operation had occurred only ten months prior to the 2002 survey, this result would not be unexpected.

Ten months later, during the August 2003 survey, the number of taxa composing 75% of the population (dominance) on the CAD site had increased to twenty, including eight species that also composed 75% of the population at the Harbor sites. Representatives of this group included the crustaceans *Amphideutopus oculatus and Neotrypaea sp.,* along with several polychaetes including *Monticellina siblina, Leitoscoloplos pugettensis, Spiophanes duplex, Cossura sp. A,* and *Spiochaetopterus costarum*. Among these three species, only *Spiophanes* had not been reported to increase in abundance in areas of low to moderate organic enrichment.

Amphideutopus was the most abundant organism found at the Harbor sites during both years. During 2002 it composed less than 1% of the CAD site population, but in 2003 had increased to the third most abundant organism on the CAD site (8%). Of the most abundant species found on the CAD site, 33% were indicative of low to moderate organic enrichment. This represented a 50% reduction in the numbers of pollution tolerant species over the previous year.

The SEIBP population clustered with CAD site stations in 2003, and, of the ten species that composed 75% of the population, eight were also members of the most abundant species on the CAD site. Considering that the sediments covering the NEIBP CAD site originated from the SEIBP, it is likely that the CAD site infauna population had either been inoculated with organisms from the SEIBP or that the similar depth and grain size habitat at the CAD site encouraged the recruitment of similar species. Of the most abundant species collected at the SEIBP, 44% were indicative of low to moderate organic enrichment or a semi-healthy habitat.

Findings of the Year 2000 Baseline survey showed that station depth was the most important factor controlling the distribution of infauna in the harbors (MEC 2000). Stations located in shallow water (3 – 6 m) were generally higher in species abundance, numbers of species and diversity, than those in deeper water (7 – 25 m). Also, stations located in more enclosed areas (basins and slips) were less healthy than stations located in the more open channels and outer harbor areas. The species distribution patterns within these station groups were complex and did not correspond to any single factor, such as grain size, depth or years since dredging. Station cluster groups with the highest habitat quality, as measured by abundance, numbers of taxa and diversity, were found in the outer harbors and main Los Angeles Harbor channel. The differences within this outer harbor station group were depth and years since dredging.

The composition of species at the CAD site during the 2002 and 2003 surveys was similar to the population found in the basins and slips from the middle to outer Long Beach Harbor (cluster Group 7) as reported in the Year 2000 Baseline survey. These mid to outer harbor stations were 15 to 25 meters in depth, composed of low to moderately fine sediments (13 to 85%), and had been dredged during the 1990's. The CAD site and middle to outer harbor station group had nine relatively abundant species in common. These included seven polychaetes (*Aphelochaeta monilaris, Cossura candida, Leitoscoloplos pugettensis, Montecillina siblina, Paraprionospio pinnata, Spiochaetopterus costarum, Spiophanes berkeleyorum*), a crustacean (*Neotrypaea sp.*), and a phoronid (*Phoronis sp.*). Seven of these species were also abundant at the SEIBP sites. In contrast, the CAD site Harbor group shared only three species with the Year 2000 middle to outer harbor station group.

It appears from these findings that the disturbance caused by dredging or, in the case of the CAD site, capping played a key role in determining the composition of the infauna community. The middle to outer harbor stations (Year 2000 survey) were similar in sediment composition and recent dredging activity and shared many of the same species with the CAD site and SEIBP. Also, immediately following capping, re-colonization occurred at a rapid pace on the CAD site. Two mechanisms could have been involved. First, inoculation of species from the SEIBP to the CAD site during the capping process is likely, since the composition of the infauna populations at the CAD site and SEIBP were very similar in terms of abundance, numbers of species, dominance, BRI and shared species. Secondly, recruitment by infauna from the nearby Harbor sediments may have also occurred, considering the numbers of dominant species (those comprising 75% of the population) shared by the CAD site, SEIBP and Harbor sites.

Of eight organisms collected in the survey that are potential bioturbators, only the ghost shrimp (*Neotrypaea sp.*) is reportedly capable of burrowing to depths that could potentially penetrate the LARE material. Members of this group have been reported to create burrows ranging from >50 to 90 cm in depth (Atkinson and Nash 1990, Suchanek 1985). During both survey years, a total of 46 individuals were collected from the survey area with the majority found at CAD site stations. The impact of these burrowers is difficult to assess. The individuals collected during both 2002 and 2003 were small (<3 cm) and most likely incapable of burrowing to great depths. However, the depth of penetration of the van veen grab used to collect the infauna samples does not exceed 15 cm. Thus, it is very possible that larger, adult ghost shrimp could have easily avoided our grab.

Although beyond the scope of this study, two other methods may be available to evaluate the extent of ghost shrimps' burrowing capabilities (AMEC 2004, draft). To determine whether or not the larger, adult shrimp occur on the CAD site, a diver-held vacuum system could be used to remove them directly from their burrows (Ogden 1994). In the second method, resins poured into the burrows by divers can be used to make a cast of the burrow system (Dworschak 2002, Ogden 1994, Atkinson and Nash 1990).

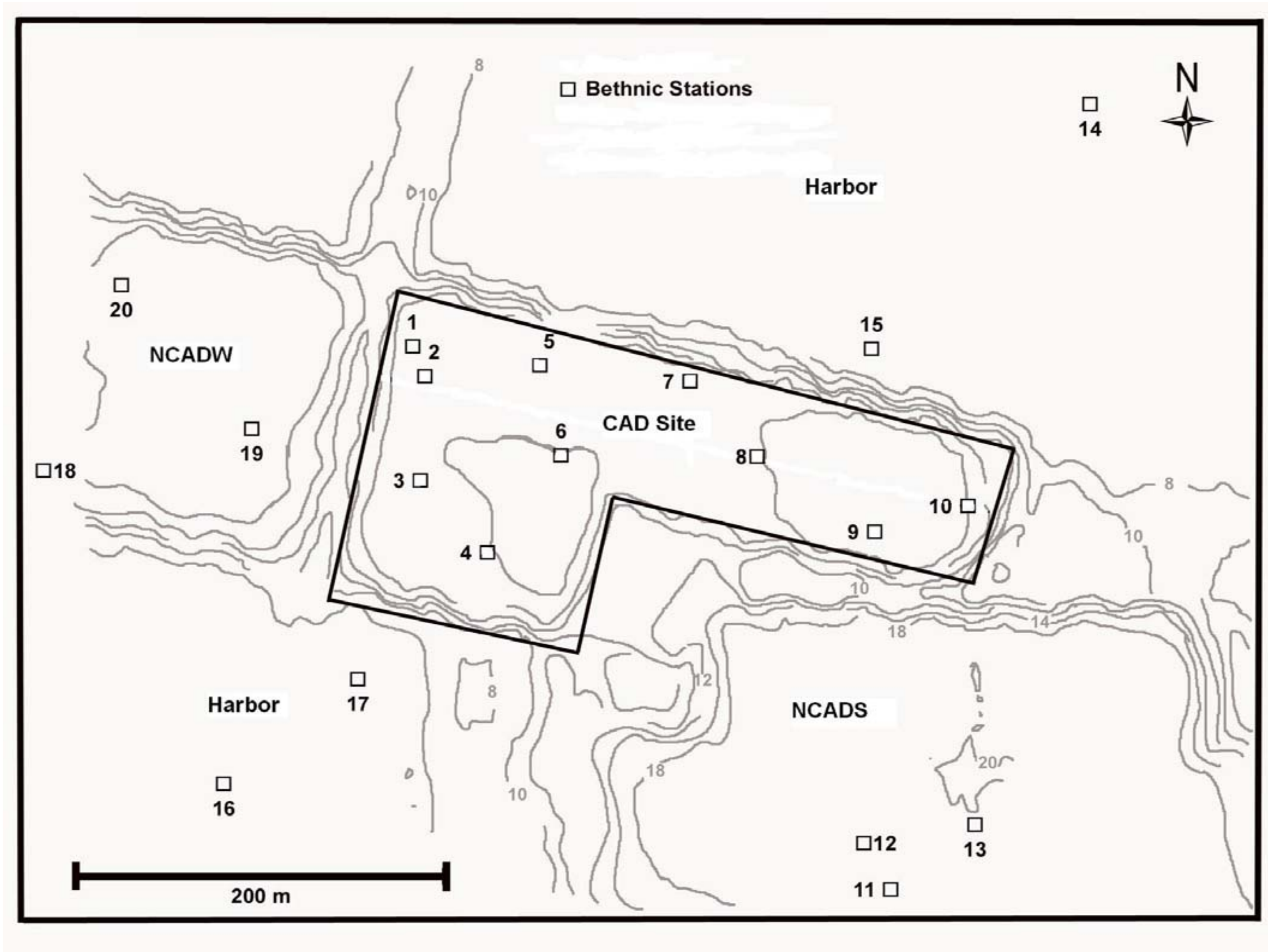


Figure 5-1. NEIBP survey area including all benthic infauna sampling locations and design strata: NEIBP CAD site (CAD site), non-capped NEIBP south (NCADS), non-capped NEIBP west (NCADW), Harbor surface (Harbor).

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Table 5-1. Particle size for sediment samples collected at 22 infauna sampling stations in the NEIBP survey area during the 2003 survey. Results are presented as averages by strata.

	Partitioned Fractions (%)				Percentile (microns)			Percentile (phi)			Dispersion or Sorting Index [2.]	Category [1.]	Sorting [2.]
Sample Type	Sand	Silt	Clay	Fines	16%	median [1.] 50%	84%	16%	median 50%	84%			
CAD Site Stations (1-10)	43.8	47.1	9.2	56.2	5.3	42.8	115.6	7.6	5.0	3.2	2.2	Course Silt	very poorly sorted
NCADS Stations (11-13)	12.1	74.1	13.7	87.9	3.2	10.6	36.6	8.3	6.6	4.8	1.8	Fine Silt	poorly sorted
Harbor Stations (14-17)	67.6	27.4	5.0	32.4	11.3	81.0	153.0	6.5	3.7	2.8	1.9	Very Fine Sand	poorly sorted
NCADW Stations (18-20)	19.2	66.9	13.9	80.8	3.3	12.4	52.0	8.3	6.4	4.3	2.0	Fine Silt	poorly sorted
SEIBP Staitons (21-22)	16.9	70.9	12.2	83.1	3.6	13.2	48.0	8.1	6.3	4.4	1.8	Fine Silt	poorly sorted

[1.] Median (µ): 0-4 = clay, 4-8 = very fine silt, 8-16 = fine silt, 16-31 = medium silt, 31-63 = coarse silt, 63-125 = very fine sand, 125-250 = fine sand, 250-500 = medium sand, 500-1000 = coarse sand.

[2.] Sorting Index: <0.35 = very well sorted, 0.35-0.50 = well sorted, 0.50-0.71 = moderately well sorted, 0.71-1.00 = moderately sorted, 1.0-2.0 = poorly sorted, 2.0-4.0 = very poorly sorted, >4.0 = extremely poorly sorted.

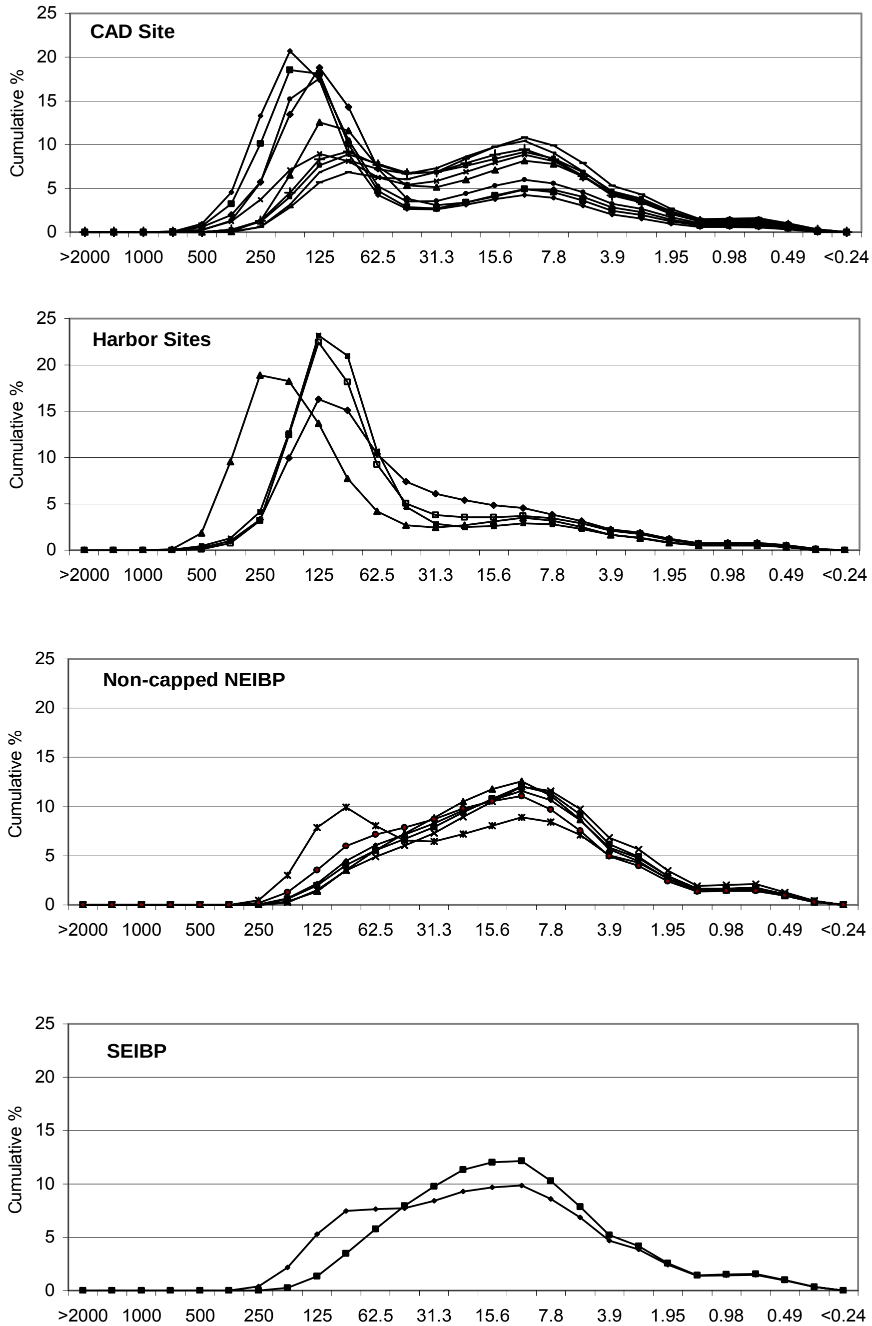

Figure 5-2. Sediment particle size (μ) in percent combined by strata for the NEIBP infauna survey area in 2003.

Table 5-2. Benthic infauna population metrics for the NEIBP survey area. The metrics are divided into groups based on sampling strata.

	CAD Stations											NCADS[1]				NCADW[2]				Habor					SEIBP		
Station	1	2	3	4	5	6	7	8	9	10	AVG	11	12	13	AVG	18	19	20	AVG	14	15	16	17	AVG	21	22	AVG
Individuals																											
2002	220	278	176	344	264	301	235	117	164	911	301	931	628	1245	935	1419	1123	780	1107	409	707	769	732	654	NS	NS	-
2003	212	242	232	161	643	182	138	57	249	538	265	686	656	351	564	1174	1205	1265	1215	606	494	802	825	682	288	100	194
Species																											
2002	26	27	27	32	29	22	18	23	20	54	28	12	5	7	8	23	27	16	22	66	88	97	90	85	NS	NS	-
2003	40	48	42	34	88	37	28	21	37	89	46	5	6	4	5	13	21	14	16	74	77	81	84	79	45	27	36
Diversity																											
2002	1.91	1.84	2.27	2.12	1.90	1.57	1.66	2.05	1.72	2.74	1.98	0.42	0.17	0.17	0.25	0.70	0.92	0.90	0.84	3.38	3.12	3.48	3.26	3.31	NS	NS	-
2003	3.13	3.19	2.90	2.95	3.15	3.03	2.68	2.57	2.69	3.71	3.00	0.30	0.28	0.32	0.30	0.36	0.76	0.65	0.59	3.13	2.86	2.81	2.28	2.77	2.89	2.55	2.72
Dominance																											
2002	2	2	4	3	2	1	2	4	2	6	3	1	1	1	1	1	1	1	1	17	14	17	13	15	NS	NS	-
2003	12	13	10	11	14	11	7	7	6	23	11	1	1	1	1	1	1	1	1	14	16	8	7	11	10	6	8
BRI																											
2002	18.4	24.7	19.7	19.0	23.1	18.7	20.6	24.7	27.2	19.1	21.5	33.1	32.5	29.5	31.7	22.2	19.6	22.0	21.3	11.6	9.6	12.1	13.0	11.6	NS	NS	-
2003	17.6	17.0	18.7	23.0	7.2	23.1	12.3	18.9	27.6	16.2	18.1	31.5	32.2	32.8	32.2	25.3	23.9	25.8	25.0	11.7	7.1	3.5	8.4	7.7	18.8	18.2	18.5

1. NCADS - Non CAD Borrow Pit South
2. NCADW - Non CAD Borrow Pit West
NS - Not Sampled

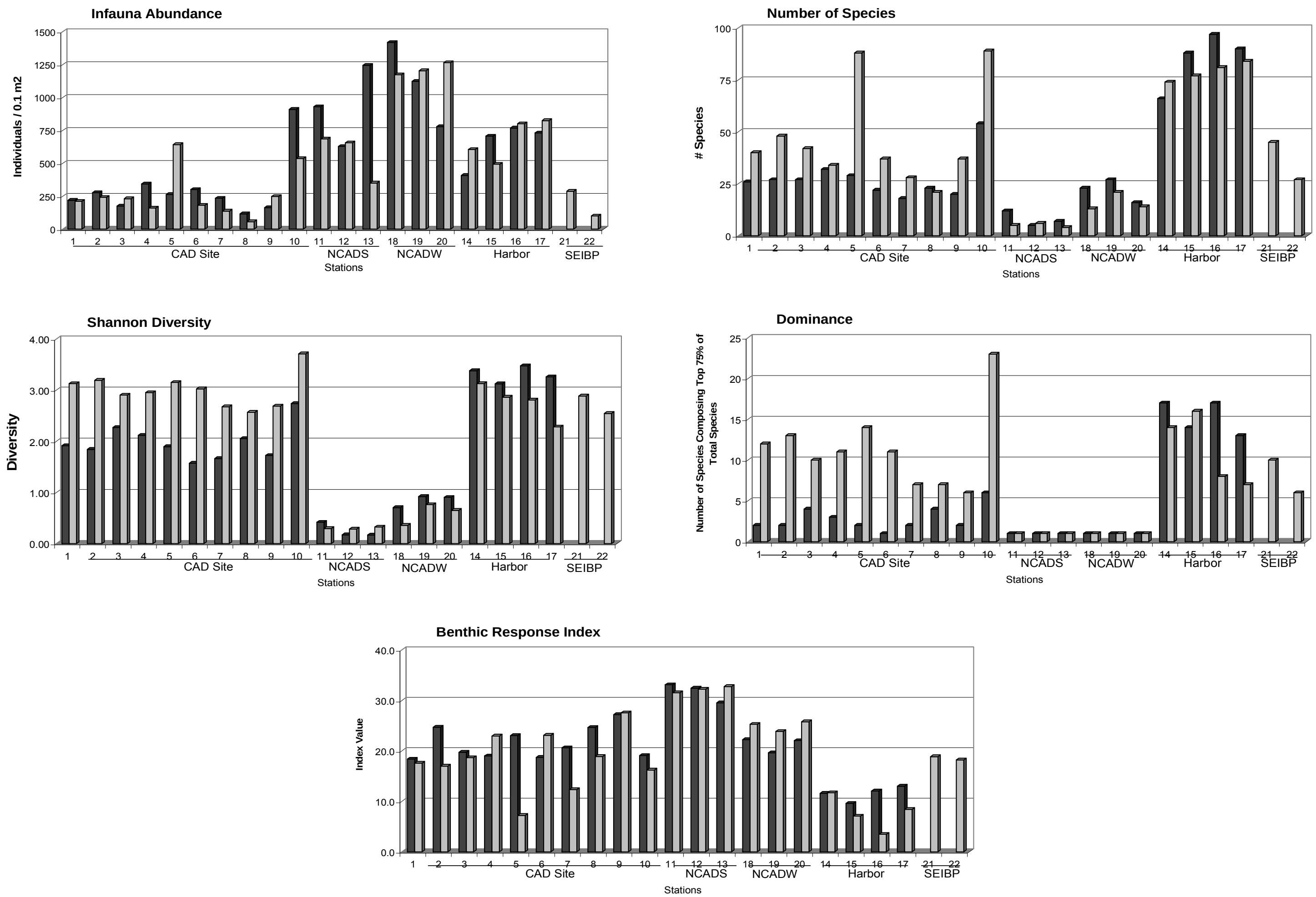

Figure 5-3. Infauna population metrics for the October 2002 and August 2003 NEIBP surveys. Stations are broken into sampling strata: NEIBP CAD site (CAD site), non-capped NEIBP south (NCADS), non-capped NEIBP west (NCADW), Habor surface (Habor) and SEIBP. Light grey bars represent 2002 data, dark bars represent 2003.

Table 5-3. Cumulative abundance of taxa (1.0 mm screen size) in the NEIBP infauna survey area during October 2002. Grayed species represent 75% of the total abundance. All species not shown.

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	5486	46.72	46.72
Polychaeta	Paraprionospio pinnata	1333	11.35	58.07
Polychaeta	Mediomastus sp	1008	8.58	66.66
Malacostraca	Amphideutopus oculatus	397	3.38	70.04
Phoronida	Phoronis sp	366	3.12	73.16
Polychaeta	Monticellina siblina	248	2.11	75.27
Polychaeta	Spiophanes duplex	245	2.09	77.35
Polychaeta	Sigambra tentaculata	234	1.99	79.35
Polychaeta	Pseudopolydora paucibranchiata	175	1.49	80.84
Polychaeta	Leitoscoloplos pugettensis	152	1.29	82.13
Polychaeta	Spiochaetopterus costarum	98	0.83	82.97
Malacostraca	Eochelidium sp A	83	0.71	83.67
Ostracoda	Euphilomedes carcharodonta	79	0.67	84.35
Polychaeta	Cossura sp A	78	0.66	85.01
Malacostraca	Leptochelia dubia	68	0.58	85.59
Polychaeta	Prionospio (Prionospio) heterobranchia	66	0.56	86.15
Polychaeta	Petaloclymene pacifica	63	0.54	86.69
Polychaeta	Scoletoma sp A	63	0.54	87.23
Polychaeta	Chaetozone corona	57	0.49	87.71
Polychaeta	Scoletoma sp C	55	0.47	88.18
Polychaeta	Scoletoma sp	50	0.43	88.61
Polychaeta	Euchone limnicola	49	0.42	89.02
Polychaeta	Apoprionospio pygmaea	49	0.42	89.44
Malacostraca	Spiophanes berkeleyorum	48	0.41	89.85
Polychaeta	Ampelisca cristata microdentata	48	0.41	90.26
Malacostraca	Neotrypaea sp	45	0.38	90.64
Malacostraca	Monocorophium acherusicum	43	0.37	91.01
Polychaeta	Prionospio (Minuspio) lighti	32	0.27	91.28
Polychaeta	Exogone lourei	28	0.24	91.52
Malacostraca	Metamysidopsis elongata	27	0.23	91.75
Polychaeta	Nephtys cornuta	26	0.22	91.97
Polychaeta	Armandia brevis	26	0.22	92.19
Polychaeta	Euclymeninae sp A	26	0.22	92.41
Polychaeta	Levinsenia gracilis	25	0.21	92.62
Polychaeta	Aphelochaeta monilaris	25	0.21	92.84
Malacostraca	Sinocorophium cf. heteroceratum	23	0.20	93.03
Malacostraca	Photis brevipes	23	0.20	93.23
Polychaeta	Photis bifurcata	22	0.19	93.42
Malacostraca	Amphicteis scaphobranchiata	22	0.19	93.60
Polychaeta	Nereis procera	21	0.18	93.78
Polychaeta	Monticellina cryptica	20	0.17	93.95
Polychaeta	Ampharete labrops	20	0.17	94.12
Polychaeta	Anotomastus gordiodes	20	0.17	94.29
Polychaeta	Podarkeopsis glabrus	19	0.16	94.46
Polychaeta	Goniada littorea	19	0.16	94.62
Malacostraca	Paramicrodeutopus schmitti	18	0.15	94.77
Bivalvia	Macoma yoldiformis	17	0.14	94.92
Malacostraca	Caecognathia crenulatifrons	15	0.13	95.04
Polychaeta	Dorvillea (Schistomeringos) longicornis	15	0.13	95.17
Polychaeta	Pectinaria californiensis	15	0.13	95.30
Anopla	Tubulanus polymorphus	15	0.13	95.43
Malacostraca	Caecognathia sp	14	0.12	95.55
Bivalvia	Mactrotoma californica	14	0.12	95.67
Malacostraca	Pyromaia tuberculata	14	0.12	95.78
Polychaeta	Tenonia priops	13	0.11	95.90
Bivalvia	Prionospio (Prionospio) jubata	12	0.10	96.00
Polychaeta	Diplodonta sericata	12	0.10	96.10
Polychaeta	Streblosoma sp B	12	0.10	96.20
	Total abundance represented by dominant species (75%)	8,838	75.27	
	Total number of species represented by dominant species (75%)	6		
	Total abundance of all species	11,742	100.00	
	Total number of species	197		

Table 5-4. Cumulative abundance of taxa (1.0 mm screen size) in the NEIBP infauna survey area during August 2003. Grayed species represent 75% of total abundance. All species not shown.

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	4725	42.55	42.55
Malacostraca	Amphideutopus oculatus	1207	10.87	53.42
Polychaeta	Cossura sp A	431	3.88	57.30
Polychaeta	Monticellina siblina	408	3.67	60.97
Polychaeta	Spiophanes duplex	376	3.39	64.36
Polychaeta	Sigambra tentaculata	322	2.90	67.26
Polychaeta	Mediomastus sp	311	2.80	70.06
Polychaeta	Chaetozone corona	268	2.41	72.47
Polychaeta	Paraprionospio pinnata	193	1.74	74.21
Ostracoda	Euphilomedes carcharodonta	184	1.66	75.87
Phoronida	Phoronis sp	179	1.61	77.48
Polychaeta	Scoletoma sp B	125	1.13	78.60
Polychaeta	Aphelochaeta monilaris	119	1.07	79.68
Anopla	Tubulanus polymorphus	86	0.77	80.45
Scaphopoda	Cadulus aberrans	79	0.71	81.16
Bivalvia	Tagelus subteres	77	0.69	81.86
Polychaeta	Leitoscoloplos pugettensis	75	0.68	82.53
Polychaeta	Streblosoma sp B	69	0.62	83.15
Malacostraca	Ampelisca cristata cristata	63	0.57	83.72
Polychaeta	Prionospio (Prionospio) heterobranchia	62	0.56	84.28
Polychaeta	Ampharete labrops	60	0.54	84.82
Malacostraca	Sinocorophium cf. heteroceratum	52	0.47	85.29
Polychaeta	Scoletoma sp	45	0.41	85.69
Polychaeta	Euclymeninae	45	0.41	86.10
Polychaeta	Spiophanes berkeleyorum	45	0.41	86.50
Polychaeta	Pista disjuncta	41	0.37	86.87
Bivalvia	Nuculana taphria	40	0.36	87.23
Bivalvia	Macoma yoldiformis	39	0.35	87.58
Polychaeta	Cirratulidae	38	0.34	87.92
Bivalvia	Mactrotoma californica	37	0.33	88.26
Polychaeta	Monticellina cryptica	35	0.32	88.57
Polychaeta	Notomastus lineatus	34	0.31	88.88
Malacostraca	Rudilemboides stenopropodus	34	0.31	89.19
Polychaeta	Nephtys cornuta	32	0.29	89.47
Polychaeta	Chone mollis	32	0.29	89.76
Malacostraca	Neotrypaea sp	32	0.29	90.05
Bivalvia	Cooperella subdiaphana	29	0.26	90.31
Polychaeta	Glycera americana	28	0.25	90.56
Polychaeta	Aphelochaeta glandaria	25	0.23	90.79
Bivalvia	Theora lubrica	24	0.22	91.00
Malacostraca	Caecognathia crenulatifrons	24	0.22	91.22
Polychaeta	Prionospio (Minuspio) lighti	24	0.22	91.44
Polychaeta	Nereis procera	23	0.21	91.64
Polychaeta	Amphicteis scaphobranchiata	22	0.20	91.84
Polychaeta	Levinsenia gracilis	21	0.19	92.03
Polychaeta	Aricidea (Acmira) horikoshii	21	0.19	92.22
Polychaeta	Amaeana occidentalis	20	0.18	92.40
Polychaeta	Petaloclymene pacifica	19	0.17	92.57
Malacostraca	Caecognathia sp	19	0.17	92.74
Bivalvia	Diplodonta sericata	18	0.16	92.90
Malacostraca	Scleroplax granulata	17	0.15	93.06
Polychaeta	Spiochaetopterus costarum	17	0.15	93.21
Bivalvia	Periploma discus	16	0.14	93.35
Anthozoa	Edwardsia californica	16	0.14	93.50
Malacostraca	Ericthonius brasiliensis	16	0.14	93.64
Polychaeta	Notomastus sp A	15	0.14	93.78
Polychaeta	Pseudopolydora paucibranchiata	15	0.14	93.91
Malacostraca	Listriella goleta	15	0.14	94.05
Polychaeta	Euchone limnicola	14	0.13	94.17
	Total abundance represented by dominant species (75%)	8,425	75.87	
	Total number of species represented by dominant species (75%)	10		
	Total abundance of all species	11,105	100.00	
	Total number of species	232		

Table 5-5. Species ranked in order of combined abundance for stations located at the CAD site (1-10), Harbor (14-17), south non-capped NEIBP (NCADS 11-13) and west non-capped NEIBP (NCADW 18-20) during 2002 (1.0 mm screen size). Grayed species represent 75% of stratum's total abundance. Only the top 25 species are shown.

CAD Site: Stations 1 - 10

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Paraprionospio pinnata	966	32.15	32.15
Polychaeta	Mediomastus sp	637	21.20	53.34
Order Phoronida	Phoronis sp	317	10.55	63.89
Polychaeta	Monticellina siblina	188	6.26	70.15
Polychaeta	Cossura candida	153	5.09	75.24
Polychaeta	Leitoscoloplos pugettensis	80	2.66	77.90
Polychaeta	Spiophanes duplex	61	2.03	79.93
Polychaeta	Cossura sp A	48	1.60	81.53
Polychaeta	Chaetozone corona	45	1.50	83.03
Polychaeta	Spiophanes berkeleyorum	41	1.36	84.39
Malacostraca	Neotrypaea sp	34	1.13	85.52
Polychaeta	Prionospio (Minuspio) lighti	26	0.87	86.39
Polychaeta	Sigambra tentaculata	24	0.80	87.19
Malacostraca	Amphideutopus oculatus	22	0.73	87.92
Polychaeta	Aphelochaeta monilaris	21	0.70	88.62
Polychaeta	Spiochaetopterus costarum	19	0.63	89.25
Polychaeta	Scoletoma sp C	18	0.60	89.85
Polychaeta	Euchone limnicola	17	0.57	90.42
Polychaeta	Nephtys cornuta	16	0.53	90.95
Polychaeta	Monticellina cryptica	15	0.50	91.45
Polychaeta	Dorvillea (Schistomeringos) longicornis	15	0.50	91.95
Polychaeta	Podarkeopsis glabrus	13	0.43	92.38
Polychaeta	Scoletoma sp	11	0.37	92.75
Polychaeta	Armandia brevis	11	0.37	93.11
Polychaeta	Tenonia priops	10	0.33	93.44
	Total Abundance	3005	100.00	
	Total number of species	89		

Harbor Sites: Stations 14 - 17

Class	Species	Total Abundance	% of Total	Cumulative %
Malacostraca	Amphideutopus oculatus	360	13.76	13.76
Polychaeta	Mediomastus sp	326	12.46	26.21
Polychaeta	Spiophanes duplex	182	6.95	33.17
Polychaeta	Pseudopolydora paucibranchiata	175	6.69	39.85
Malacostraca	Eochelidium sp A	79	3.02	42.87
Ostracoda	Euphilomedes carcharodonta	76	2.90	45.78
Polychaeta	Prionospio (Prionospio) heterobranchia	66	2.52	48.30
Malacostraca	Leptochelia dubia	65	2.48	50.78
Polychaeta	Leitoscoloplos pugettensis	64	2.45	53.23
Polychaeta	Scoletoma sp A	62	2.37	55.60
Polychaeta	Petaloclymene pacifica	61	2.33	57.93
Polychaeta	Monticellina siblina	59	2.25	60.18
Malacostraca	Ampelisca cristata microdentata	47	1.80	61.98
Malacostraca	Monocorophium acherusicum	39	1.49	63.47
Polychaeta	Scoletoma sp	39	1.49	64.96
Polychaeta	Apoprionospio pygmaea	39	1.49	66.45
Polychaeta	Scoletoma sp C	34	1.30	67.75
Polychaeta	Euchone limnicola	32	1.22	68.97
Polychaeta	Cossura sp A	30	1.15	70.12
Polychaeta	Exogone lourei	28	1.07	71.19
Polychaeta	Paraprionospio pinnata	28	1.07	72.26
Polychaeta	Euclymeninae sp A	26	0.99	73.25
Polychaeta	Spiochaetopterus costarum	24	0.92	74.17
Polychaeta	Levinsenia gracilis	24	0.92	75.09
Malacostraca	Photis brevipes	23	0.88	75.96
	Total Abundance	2617	100.00	
	Total number of species	165		

Table 5-5. Continued.

NCADS Sites: Stations 11 - 13

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	2664	95.14	95.14
Polychaeta	Sigambra tentaculata	77	2.75	97.89
Polychaeta	Paraprionospio pinnata	42	1.50	99.39
Order Phoronida	Phoronis sp	7	0.25	99.64
Malacostraca	Neotrypaea sp	2	0.07	99.71
Polychaeta	Spiochaetopterus costarum	1	0.04	99.75
Polychaeta	Nereis procera	1	0.04	99.79
Polychaeta	Mediomastus sp	1	0.04	99.82
Bivalvia	Mactridae	1	0.04	99.86
Polychaeta	Diopatra sp	1	0.04	99.89
Polychaeta	Chaetozone corona	1	0.04	99.93
Polychaeta	Capitella capitata Cmplx	1	0.04	99.96
Malacostraca	Amphideutopus oculatus	1	0.04	100.00
	Total abundance	2800	100.00	
	Total number of species	13		

NCADW Sites: 18 - 20

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	2669	80.39	80.39
Polychaeta	Paraprionospio pinnata	297	8.95	89.34
Polychaeta	Sigambra tentaculata	132	3.98	93.31
Polychaeta	Spiochaetopterus costarum	54	1.63	94.94
Polychaeta	Mediomastus sp	44	1.33	96.27
Order Phoronida	Phoronis sp	35	1.05	97.32
Malacostraca	Amphideutopus oculatus	14	0.42	97.74
Polychaeta	Leitoscoloplos pugettensis	8	0.24	97.98
Malacostraca	Sinocorophium cf. heteroceratum	8	0.24	98.22
Malacostraca	Neotrypaea sp	6	0.18	98.40
Malacostraca	Mysidopsis intii	4	0.12	98.52
Polychaeta	Aphelochaeta monilaris	4	0.12	98.64
Malacostraca	Eochelidium sp A	3	0.09	98.73
Polychaeta	Scoletoma sp C	3	0.09	98.83
Polychaeta	Nephtys cornuta	3	0.09	98.92
Malacostraca	Leptochelia dubia	3	0.09	99.01
Polychaeta	Spiophanes duplex	2	0.06	99.07
Polychaeta	Pectinaria californiensis	2	0.06	99.13
Malacostraca	Monocorophium acherusicum	2	0.06	99.19
Polychaeta	Podarkeopsis glabrus	2	0.06	99.25
Gastropoda	Gastropoda	2	0.06	99.31
Anthozoa	Zaolutus actius	2	0.06	99.37
Malacostraca	Photis bifurcata	2	0.06	99.43
Polychaeta	Tenonia priops	2	0.06	99.49
	Total Abundance	3320	100.00	
	Total number of species	41		

Table 5-6. Species ranked in order of combined abundance for stations located at the CAD site (1-10), Harbor (14-17), south non-capped NEIBP (NCADS 11-13) west non-capped NEIBP (NCADW 18-20), SEIBP (21-22) during 2003 (1.0 mm screen size). Grayed species represent 75% of stratum's total abundance. Only the top 25 species are shown.

CAD Site: Stations 1 - 10

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Monticellina siblina	305	11.50	11.50
Polychaeta	Chaetozone corona	241	9.08	20.58
Malacostraca	Amphideutopus oculatus	217	8.18	28.76
Polychaeta	Mediomastus sp	207	7.80	36.56
Polychaeta	Paraprionospio pinnata	123	4.64	41.20
Polychaeta	Cossura sp A	117	4.41	45.61
Order Phoronida	Phoronis sp	96	3.62	49.23
Polychaeta	Aphelochaeta monilaris	93	3.51	52.73
Polychaeta	Spiophanes duplex	81	3.05	55.79
Ostracoda	Euphilomedes carcharodonta	80	3.02	58.80
Scaphopoda	Cadulus aberrans	73	2.75	61.55
Anopla	Tubulanus polymorphus	61	2.30	63.85
Polychaeta	Scoletoma sp B	59	2.22	66.08
Polychaeta	Leitoscoloplos pugettensis	56	2.11	68.19
Polychaeta	Streblosoma sp B	54	2.04	70.22
Polychaeta	Spiophanes berkeleyorum	36	1.36	71.58
Polychaeta	Cirratulidae	36	1.36	72.94
Malacostraca	Neotrypaea sp	29	1.09	74.03
Bivalvia	Nuculana taphria	25	0.94	74.97
Polychaeta	Scoletoma sp	25	0.94	75.91
Polychaeta	Monticellina cryptica	23	0.87	76.78
Polychaeta	Aphelochaeta glandaria	23	0.87	77.65
Polychaeta	Nephtys cornuta	23	0.87	78.51
Polychaeta	Ampharete labrops	21	0.79	79.31
Polychaeta	Cossura candida	21	0.79	80.10
	Total abundance	2653	100.00	
	Total number of species	159		

Harbor Sites: Stations 14 - 17

Class	Species	Total Abundance	% of Total	Cumulative %
Malacostraca	Amphideutopus oculatus	983	36.05	36.05
Polychaeta	Spiophanes duplex	293	10.74	46.79
Ostracoda	Euphilomedes carcharodonta	96	3.52	50.31
Polychaeta	Mediomastus sp	80	2.93	53.25
Bivalvia	Tagelus subteres	76	2.79	56.03
Polychaeta	Prionospio (Prionospio) heterobranchia	61	2.24	58.27
Polychaeta	Scoletoma sp B	59	2.16	60.43
Malacostraca	Sinocorophium cf. heteroceratum	51	1.87	62.30
Malacostraca	Ampelisca cristata cristata	47	1.72	64.03
Polychaeta	Euclymeninae	39	1.43	65.46
Polychaeta	Ampharete labrops	38	1.39	66.85
Bivalvia	Mactrotoma californica	37	1.36	68.21
Polychaeta	Notomastus lineatus	34	1.25	69.45
Malacostraca	Rudilemboides stenopropodus	34	1.25	70.70
Bivalvia	Cooperella subdiaphana	29	1.06	71.76
Polychaeta	Monticellina siblina	28	1.03	72.79
Polychaeta	Cossura candida	25	0.92	73.71
Polychaeta	Pista disjuncta	22	0.81	74.51
Polychaeta	Levinsenia gracilis	20	0.73	75.25
Bivalvia	Macoma yoldiformis	19	0.70	75.94
Order Phoronida	Phoronis sp	19	0.70	76.64
Anopla	Tubulanus polymorphus	19	0.70	77.34
Polychaeta	Leitoscoloplos pugettensis	19	0.70	78.03
Bivalvia	Diplodonta sericata	18	0.66	78.69
Polychaeta	Scoletoma sp	17	0.62	79.32
	Total abundance	2727	100.00	
	Total number of species	170		

Table 5-6. Continued.

NCADS Sites: Stations 11 - 13

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	1565	92.44	92.44
Polychaeta	Sigambra tentaculata	117	6.91	99.35
Malacostraca	Neotrypaea gigas	3	0.18	92.44
Malacostraca	Neotrypaea sp	2	0.12	99.65
Malacostraca	Alienacanthomysis macropsis	2	0.12	92.44
Polychaeta	Scoletoma sp B	1	0.06	99.82
Polychaeta	Levinsenia gracilis	1	0.06	92.44
Polychaeta	Glycera americana	1	0.06	99.94
Malacostraca	Caprella sp	1	0.06	92.44
	Total abundance	1693	100.00	
	Total number of species	9		

NCADW Sites: 18 - 20

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Cossura candida	3082	84.58	84.58
Polychaeta	Cossura sp A	296	8.12	92.70
Polychaeta	Sigambra tentaculata	193	5.30	98.00
Polychaeta	Paraprionospio pinnata	11	0.30	98.30
Polychaeta	Aphelochaeta monilaris	7	0.19	98.49
Polychaeta	Mediomastus sp	7	0.19	98.68
Polychaeta	Nephtys cornuta	6	0.16	98.85
Order Phoronida	Phoronis sp	6	0.16	99.01
Malacostraca	Alienacanthomysis macropsis	5	0.14	99.15
Ostracoda	Euphilomedes carcharodonta	4	0.11	99.26
Malacostraca	Neotrypaea gigas	4	0.11	99.37
Polychaeta	Monticellina cryptica	3	0.08	99.45
Malacostraca	Pinnotheridae	2	0.05	99.51
Gastropoda	Olivella baetica	2	0.05	99.56
Malacostraca	Majidae	1	0.03	99.59
Malacostraca	Caprella natalensis	1	0.03	99.62
Polychaeta	Chaetozone corona	1	0.03	99.64
Polychaeta	Aphelochaeta glandaria	1	0.03	99.67
Bivalvia	Compsomyax subdiaphana	1	0.03	99.70
Malacostraca	Amphideutopus oculatus	1	0.03	99.73
Polychaeta	Ampharete labrops	1	0.03	99.75
Bivalvia	Cryptomya californica	1	0.03	99.78
Polychaeta	Glycera americana	1	0.03	99.81
Malacostraca	Listriella goleta	1	0.03	99.84
Malacostraca	Oxyurostylis pacifica	1	0.03	99.86
	Total abundance	3644	100.00	
	Total number of species	30		

SEIBP Sites: 21 - 22

Class	Species	Total Abundance	% of Total	Cumulative %
Polychaeta	Monticellina siblina	75	19.33	19.33
Order Phoronida	Phoronis sp	58	14.95	34.28
Polychaeta	Paraprionospio pinnata	43	11.08	45.36
Polychaeta	Cossura candida	32	8.25	53.61
Polychaeta	Aphelochaeta monilaris	19	4.90	58.51
Polychaeta	Mediomastus sp	17	4.38	62.89
Polychaeta	Chaetozone corona	14	3.61	66.49
Polychaeta	Cossura sp A	14	3.61	70.10
Gastropoda	Turbonilla sp	9	2.32	72.42
Polychaeta	Spiophanes berkeleyorum	9	2.32	74.74
Polychaeta	Prionospio (Minuspio) lighti	6	1.55	76.29
Malacostraca	Amphideutopus oculatus	6	1.55	77.84
Malacostraca	Scleroplax granulata	6	1.55	79.38
Polychaeta	Scoletoma sp B	6	1.55	80.93
Anopla	Tubulanus polymorphus	6	1.55	82.47
Anthozoa	Edwardsia californica	5	1.29	83.76
Bivalvia	Nuculana taphria	4	1.03	84.79
Ostracoda	Euphilomedes carcharodonta	4	1.03	85.82
Polychaeta	Monticellina cryptica	3	0.77	86.60
Bivalvia	Periploma discus	3	0.77	87.37
Polychaeta	Nereis procera	3	0.77	88.14
Polychaeta	Scoletoma sp	3	0.77	88.92
Polychaeta	Spiochaetopterus costarum	3	0.77	89.69
Gastropoda	Odostomia sp	2	0.52	90.21
Anopla	Lineidae	2	0.52	90.72
	Total abundance	388	100.00	
	Total number of species	53		

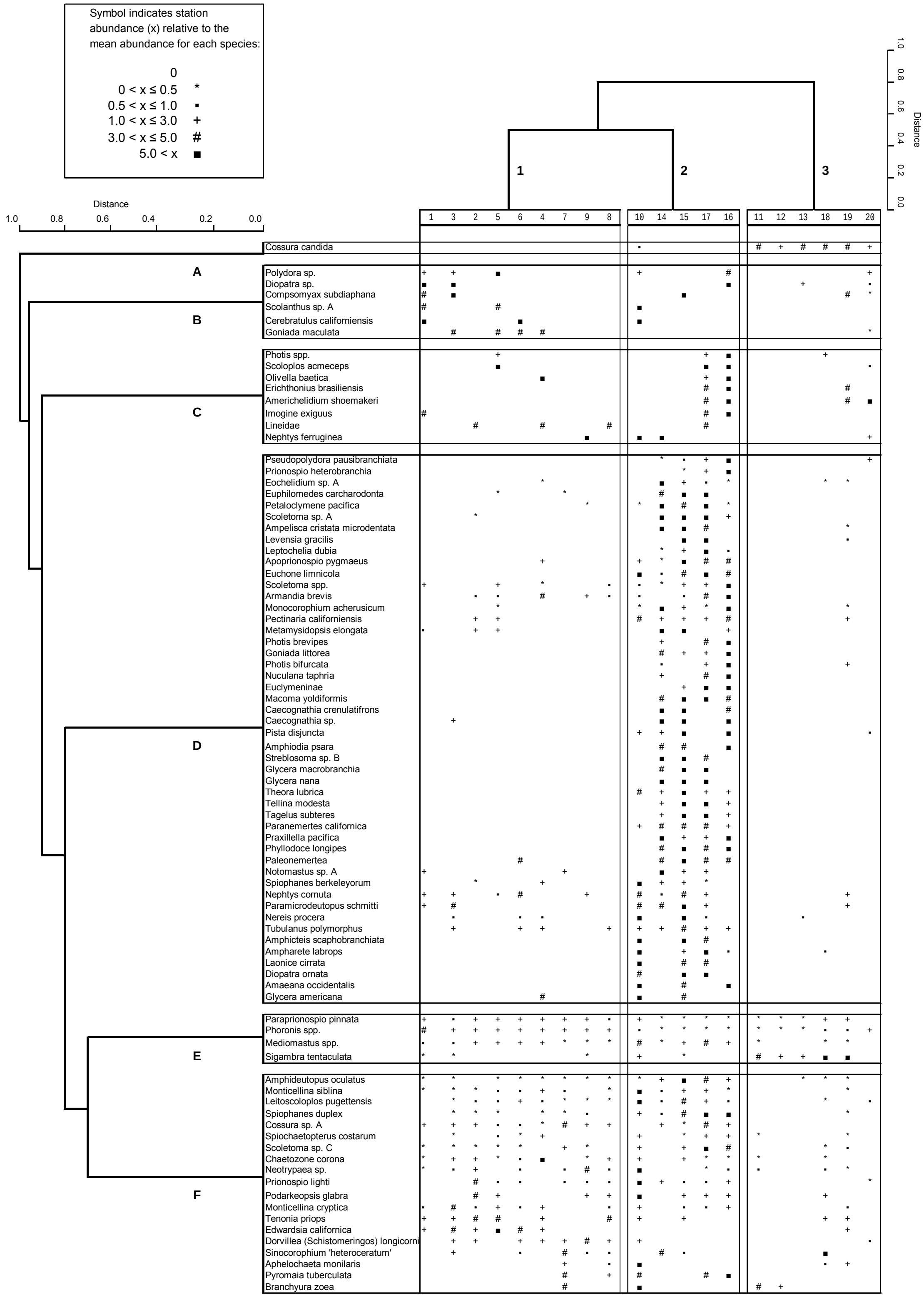

Figure 5-4. 2002 two-way coincidence table of species groups vs. stations as resolved by cluster analysis (UPGMA) using the Bray-Curtis Similarity Metric. Data were square root transformed. Symbols represent the relative abundance of each species at a station.

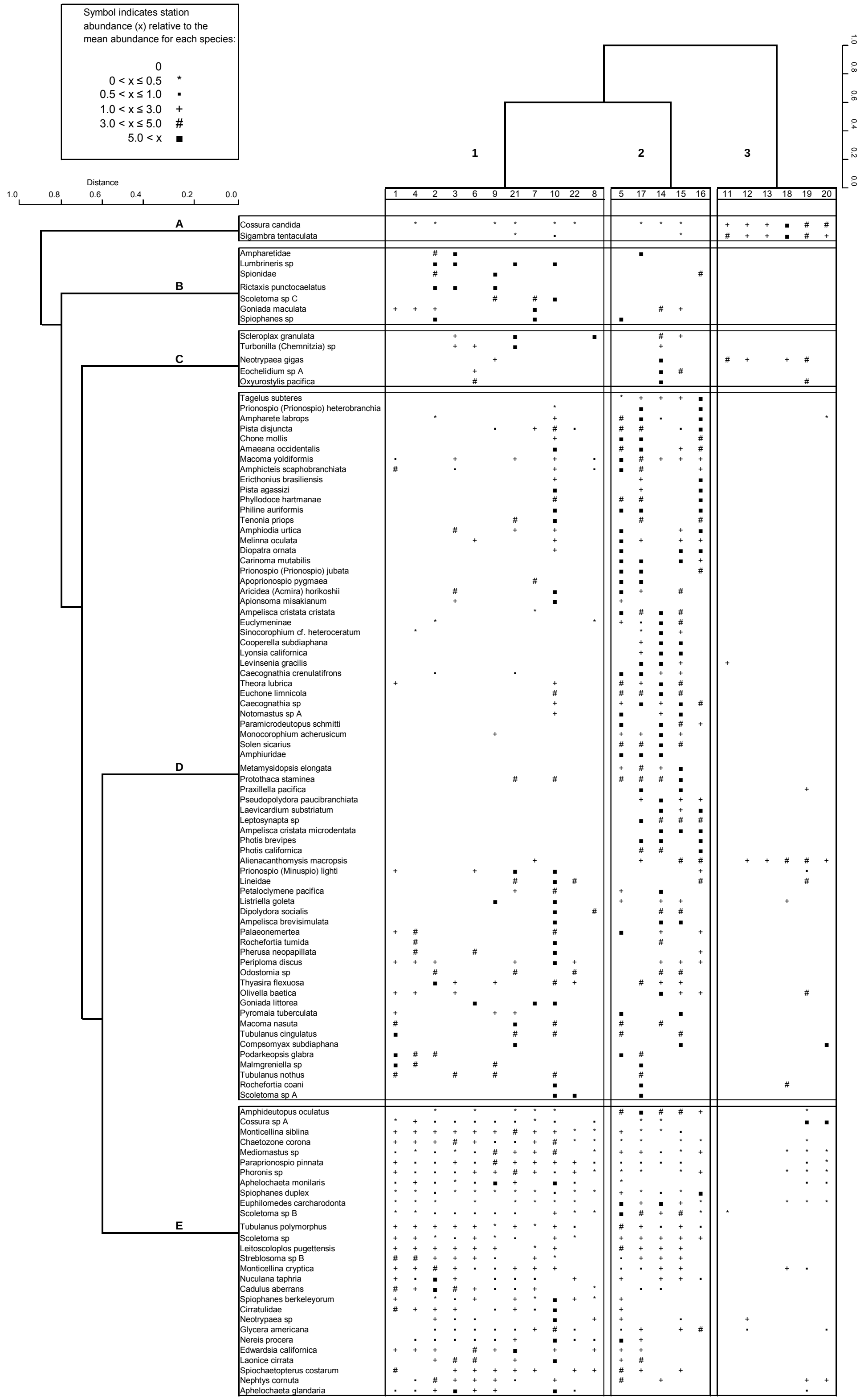

Figure 5-5. 2003 two-way coincidence table of species groups vs. stations as resolved by cluster analysis (UPGMA) using the Bray-Curtis Similarity Metric. Data were square root transformed. Symbols represent the relative abundance of each species at a station.

Table 5-7. 2002 comparison of abundances and numbers of species collected on 1.0 vs. 0.5 mm mesh screens by station and stratum in the NEIBP survey area.

Station	Strata	Combined Abund	Combined Species	1.0 mm Abund	1.0 mm Species	0.5 mm Abund	0.5 mm Species	Species Common to Both	Species Unique 1.0 mm	Species Unique 0.5 mm
1	CAD	400	52	220	26	180	36	10	16	26
7	CAD	476	37	235	18	241	31	12	6	19
8	CAD	234	33	117	23	117	22	12	11	10
17	Harbor	1612	104	732	90	880	43	29	61	14
19	Uncapped Borrow Pit	1578	44	1123	27	455	31	14	13	17
	Total	4300	270	2427	184	1873	163			
	% of Total			56	68	44	60			

Table 5-8. 2003 comparison of abundances and numbers of species collected on 1.0 vs. 0.5 mm mesh screens by station and stratum in the NEIBP survey area.

Station	Strata	Combined Abund	Combined Species	1.0 mm Abund	1.0 mm Species	0.5 mm Abund	0.5 mm Species	Species Common to Both	Species Unique 1.0 mm	Species Unique 0.5 mm
1	CAD	366	48	212	40	154	20	12	28	8
7	CAD	179	38	138	28	41	18	8	20	10
8	CAD	297	44	249	37	48	13	6	31	7
17	Harbor	1361	102	825	84	536	47	29	55	18
19	Uncapped Borrow Pit	1565	31	1205	21	360	22	12	9	10
	SEIBP	450	55	288	45	162	22	12	33	10
	Total	4218	318	2917	255	1301	142			
	% of Total			69	80	31	45			

Table 5-9. Comparison of abundances of taxa collected on 1.0 vs. 0.5 mm mesh screens by station, stratum, mesh size and phylogenic group in the NEIBP survey area during 2002 and 2003.

Taxonomic Group	Year	Station/Strata											
		CAD Site						Harbor		Non-CAD Borrow Pit		SEIBP	
		1		7		8		17		19		21	
		mesh sz (mm)		mesh sz (mm)		mesh sz (mm)		mesh sz (mm)		mesh sz (mm)		mesh sz (mm)	
		1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5
Annelids	2002	151	20	181	21	83	13	504	21	1089	14	-	-
	2003	159	150	99	35	209	41	237	123	1189	344	195	156
Arthropods	2002	6	10	11	4	8	6	187	16	17	12	-	-
	2003	3	2	10	5	9	6	542	400	9	15	17	5
Mollusks	2002	2	1	0	0	0	0	23	4	1	1	-	-
	2003	25	0	11	0	6	1	28	11	2	1	22	0
Echinoderms	2002	0	0	0	0	0	0	4	0	0	0	-	-
	2003	0	0	0	0	0	0	4	0	0	0	3	0
Other Phyla	2002	61	4	41	5	26	3	14	2	16	3	-	-
	2003	25	2	18	1	25	0	14	2	5	0	51	1

Table 5-10. Cumulative abundance of taxa (0.5 mm screen size) from five stations in the NEIBP infauna survey area during October 2002. Grayed species represent 75% of the total abundance.

Species	Total Abundance	% of Total	Cumulative %
Cossura candida	398	21.28	21.28
Mediomastus sp	367	19.63	40.91
Amphideutopus oculatus	212	11.34	52.25
Leptochelia dubia	115	6.15	58.40
Photis bifurcata	114	6.10	64.49
Prionospio (Minuspio) lighti	77	4.12	68.61
Rutiderma lomae	61	3.26	71.87
Apoprionospio pygmaea	51	2.73	74.60
Euphilomedes carcharodonta	34	1.82	76.42
Leitoscoloplos pugettensis	34	1.82	78.24
Nephtys cornuta	33	1.76	80.00
Aphelochaeta monilaris	31	1.66	81.66
Spiophanes duplex	30	1.60	83.26
Sigambra tentaculata	30	1.60	84.87
Phoronis sp	21	1.12	85.99
Paraprionospio pinnata	19	1.02	87.01
Levinsenia gracilis	17	0.91	87.91
Chaetozone corona	15	0.80	88.72
Neotrypaea sp	15	0.80	89.52
Photis sp	14	0.75	90.27
Paramicrodeutopus schmitti	14	0.75	91.02
Eochelidium sp A	13	0.70	91.71
Podarkeopsis glabrus	12	0.64	92.35
Monocorophium acherusicum	12	0.64	92.99
Rudilemboides stenopropodus	11	0.59	93.58
Dorvillea (Schistomeringos) longicornis	10	0.53	94.12
Cossura sp A	6	0.32	94.44
Ampelisca cristata microdentata	6	0.32	94.76
Spiochaetopterus costarum	5	0.27	95.03
Armandia brevis	5	0.27	95.29
Nereis procera	5	0.27	95.56
Oxyurostylis pacifica	5	0.27	95.83
Sinocorophium cf. heteroceratum	5	0.27	96.10
Cirratulidae	4	0.21	96.31
Lineidae	4	0.21	96.52
Americhelidium shoemakeri	4	0.21	96.74
Tubulanus polymorphus	4	0.21	96.95
Euchone limnicola	4	0.21	97.17
Monticellina cryptica	4	0.21	97.38
Tenonia priops	4	0.21	97.59
Caecognathia sp	3	0.16	97.75
Aricidea (Acmira) sp	3	0.16	97.91
Gastropoda	2	0.11	98.02
Tellina modesta	2	0.11	98.13
Dipolydora socialis	2	0.11	98.24
Exogone lourei	2	0.11	98.34
Cumella californica	2	0.11	98.45
Oligochaeta	2	0.11	98.56
Anthozoa	2	0.11	98.66
Palaeonemertea	2	0.11	98.77
Cumingia californica	1	0.05	98.82
Capitella capitata Cmplx	1	0.05	98.88
Discosolenia burchami	1	0.05	98.93
Argissa hamatipes	1	0.05	98.98
Mysidopsis intii	1	0.05	99.04
Scoletoma sp A	1	0.05	99.09
Prionospio (Prionospio) heterobranchia	1	0.05	99.14
Polydora sp	1	0.05	99.20
Pilargidae	1	0.05	99.25
Phyllodoce longipes	1	0.05	99.30
Pherusa neopapillata	1	0.05	99.36
Petaloclymene pacifica	1	0.05	99.41
Lyonsia californica	1	0.05	99.47
Nephtys caecoides	1	0.05	99.52
Edwardsiidae	1	0.05	99.57
Mysidacea	1	0.05	99.63
Melphisana bola Cmplx	1	0.05	99.68
Listriella goleta	1	0.05	99.73
Hydrozoa	1	0.05	99.79
Hoplonemertea	1	0.05	99.84
Hippomedon zetesimus	1	0.05	99.89
Eusarsiella thominx	1	0.05	99.95
Olivella baetica	1	0.05	100.00
Total Abundance	1870	100.00	
Total number of species	73		

Table 5-11. Cumulative abundance of taxa (0.5 mm screen size) from five stations in the NEIBP and one station in the SEIBP infauna survey area during August 2003. Grayed species represent 75% of the total abundance.

Species	Total Abundance	% of Total	Cumulative %
Amphideutopus oculatus	298	22.91	22.91
Cossura sp A	173	13.30	36.20
Mediomastus sp	171	13.14	49.35
Cossura candida	119	9.15	58.49
Nephtys cornuta	65	5.00	63.49
Euphilomedes carcharodonta	64	4.92	68.41
Monticellina siblina	60	4.61	73.02
Cirratulidae	59	4.53	77.56
Aphelochaeta monilaris	42	3.23	80.78
Prionospio (Minuspio) lighti	31	2.38	83.17
Leitoscoloplos pugettensis	24	1.84	85.01
Copepoda	19	1.46	86.47
Monticellina cryptica	13	1.00	87.47
Photis sp	12	0.92	88.39
Aphelochaeta glandaria	11	0.85	89.24
Rutiderma lomae	7	0.54	89.78
Levinsenia gracilis	7	0.54	90.32
Apoprionospio pygmaea	7	0.54	90.85
Spiophanes duplex	5	0.38	91.24
Aphelochaeta sp	5	0.38	91.62
Paraprionospio pinnata	5	0.38	92.01
Cossura sp	5	0.38	92.39
Caecognathia sp	5	0.38	92.77
Tagelus subteres	5	0.38	93.16
Sigambra tentaculata	4	0.31	93.47
Prionospio (Prionospio) jubata	4	0.31	93.77
Leptostylis calva	4	0.31	94.08
Photis bifurcata	4	0.31	94.39
Aricidea (Acmira) catherinae	3	0.23	94.62
Leptochelia dubia	3	0.23	94.85
Spionidae	3	0.23	95.08
Scoletoma sp B	3	0.23	95.31
Phoronis sp	3	0.23	95.54
Paramicrodeutopus schmitti	3	0.23	95.77
Rochefortia tumida	2	0.15	95.93
Tenonia priops	2	0.15	96.08
Euchone limnicola	2	0.15	96.23
Streblosoma sp B	2	0.15	96.39
Glycera americana	2	0.15	96.54
Chone mollis	2	0.15	96.69
Spiochaetopterus costarum	2	0.15	96.85
Bivalvia	2	0.15	97.00
Praxillella pacifica	2	0.15	97.16
Podarkeopsis glabrus	2	0.15	97.31
Photis californica	2	0.15	97.46
Palaeonemertea	2	0.15	97.62
Ampharetidae	1	0.08	97.69
Asteropella slatteryi	1	0.08	97.77
Aricidea (Aricidea) wassi	1	0.08	97.85
Aricidea (Acmira) horikoshii	1	0.08	97.92
Tubulanus polymorphus	1	0.08	98.00
Cirrophorus furcatus	1	0.08	98.08
Vitrinella oldroydi	1	0.08	98.16
Cooperella subdiaphana	1	0.08	98.23
Theora lubrica	1	0.08	98.31
Typhlotanais crassus	1	0.08	98.39
Ampelisca cristata cristata	1	0.08	98.46
Amaeana occidentalis	1	0.08	98.54
Scoletoma sp A	1	0.08	98.62
Prionospio (Prionospio) heterobranchia	1	0.08	98.69
Phyllodoce hartmanae	1	0.08	98.77
Photis brevipes	1	0.08	98.85
Petaloclymene pacifica	1	0.08	98.92
Oxyurostylis pacifica	1	0.08	99.00
Olivella baetica	1	0.08	99.08
Glycera sp	1	0.08	99.15
Xenoleberis californica	1	0.08	99.23
Deflexilodes norvegicus	1	0.08	99.31
Malmgreniella sp	1	0.08	99.39
Scoloplos sp	1	0.08	99.46
Spiophanes sp	1	0.08	99.54
Monocorophium acherusicum	1	0.08	99.62
Exogone lourei	1	0.08	99.69
Eusarsiella thominx	1	0.08	99.77
Ericthonius brasiliensis	1	0.08	99.85
Eochelidium sp A	1	0.08	99.92
Neotrypaea sp	1	0.08	100.00
Total abundance	1301	100.00	
Total number of species	77		

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Table 5-12. Burrowing infauna organisms collected from the NEIBP survey area.

Species	Group	Potential Burrow Depth (inches)
Amphiodia occidentalis	Crustacean	4”
Cerebratulus californiensis	Nemertean	36”, lateral displacement
Haminoea sp.	Gastropod	2”
Leptosynapta sp.	Echinoderm	6”
Neotrypaea sp.	Crustacean	>50 to 90”, vertical displacement
Pachycerianthus fimbriatus	Anthozoan	18”
Solen sicarius	Bivalve	12”
Tagelus subteres	Bivalve	12”

Table 5-13. Occurrence of the ghost shrimp (*Neotrypaea sp.*) at stations in the NEIBP survey area during 2002 and 2003. All organisms were captured on a 1.0 mm mesh screen.

	Stations																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
2002																							
Neotrypaea gigas	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	-	-	1
Neotrypaea sp	1	3	2	0	0	2	2	2	10	12	2	0	0	0	0	2	1	2	1	3	-	-	45
2003																							
Neotrypaea gigas	0	0	0	0	0	0	0	0	1	0	2	1	0	6	0	0	0	1	3	0	0	0	14
Neotrypaea sp	0	3	1	0	3	1	0	3	0	18	0	2	0	0	1	0	0	0	0	0	0	0	32

Table 5-14. 2002 vs 2003 comparison of ghost shrimp (*Neotrypaea sp.*) collected on 1.0 vs. 0.5 mm screens in the NEIBP survey area.

Station	Species	2002 mesh size (mm)		2003 mesh size (mm)	
		0.5	1.0	0.5	1.0
1	Neotrypaea sp.	0	1	0	0
7	Neotrypaea sp.	6	2	0	0
8	Neotrypaea sp.	6	2	0	1
17	Neotrypaea sp.	0	1	0	0
19	Neotrypaea sp.	3	1	1	3
21	Neotrypaea sp.	-	-	0	0

Table 5-15. Selected benthic infauna species reported to be representative of background, organically enriched, and polluted habitats (from MEC, 2002 and footnoted references).

Background	**Organically Enriched**		**Polluted**
	Low Enrichment	**Moderate Enrichment**	
Ampelisca spp.	*Anaitides* spp.	*Bittium* spp.	*Armandia bioculata* [3]
Amphiodia spp. [3,4]	*Axinopsida serricata* [3,4]	*Boccardia proboscidea* [5]	*Capitella capitata* [1,2,3,4]
Cossura candida [1]	*Cerianthus* spp.	*Cirriformia* luxuriosa 1,2	Dorvilleidae [2,3,4]
Heterophoxus oculatus [3]	*Chloeia pinnata* [4]	*Eteone* spp.	*Nereis procera* [4]
Maldane sarsi [3]	*Corophium acherusicum* [2]	*Exogone lourei* [5]	*Notomastus* sp. [2,4]
Metaphoxus, Paraphoxus [3]	*Eumida sanguinea* [2]	*Heteromastus filiformis*	Oligochaeta [2]
Nereis procera [1]	*Euphilomedes* spp. [3,4]	*Macoma carlottensis, nasuta* [2,3]	*Ophryotrocha* spp.
Pectinaria californiensis [3]	*Glycinde picta* [2]	*Nereis diversicolor* [2]	Rochefortia (= *Mysella*) pedroana 4
Phoronis spp. [3,4]	*Goniada maculata* [2]	*Nereis grubei* [5]	*Schistomeringos longicornis* [2,3,4]
Spiophanes missionensis [4]	*Hetreophoxus oculatus* [4]	*Ophiodromus puggetensis* [2]	*Solemya* spp. [2,3]
Stenenelenella uniformis [3]	*Leitoscoloplos (=Haploscoloplos)*	*Parvilucina tenuisculpta* [3,4]	Stenothoidae amphipods [3]
Tharyx ? parvus [1]	*Lumbrineris* spp.	*Polydora ciliata, ligni*	*Tharyx* spp.
	Mediomastus spp. [3,4]	*Pseudopolydora paucibranchiata* [1,2]	
	Neanthes spp.	*Schistomeringos longicornis* [1]	
	Nephtys cornuta [2]	*Scololepis fulginosa* [2]	
	Photis spp.	*Spiochaetopterus costarum* [3,4]	
	Paraprionospio (= *Prionospio*) *pinnata* [2]	*Streblospio benedicti* [2]	
	Prionospio lighti (cirrifera), *heterobranchia, steenstrupi* [2,4]	*Tharyx* spp.	
	Pygospio elegans [2]	*Thyasira flexuosa* [2]	
	Rochefortia (= *Mysella*) *pedroana, tumida* [3]		
	Scoloplos armiger		
	Tharyx spp.		

Notes: (1) Species reported by Pearson and Rosenberg were assigned based on review of their comments. Species reported as "transitional" by Thompson were assigned based on consistency with other reports.
(2) Species in more than one category were considered transitional.
Sources: 1 Reish 1959, 2 Pearson and Rosenberg 1978, 3 Word 1978, 4 Thompson 1982, 5 Dorsey et al. 1983.

Table 5-16. Comparison of community metrics measured during the 2002 and 2003 CAD site surveys with the Year 2000 Baseline survey (MEC 2000). Each metric is presented as the average and range of all stations from each stratum, with all deep and shallow water strata from the Year 2000 Baseline survey combined into a single range.

Metric	Year 2000 Baseline				CAD Site Survey 2002 - 2003					
	Deep Water (11 - 25 m)		Shallow Water (4 - 6 m)		CAD Site (12 -14 m)		Harbor (8 to 12 m)		Non-Capped NEIBP (18 - 20 m)	
	Avg	Range	Avg	Range	Avg	Range	Avg	Range	Avg	Range
Abundance	249	90 - 515	716	291 - 1,040	283	57 - 911	668	409 - 825	955	351 - 1419
Number of Species	34	12 - 47	37	13 - 58	37	18 - 89	82	66 - 97	13	4 - 27
Shannon Diversity	2.76	1.41 - 3.28	2.29	1.10 - 2.92	2.49	1.57 - 3.71	3.04	2.81 - 3.48	0.49	0.36 - 3.48
Dominance	11	4 - 17	7	2 - 11	7	1 - 23	13	7 - 17	1	1

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APPENDIX B – ACKNOWLEDGEMENTS

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APPENDIX C – CORE AND BURROW MOUND PARTICLE SIZE AND CHEMISTRY

Table C-1. Particle sizes of burrow mound and core samples collected from the NEIBP in October 2002.

Sample ID	phi Size ≥0.5 / Microns ≥700 / coarse sand	1 / 500 / coarse sand	1.5 / 350 / med sand	2 / 250 / med sand	2.5 / 176 / fine sand	3 / 125 / fine sand	3.5 / 88 / very fine sand	4 / 62 / very fine sand	4.5 / 44 / very fine sand	5 / 31 / coarse silt	5.5 / 22 / med silt	6 / 16 / med silt	6.5 / 11 / silt	7 / 7.8 / fine silt	7.5 / 5.5 / very fine silt	8 / 3.9 / very fine silt	8.5 / 2.8 / clay	<9 / <2 / clay	Summary Percent Sand	Silt	Clay	Fines	Percentile (microns) 16%	50%	84%	Percentile (phi) 16%	50%	84%	Dispersion or Sorting Index
Bioturbator 1	2.9	6.0	11.8	15.1	18.0	17.2	12.3	5.7	2.6	1.6	1.3	1.4	1.3	1.1	0.9	0.6	0.4	0.0	88.9	10.8	0.4	11.2	58.9	135.3	286.9	4.08	2.88	1.79	1.146
Bioturbator 2	0.0	0.0	1.2	2.9	6.1	8.5	8.8	6.7	5.9	6.3	7.8	9.4	9.3	8.4	7.2	5.6	4.1	1.8	34.1	60.0	5.8	65.8	4.1	12.4	42.7	7.93	6.34	4.55	1.693
Bioturbator 3	0.0	0.0	0.3	0.7	2.0	3.1	4.4	5.1	6.7	8.2	10.5	12.5	12.0	10.6	9.2	7.0	5.1	2.4	15.6	76.7	7.6	84.3	4.1	12.4	42.7	7.93	6.34	4.55	1.693
Bioturbator 4	2.7	2.0	7.7	12.5	16.6	16.6	12.8	6.7	3.5	2.5	2.5	2.9	2.8	2.6	2.3	1.7	1.3	0.0	77.8	20.8	1.3	22.1	25.2	105.8	227.4	5.31	3.24	2.13	1.593
Bioturbator 5	0.0	0.0	2.0	4.3	8.4	11.1	10.6	7.0	5.2	4.9	6.2	7.7	7.8	7.4	6.6	5.2	4.0	1.6	43.4	51.0	5.6	56.6	5.2	30.4	121.0	7.60	5.04	3.04	2.277
Bioturbator 6	3.6	4.1	8.5	11.4	14.9	15.6	12.1	6.2	3.1	2.2	2.4	2.9	2.9	2.9	2.7	2.3	1.8	0.3	76.4	21.5	2.1	23.6	15.8	107.1	252.6	5.99	3.22	1.98	2.005
2S	2.4	6.9	12.3	14.8	15.3	13.4	9.8	5.3	3.2	2.6	2.5	2.7	2.4	2.0	1.8	1.5	1.2	0.1	80.1	18.6	1.4	19.9	32.0	130.5	292.7	4.96	2.93	1.76	1.600
2M	2.7	7.8	15.0	18.8	19.2	15.3	9.5	4.2	1.9	1.0	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.0	92.5	6.9	0.6	7.5	74.0	159.1	313.0	3.75	2.65	1.67	1.043
2B	1.2	2.3	1.5	1.9	3.2	4.6	7.5	9.7	10.8	10.2	9.8	9.4	7.6	6.2	5.3	4.1	3.2	1.4	31.9	63.6	4.6	68.1	6.3	24.6	86.7	7.32	5.35	3.52	1.899
3S	2.4	9.5	17.5	20.2	18.9	14.4	9.1	4.0	1.6	0.8	0.4	0.4	0.3	0.2	0.2	0.2	0.1	0.0	95.9	4.0	0.1	4.1	84.1	174.6	324.3	3.57	2.51	1.62	0.976
3M	0.6	9.1	15.0	18.2	18.9	15.8	10.2	4.6	2.2	1.4	0.9	0.9	0.7	0.5	0.4	0.3	0.3	0.0	92.4	7.3	0.3	7.6	69.2	148.1	305.3	3.85	2.75	1.70	1.074
3B	0.0	3.2	2.4	3.9	5.7	6.6	8.3	8.9	9.2	8.8	8.4	8.3	7.2	5.8	4.9	4.0	3.0	1.1	39.1	56.7	4.2	60.9	6.7	31.2	122.4	7.22	5.00	3.03	2.098
4S	0.6	9.2	15.2	18.0	18.6	15.8	10.7	4.9	2.1	1.2	0.8	0.8	0.6	0.5	0.4	0.4	0.3	0.0	93.0	6.8	0.3	7.1	72.2	156.6	305.7	3.79	2.67	1.70	1.044
4M	0.0	2.9	4.5	8.4	14.0	17.1	16.2	10.8	6.7	4.7	3.6	3.1	2.3	1.8	1.5	1.3	1.1	0.1	73.9	25.0	1.2	26.2	24.0	83.9	178.2	5.38	3.57	2.48	1.450
4B	0.0	5.1	4.1	5.6	7.1	7.3	8.3	8.3	8.0	7.6	7.4	7.4	6.5	5.4	4.7	3.6	2.6	0.9	45.7	50.6	3.6	54.2	7.2	35.4	168.9	7.12	4.82	2.56	2.278
5S	0.1	2.5	7.2	13.5	20.6	22.4	17.3	8.5	3.6	1.7	1.0	0.8	0.4	0.2	0.1	0.0	0.0	0.0	92.2	7.8	0.0	7.8	61.1	115.1	215.8	4.03	3.11	2.20	0.913
5M	3.9	8.5	15.7	18.5	18.7	15.7	10.6	5.0	2.1	0.9	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	96.5	3.5	0.0	3.5	81.0	168.9	325.4	3.62	2.56	1.61	1.006
5B	6.0	8.3	13.8	14.5	13.2	10.4	7.8	5.2	3.9	3.0	2.8	2.8	2.3	1.9	1.6	1.4	1.1	0.1	79.2	19.7	1.2	20.9	30.0	146.5	335.4	5.06	2.77	1.57	1.748
6S	3.1	5.6	12.4	17.0	20.0	18.1	12.5	5.9	2.5	1.1	0.6	0.5	0.2	0.2	0.1	0.1	0.1	0.0	94.6	5.3	0.1	5.4	72.3	145.1	288.4	3.79	2.78	1.78	1.001
6M	0.4	0.0	3.4	7.5	12.3	14.0	12.6	8.5	6.2	5.0	4.7	4.8	4.4	4.0	3.6	3.5	3.0	1.4	58.6	36.3	4.4	40.7	8.9	64.6	160.7	6.82	3.95	2.63	2.095
6B	7.0	5.1	5.3	5.8	7.3	7.8	8.5	8.3	8.2	7.3	6.7	6.4	5.0	3.8	3.1	2.4	1.7	0.3	55.1	42.9	2.1	44.9	10.8	53.2	276.4	6.54	4.23	1.85	2.346
7S	2.9	6.1	13.7	18.7	20.6	17.0	10.7	4.7	2.1	1.2	0.8	0.6	0.4	0.3	0.1	0.1	0.1	0.0	94.4	5.6	0.1	5.7	76.2	154.5	297.1	3.71	2.69	1.74	0.984
7M	2.6	6.9	15.3	21.0	21.8	16.5	9.7	4.0	1.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.9	2.2	0.0	2.2	88.2	166.2	307.6	3.50	2.58	1.69	0.904
7B	5.7	3.7	3.0	2.7	4.0	5.3	7.2	8.4	8.9	8.1	7.9	7.9	6.7	5.7	5.1	4.3	3.5	1.6	40.1	54.8	5.1	59.9	6.2	33.3	189.7	7.33	4.91	2.39	2.471
8S	4.1	8.2	14.1	16.6	16.5	12.6	7.9	3.9	2.7	2.1	1.9	2.0	1.7	1.5	1.3	1.3	1.1	0.4	83.9	14.6	1.4	16.0	57.0	152.8	318.4	4.13	2.70	1.64	1.244
8M	2.0	6.3	13.4	18.2	20.7	18.1	12.0	5.4	2.2	1.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	96.2	3.8	0.0	3.8	75.2	151.1	292.6	3.73	2.72	1.76	0.983
8B	4.9	6.5	8.6	10.0	11.3	9.9	8.4	7.1	6.4	5.3	4.8	4.6	3.6	2.8	2.4	1.9	1.3	0.2	66.7	31.8	1.6	33.3	17.0	92.3	290.7	5.88	3.43	1.77	2.053
9S	2.7	6.9	12.9	17.1	19.7	17.8	12.3	5.7	2.4	1.1	0.6	0.4	0.2	0.1	0.1	0.0	0.0	0.0	95.2	4.9	0.0	4.9	75.4	151.3	293.6	3.73	2.72	1.76	0.984
9M	1.6	4.8	9.7	13.5	16.3	15.2	11.5	6.8	4.3	3.0	2.6	2.6	2.2	1.7	1.5	1.3	1.1	0.2	79.3	19.3	1.3	20.6	40.1	120.5	241.6	4.64	3.05	2.04	1.300
9B	4.9	5.1	5.0	5.3	7.0	7.5	7.8	7.5	7.5	6.7	6.6	6.6	5.7	4.9	4.3	3.7	2.9	1.2	50.0	45.9	4.1	50.0	7.3	43.2	232.6	7.10	4.53	2.10	2.500
10S	0.8	4.8	10.4	16.0	20.7	20.2	14.7	7.0	2.9	1.3	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	94.7	5.4	0.0	5.4	68.4	130.0	252.1	3.87	2.94	1.98	0.943
10M	2.2	6.2	11.9	15.1	16.0	13.9	10.6	6.9	4.8	3.3	2.5	2.1	1.4	1.0	0.8	0.7	0.6	0.0	82.9	16.4	0.6	17.0	39.6	128.8	285.9	4.66	2.95	1.80	1.430
10B	16.6	18.0	14.6	9.9	8.5	6.9	5.4	4.2	3.5	2.7	2.3	2.2	1.7	1.2	1.0	0.7	0.4	0.0	84.1	15.4	0.4	15.8	38.6	131.4	299.3	4.70	2.92	1.73	1.482

Table C-2. Particle sizes of core samples collected from the NEIBP in August 2003.

Sample ID	Microns (μ) 2000 coarse sand	1414 coarse sand	1000 med sand	707 med sand	500 fine sand	354 fine sand	250 very fine sand	176 very fine sand	125 very fine sand	88 coarse silt	63 med silt	31 med silt	16 silt	8 fine silt	4 very fine silt	3 very fine silt	2 clay	Fractions % Sand	Silt	Clay	Fines	Percentiles (μ) 16%	50%	84%	Percentile (phi) 16%	50%	84%	Dispersion or Sorting Index
2 10-20	0.0	0.7	0.8	1.4	4.2	7.7	10.9	15.4	19.9	16.6	7.8	8.4	2.5	2.5	1.0	0.0	0.0	85.6	14.4	0.0	14.4	68.6	150.8	339.8	3.86	2.72	1.55	1.158
2 20 -30	0.0	3.0	3.1	3.5	5.5	8.4	11.3	14.1	16.8	13.4	5.8	6.5	2.3	2.7	1.5	0.1	0.1	84.9	13.2	0.1	13.3	67.3	172.0	478.3	3.89	2.53	1.05	1.419
2 30-40	0.0	0.0	0.0	0.4	5.1	7.7	11.3	16.6	22.9	20.6	6.8	8.7	0.0	0.0	0.0	0.0	0.0	91.3	8.7	0.0	8.7	88.9	153.5	324.8	3.49	2.70	1.61	0.937
2 40-50	0.0	0.0	0.0	0.6	5.7	8.6	14.5	20.5	22.6	17.4	4.4	5.7	0.0	0.0	0.0	0.0	0.0	94.3	5.7	0.0	5.7	101.5	175.8	343.1	3.30	2.50	1.53	0.881
2 50-60	0.0	0.0	1.1	2.0	5.0	9.8	14.2	16.1	14.8	8.8	2.5	4.9	3.9	5.2	4.0	0.5	0.8	74.4	18.5	0.8	19.3	13.8	169.9	373.8	6.19	2.55	1.41	2.388
2 60-70	0.0	0.0	0.0	0.6	2.6	4.3	5.8	6.2	8.8	7.8	3.5	7.7	7.9	11.5	11.1	1.7	2.8	39.5	39.9	2.8	42.7	1.7	23.6	210.3	9.22	5.41	2.24	3.490
2 70-76	0.0	0.2	1.4	3.5	6.8	10.8	15.5	18.6	17.1	11.0	4.2	4.8	1.8	2.0	0.9	0.1	0.1	89.2	9.6	0.1	9.6	92.7	199.9	431.4	3.43	2.32	1.20	1.113
2M	0.0	0.0	0.2	1.3	4.1	6.9	9.4	13.4	18.8	17.0	9.2	11.5	4.0	3.1	1.1	0.0	0.0	80.3	19.7	0.0	19.7	53.9	134.2	308.0	4.21	2.89	1.69	1.261
2B	0.0	0.0	0.7	2.6	6.3	5.8	2.0	0.7	5.0	5.7	5.5	19.0	17.4	17.4	8.7	0.0	0.0	34.2	62.5	0.0	62.5	9.2	35.2	333.8	6.77	4.83	1.57	2.596
2 98-108	0.0	2.5	6.6	12.3	15.4	11.1	4.9	2.4	4.0	3.4	2.8	10.2	9.4	9.1	4.9	0.0	0.0	65.3	33.5	0.0	33.5	17.1	316.3	805.9	5.87	1.65	0.30	2.788
3S	0.0	0.0	0.5	2.7	4.7	7.8	9.2	10.5	12.9	10.0	4.0	6.7	5.3	6.7	5.9	0.8	1.5	62.4	25.3	1.5	26.8	6.3	119.5	350.1	7.32	3.06	1.50	2.910
3M	0.0	2.5	2.0	3.4	7.3	9.9	10.5	13.7	16.4	11.6	5.1	8.3	4.2	3.6	1.4	0.0	0.0	82.5	17.5	0.0	17.5	56.8	173.5	487.3	4.14	2.52	1.03	1.555
3B	0.0	0.0	1.0	7.1	8.3	7.7	3.7	4.4	10.4	8.4	4.9	13.1	10.6	9.5	5.6	0.0	0.1	56.0	38.8	0.1	38.9	10.9	93.6	508.6	6.53	3.41	0.96	2.781
4S	0.0	0.1	3.7	0.3	4.3	7.4	10.1	17.6	22.7	17.8	4.3	7.9	2.5	0.8	0.3	0.0	0.0	88.4	11.6	0.0	11.6	88.0	158.9	352.8	3.50	2.65	1.49	1.004
4M	0.0	10.4	3.5	3.0	2.8	4.7	4.8	7.2	11.2	8.6	3.3	5.5	5.0	7.3	7.9	1.1	2.1	59.5	26.9	2.1	29.0	4.8	118.3	952.2	7.71	3.07	0.06	3.826
4B	0.0	0.0	0.0	0.5	2.0	2.7	1.5	1.3	6.9	7.6	6.3	21.5	22.2	20.3	7.1	0.0	0.0	28.9	71.1	0.0	71.1	10.8	31.5	120.4	6.54	4.99	3.05	1.744
5S	0.0	0.0	0.0	0.2	4.0	5.1	7.5	12.7	22.2	22.7	9.5	12.6	3.3	0.2	0.0	0.0	0.0	84.0	16.0	0.0	16.0	62.9	128.5	261.5	3.99	2.95	1.93	1.031
5M	0.0	0.0	0.6	2.8	5.7	5.8	5.8	7.0	11.5	10.6	5.8	12.1	8.9	9.5	6.2	0.1	0.1	55.6	36.7	0.1	36.8	9.0	87.3	333.5	6.80	3.51	1.57	2.610
5B	0.0	0.0	0.0	1.2	3.4	4.1	3.8	2.4	5.5	4.8	4.1	15.5	15.7	16.5	10.4	0.2	0.3	29.2	58.3	0.3	58.6	5.9	24.7	161.5	7.42	5.34	2.62	2.398
6S	0.0	0.0	0.0	0.5	2.9	5.4	8.0	13.9	21.4	18.7	8.0	8.2	2.8	3.6	2.3	0.2	0.4	78.7	17.1	0.4	17.5	46.7	128.9	256.2	4.42	2.95	1.96	1.232
6M	0.0	0.0	0.5	1.4	3.1	4.5	6.3	9.9	15.8	13.5	7.5	13.9	8.6	8.1	4.3	0.0	0.0	62.3	35.0	0.0	35.1	17.3	102.4	246.6	5.85	3.28	2.01	1.921
6B	0.0	3.3	4.1	5.8	9.9	11.6	10.9	10.8	11.0	7.5	3.5	8.1	5.6	5.2	2.6	0.0	0.0	78.4	21.6	0.0	21.6	41.1	215.9	634.4	4.60	2.20	0.64	1.980
7S	0.0	0.0	0.0	0.1	0.6	1.9	1.8	3.8	12.8	14.6	10.1	18.1	10.2	9.4	6.3	0.2	0.5	45.6	44.1	0.5	44.6	7.6	55.0	140.0	7.04	4.18	2.83	2.105
7M	0.0	0.5	1.5	1.8	3.9	6.1	8.8	14.4	19.9	16.4	7.8	9.9	3.8	3.6	1.6	0.0	0.0	81.0	19.0	0.0	19.0	54.1	140.3	321.0	4.21	2.83	1.63	1.288
7B	0.0	0.0	0.0	0.0	2.9	2.4	0.7	0.8	4.7	5.0	4.2	15.9	16.4	19.0	12.9	0.5	0.5	20.6	64.7	0.5	65.2	4.6	18.2	91.5	7.77	5.78	3.45	2.165
8S	0.0	0.0	0.1	0.6	2.2	5.2	8.7	13.9	19.3	19.2	12.2	8.0	5.6	2.7	1.9	0.6	0.0	81.3	18.7	0.0	18.7	66.6	147.8	299.9	3.91	2.75	1.73	1.089
8M	0.0	0.0	0.0	0.9	8.7	13.6	19.6	21.5	18.3	11.3	2.1	4.2	0.0	0.0	0.0	0.0	0.0	95.8	4.2	0.0	4.2	120.2	221.2	412.1	3.05	2.17	1.27	0.891
8B	0.0	0.0	1.0	4.6	9.2	9.7	9.5	9.3	9.4	6.6	3.9	10.9	8.6	8.1	4.6	0.0	0.1	63.1	32.2	0.1	32.3	14.0	138.4	480.2	6.17	2.85	1.05	2.560
9S	0.0	0.8	1.3	2.2	4.2	6.9	11.2	18.3	22.8	17.5	7.3	5.8	1.2	0.5	0.0	0.0	0.0	92.4	7.6	0.0	7.6	91.1	162.9	346.8	3.45	2.61	1.52	0.967
9M	0.0	0.6	1.3	2.0	5.4	9.3	12.6	14.6	15.2	10.8	4.3	6.2	3.4	4.5	3.4	0.4	0.6	76.0	17.9	0.6	18.5	21.3	160.0	383.5	5.55	2.64	1.37	2.091
9B	0.0	1.7	4.1	6.3	8.5	7.8	6.6	10.3	15.3	11.5	5.3	10.3	5.7	4.7	1.8	0.0	0.0	77.5	22.5	0.0	22.5	43.6	157.9	601.6	4.52	2.66	0.72	1.899
10S	0.0	0.2	1.9	3.5	6.5	9.6	14.0	16.5	15.2	9.7	3.3	4.9	3.0	4.7	3.5	0.3	0.1	80.5	16.3	0.1	16.5	42.6	184.9	428.9	4.55	2.43	1.21	1.670
10M	0.0	0.0	1.3	2.5	4.2	7.8	12.3	15.7	17.5	16.3	10.8	4.2	4.2	1.3	1.4	0.5	0.0	88.4	11.6	0.0	11.6	105.0	220.1	496.8	3.25	2.18	1.00	1.124
10B	0.0	3.5	7.1	12.3	17.3	12.4	6.6	5.3	6.3	4.7	2.7	7.6	6.0	5.6	2.8	0.0	0.0	78.0	22.0	0.0	22.0	37.3	386.9	834.8	4.75	1.36	0.25	2.249

Table C-3. Particle sizes of burrow mound samples collected from the NEIBP in August 2003.

Sample ID	Microns (µ) 2000 coarse sand	1414 coarse sand	1000 med sand	707 med sand	500 fine sand	354 fine sand	250 very fine sand	176 very fine sand	125 very fine sand	88 coarse silt	63 med silt	31 med silt	16 silt	8 fine silt	4 very fine silt	3 very fine silt	2 clay	Fractions % Sand	Silt	Clay	Fines	Percentiles (µ) 16%	50%	84%	Percentile (phi) 16%	50%	84%	Dispersion or Sorting Index
CAD Surface	0.0	0.0	0.0	0.0	0.0	0.9	7.6	10.0	8.9	4.8	5.5	20.7	19.7	11.9	2.7	2.7	4.5	37.8	57.7	4.5	62.2	7.8	54.5	102.5	7.00	4.20	3.28	1.861
CAD Surface	0.0	0.0	0.0	0.0	0.0	1.3	9.5	12.6	11.3	7.3	8.9	10.2	14.1	11.4	3.4	3.8	6.2	50.9	43.0	6.2	49.1	4.7	33.2	152.9	7.74	4.91	2.70	2.520
CAD Surface	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.1	10.9	10.3	12.5	13.0	17.5	14.3	4.1	4.5	7.0	39.6	53.4	7.0	60.4	4.1	18.3	90.2	7.95	5.78	3.47	2.241
CAD Surface	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	7.5	9.2	13.5	15.9	20.0	15.2	4.4	4.8	7.5	32.2	60.3	7.5	67.8	3.8	15.0	69.3	8.04	6.06	3.85	2.097
CAD Surface	0.0	0.0	0.0	0.0	0.0	0.7	6.6	15.3	16.4	8.8	7.9	9.3	12.8	10.4	3.1	3.4	5.4	55.7	39.0	5.4	44.3	5.3	52.1	145.1	7.57	4.26	2.78	2.395
CAD Surface	0.0	0.0	0.0	0.0	0.0	0.1	2.4	11.2	17.4	11.8	10.7	9.9	12.9	10.8	3.3	3.7	5.8	53.6	40.6	5.8	46.4	4.9	39.4	119.4	7.68	4.67	3.06	2.308
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	6.5	10.0	16.2	18.3	21.7	13.8	3.4	3.5	5.5	33.9	60.6	5.5	66.1	4.8	17.3	66.7	7.71	5.86	3.90	1.905
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.3	9.9	9.2	12.1	14.8	19.5	14.9	4.2	4.7	7.4	34.6	58.0	7.4	65.4	3.9	15.7	79.7	8.00	6.00	3.65	2.177
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.4	6.4	18.5	22.1	12.0	7.9	7.2	9.9	7.5	2.1	2.3	3.7	67.3	29.0	3.7	32.7	8.2	82.0	148.6	6.93	3.60	2.74	2.094
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.9	7.3	8.2	14.2	16.9	21.2	14.6	3.8	4.0	6.5	33.0	60.6	6.5	67.0	4.3	16.0	70.4	7.86	5.97	3.82	2.018
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	6.3	10.3	14.8	17.0	21.5	14.6	3.9	4.2	6.6	32.2	61.2	6.6	67.8	4.3	15.6	66.0	7.88	6.00	3.92	1.982
CAD Burrow	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.1	8.2	8.2	13.1	15.9	20.3	15.2	4.2	4.5	7.1	32.7	60.2	7.1	67.3	4.0	15.1	71.1	7.98	6.06	3.81	2.084
Harbor Burrow	0.0	0.0	0.0	0.0	0.0	0.1	1.8	13.1	29.7	19.4	13.5	7.8	6.1	4.0	1.1	1.1	2.3	77.6	20.1	2.3	22.4	18.0	80.3	123.4	5.80	3.64	3.01	1.392
Harbor Burrow	0.0	0.0	0.0	0.0	0.0	0.1	2.4	13.9	28.0	17.5	12.7	7.8	6.4	5.0	1.5	1.7	3.1	74.5	22.3	3.1	25.5	13.3	79.0	126.1	6.23	3.66	2.98	1.626
Harbor Burrow	0.0	0.0	0.0	0.0	0.0	0.1	1.8	14.2	31.6	19.3	12.4	7.0	5.5	3.8	1.0	1.1	2.2	79.3	18.5	2.2	20.7	19.8	84.5	125.1	5.66	3.56	2.99	1.334
Harbor Surface	0.0	0.0	0.0	0.0	0.0	0.2	2.5	13.1	27.7	18.9	13.9	7.6	6.0	4.6	1.4	1.5	2.8	76.2	21.0	2.8	23.8	15.5	78.3	124.6	6.02	3.67	3.00	1.508
Harbor Surface	0.0	0.0	0.0	0.0	0.0	0.1	2.4	13.1	26.0	17.6	13.8	8.9	7.5	5.0	1.4	1.5	2.7	73.1	24.2	2.7	26.9	13.3	75.2	124.6	6.24	3.73	3.00	1.618
Harbor Surface	0.0	0.0	0.0	0.0	0.0	0.0	1.3	12.6	31.4	20.4	13.1	6.8	5.4	4.0	1.2	1.3	2.5	78.8	18.7	2.5	21.2	18.8	81.5	122.2	5.73	3.61	3.03	1.353

Table C-4. 2002 physical and chemical composition and summary statistics of surface, mid and bottom core layers collected from the NEIBP CAD site.

Heavy Metals	MDL (mg/Kg)	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI	MIN	MAX
Percent Fines (%)	0.1	Surface	19.9	4.1	7.1	7.8	5.4	5.7	15.9	4.9	5.4	8.46	5.56	3.64	4.13	19.93
		Mid	7.5	7.6	26.2	3.5	40.7	2.2	3.8	20.6	17.0	14.34	12.98	8.48	2.20	40.67
		Bottom	68.1	60.9	54.2	20.9	44.9	59.4	33.3	49.7	15.8	45.26	18.26	11.93	15.83	68.13
		Average	31.86	24.20	29.15	10.73	30.33	22.43	17.67	25.06	12.73	22.68			10.73	31.86
		SD	32.03	31.80	23.69	9.06	21.70	32.09	14.86	22.75	6.41		20.85			
		±95% CI	36.24	35.99	26.80	10.25	24.55	36.31	16.82	25.74	7.25			7.86		
Density (g/cm^3)	0.01	Surface	2.54	2.74	2.56	2.64	2.68	2.59	2.67	2.60	2.70	2.64	0.07	0.04	2.54	2.74
		Mid	2.62	2.69	2.66	2.63	2.48	2.76	2.53	2.57	2.67	2.62	0.09	0.06	2.48	2.76
		Bottom	1.65	2.01	1.32	2.36	1.96	1.49	1.66	1.91	2.15	1.83	0.33	0.22	1.32	2.36
		Average	2.27	2.48	2.18	2.54	2.37	2.28	2.29	2.36	2.51	2.36			2.18	2.54
		SD	0.54	0.41	0.75	0.16	0.37	0.69	0.55	0.39	0.31		0.43			
		±95% CI	0.61	0.46	0.84	0.18	0.42	0.78	0.62	0.44	0.35			0.16		
TOC (%)	0.01	Surface	0.60	0.81	0.57	0.78	0.52	0.58	0.55	0.59	0.58	0.62	0.10	0.07	0.52	0.81
		Mid	0.46	0.59	0.44	0.52	0.37	0.29	0.54	0.40	0.60	0.47	0.10	0.07	0.29	0.60
		Bottom	1.82	0.91	1.90	0.64	1.27	2.50	1.05	1.28	1.04	1.38	0.58	0.38	0.64	2.50
		Average	0.96	0.77	0.97	0.65	0.72	1.12	0.71	0.76	0.74	0.82			0.65	1.12
		SD	0.75	0.16	0.81	0.13	0.48	1.20	0.29	0.46	0.26		0.53			
		±95% CI	0.85	0.19	0.91	0.15	0.55	1.36	0.33	0.52	0.29			0.20		
Total Solids (%)	0.1	Surface	74.8	78.2	76.1	63.6	73.9	75.0	80.4	78.9	74.0	75.0	4.8	3.2	63.6	80.4
		Mid	78.3	80.8	79.9	80.6	81.8	80.5	81.1	80.9	79.0	80.3	1.1	0.7	78.3	81.8
		Bottom	66.0	75.0	55.3	74.9	69.7	59.7	65.8	69.4	74.5	67.8	6.9	4.5	55.3	75.0
		Average	73.0	78.0	70.4	73.0	75.1	71.7	75.8	76.4	75.8	74.4			70.4	78.0
		SD	6.3	2.9	13.2	8.7	6.1	10.8	8.6	6.1	2.8		7.0			
		±95% CI	7.2	3.3	15.0	9.8	7.0	12.2	9.8	7.0	3.1			2.7		
Aluminum	1.0	Surface	11200	10700	7735	12300	8820	10000	7860	11600	10000	10024	1615	1055	7735	12300
		Mid	9530	9415	8500	13100	9060	8680	8380	10150	12700	9946	1766	1154	8380	13100
		Bottom	20300	11900	14500	11200	14200	23600	14700	19200	12400	15778	4273	2791	11200	23600
		Average	13677	10672	10245	12200	10693	14093	10313	13650	11700	11916			10245	14093
		SD	5796	1243	3705	954	3039	8259	3808	4861	1480		3889			
		±95% CI	6559	1406	4192	1079	3439	9346	4309	5500	1675			1467		
Antimony	0.05	Surface	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Mid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Bottom	0.00	0.00	0.00	0.00	0.25	0.49	0.00	0.00	0.00	0.08	0.17	0.11	0.00	0.49
		Average	0.00	0.00	0.00	0.00	0.08	0.16	0.00	0.00	0.00	0.03			0.00	0.16
		SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.10			
		±95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.04		
Arsenic	0.05	Surface	3.77	3.96	3.56	4.51	4.09	4.84	3.70	3.80	4.30	4.06	0.42	0.27	3.56	4.84
		Mid	3.72	4.40	3.11	6.63	3.83	4.06	4.36	3.83	4.05	4.22	0.98	0.64	3.11	6.63
		Bottom	6.25	5.22	4.42	4.70	4.24	7.09	4.30	5.35	2.96	4.95	1.21	0.79	2.96	7.09
		Average	4.58	4.53	3.70	5.28	4.05	5.33	4.12	4.33	3.77	4.41			3.70	5.33
		SD	1.45	0.64	0.67	1.17	0.21	1.57	0.36	0.89	0.71		0.98			
		±95% CI	1.64	0.72	0.75	1.33	0.23	1.78	0.41	1.00	0.81			0.37		
Barium	0.05	Surface	104.00	120.00	88.30	112.00	96.60	122.00	81.60	122.00	124.00	107.83	15.96	10.43	81.60	124.00
		Mid	338.00	119.50	96.30	170.00	93.20	111.00	99.10	104.00	129.00	140.01	77.91	50.90	93.20	338.00
		Bottom	195.00	103.00	132.00	109.00	135.50	232.00	130.00	164.00	110.00	145.61	43.58	28.47	103.00	232.00
		Average	212.33	114.17	105.53	130.33	108.43	155.00	103.57	130.00	121.00	131.15			103.57	212.33
		SD	117.96	9.67	23.27	34.39	23.50	66.91	24.51	30.79	9.85		53.09			
		±95% CI	133.48	10.95	26.33	38.91	26.59	75.71	27.73	34.84	11.14			20.02		
Beryllium	0.01	Surface	0.34	0.30	0.24	0.35	0.26	0.31	0.23	0.30	0.30	0.29	0.04	0.03	0.23	0.35
		Mid	0.34	0.30	0.25	0.37	0.26	0.26	0.23	0.28	0.36	0.29	0.05	0.03	0.23	0.37
		Bottom	0.54	0.36	0.42	0.32	0.39	0.62	0.40	0.54	0.35	0.44	0.10	0.07	0.32	0.62
		Average	0.41	0.32	0.30	0.35	0.30	0.40	0.29	0.37	0.34	0.34			0.29	0.41
		SD	0.12	0.04	0.10	0.03	0.08	0.20	0.10	0.15	0.03		0.10			
		±95% CI	0.13	0.04	0.12	0.03	0.08	0.22	0.11	0.17	0.04			0.04		
Cadmium	0.01	Surface	0.18	0.14	0.14	0.19	0.14	0.15	0.12	0.14	0.16	0.15	0.02	0.01	0.12	0.19
		Mid	0.22	0.15	0.13	0.19	0.13	0.13	0.14	0.15	0.15	0.15	0.03	0.02	0.13	0.22
		Bottom	3.35	0.84	1.52	0.38	1.86	3.78	1.44	1.82	0.93	1.77	1.13	0.74	0.38	3.78
		Average	1.25	0.38	0.60	0.25	0.71	1.35	0.57	0.70	0.41	0.69			0.25	1.35
		SD	1.82	0.40	0.80	0.11	1.00	2.10	0.76	0.97	0.45		1.00			
		±95% CI	2.06	0.46	0.91	0.12	1.13	2.38	0.86	1.09	0.51			0.38		

Table C-4. Continued.

Heavy Metals	MDL (mg/Kg)	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI	MIN	MAX
Chromium	0.05	Surface	16.50	16.00	13.80	19.50	13.70	15.90	11.40	17.00	17.50	15.70	2.40	1.57	11.40	19.50
		Mid	15.10	16.20	13.10	23.40	14.00	14.30	13.10	16.20	18.40	15.98	3.26	2.13	13.10	23.40
		Bottom	45.80	21.30	25.70	18.90	31.30	46.60	136.00	32.90	18.40	41.88	36.83	24.06	18.40	136.00
		Average	25.80	17.83	17.53	20.60	19.67	25.60	53.50	22.03	18.10	24.52			17.53	53.50
		SD	17.33	3.00	7.08	2.44	10.08	18.20	71.45	9.42	0.52		24.06			
		±95% CI	19.62	3.40	8.01	2.76	11.40	20.60	80.85	10.66	0.59			9.08		
Copper	0.01	Surface	4.90	3.32	4.85	4.96	2.94	4.87	2.33	4.19	4.75	4.12	1.00	0.66	2.33	4.96
		Mid	3.52	3.73	1.97	6.12	3.88	4.39	2.86	2.98	4.85	3.81	1.22	0.79	1.97	6.12
		Bottom	73.70	26.40	41.00	11.10	47.40	92.70	39.90	43.00	28.10	44.81	24.83	16.22	11.10	92.70
		Average	27.37	11.15	15.94	7.39	18.07	33.99	15.03	16.72	12.57	17.58			7.39	33.99
		SD	40.13	13.21	21.75	3.26	25.40	50.85	21.54	22.76	13.45		23.99			
		±95% CI	45.41	14.95	24.61	3.69	28.74	57.54	24.37	25.76	15.22			9.05		
Iron	1.0	Surface	15400	15500	12100	18400	14000	15800	12200	15800	16000	15022	1984	1296	12100	18400
		Mid	13600	15950	12700	21300	13600	14500	13800	14900	17400	15306	2656	1735	12700	21300
		Bottom	24500	15700	20400	17000	20150	30200	21700	24800	18300	21417	4510	2946	15700	30200
		Average	17833	15717	15067	18900	15917	20167	15900	18500	17233	17248			15067	20167
		SD	5843	225	4629	2193	3672	8713	5086	5474	1159		4322			
		±95% CI	6612	255	5238	2482	4155	9860	5756	6195	1312			1630		
Lead	0.01	Surface	5.22	4.43	3.31	4.99	3.73	4.40	3.65	4.38	4.30	4.27	0.62	0.40	3.31	5.22
		Mid	3.40	3.91	3.54	5.37	4.21	3.57	3.32	4.39	4.90	4.07	0.71	0.47	3.32	5.37
		Bottom	179.00	31.30	65.60	16.10	94.10	146.00	64.50	70.40	37.90	78.32	53.73	35.10	16.10	179.00
		Average	62.54	13.21	24.15	8.82	34.01	51.32	23.82	26.39	15.70	28.89			8.82	62.54
		SD	100.86	15.67	35.90	6.31	52.04	81.99	35.23	38.11	19.23		46.45			
		±95% CI	114.13	17.73	40.62	7.14	58.88	92.78	39.86	43.13	21.76			17.52		
Mercury	0.005	Surface	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Mid	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		Bottom	0.030	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.006	0.011	0.007	0.000	0.030
		Average	0.010	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.002			0.000	0.010
		SD	0.017	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000		0.007			
		±95% CI	0.020	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000			0.003		
Nickel	0.01	Surface	6.31	5.80	5.10	7.96	5.09	6.35	3.58	5.81	7.28	5.92	1.29	0.84	3.58	7.96
		Mid	4.47	6.46	4.08	9.59	4.99	5.79	4.99	5.65	7.02	5.89	1.67	1.09	4.08	9.59
		Bottom	23.70	9.48	14.20	8.34	16.20	29.10	96.20	17.90	9.65	24.97	27.58	18.02	8.34	96.20
		Average	11.49	7.25	7.79	8.63	8.76	13.75	34.92	9.79	7.98	12.26			7.25	34.92
		SD	10.61	1.96	5.57	0.85	6.44	13.30	53.07	7.03	1.45		17.87			
		±95% CI	12.01	2.22	6.30	0.97	7.29	15.05	60.06	7.95	1.64			6.74		
Selenium	0.05	Surface	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Mid	0.00	0.43	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.13	0.27	0.18	0.00	0.74
		Bottom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Average	0.00	0.14	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.04			0.00	0.25
		SD	0.00	0.25	0.00	0.43	0.00	0.00	0.00	0.00	0.00		0.16			
		±95% CI	0.00	0.28	0.00	0.48	0.00	0.00	0.00	0.00	0.00			0.06		
Silver	0.01	Surface	0.00	0.01	0.00	0.06	0.00	0.03	0.03	0.00	0.00	0.01	0.02	0.01	0.00	0.06
		Mid	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.04	0.00	0.18
		Bottom	0.62	0.21	0.41	0.02	0.74	1.18	0.25	0.36	0.13	0.44	0.36	0.24	0.02	1.18
		Average	0.27	0.07	0.14	0.03	0.25	0.40	0.09	0.12	0.04	0.16			0.03	0.40
		SD	0.32	0.12	0.24	0.03	0.43	0.67	0.14	0.21	0.08		0.29			
		±95% CI	0.36	0.13	0.27	0.03	0.48	0.76	0.15	0.24	0.08			0.11		
Zinc	0.05	Surface	33.60	32.20	27.10	47.60	31.30	34.90	25.40	31.50	37.50	33.46	6.46	4.22	25.40	47.60
		Mid	24.10	30.90	26.80	47.20	26.20	32.00	29.00	29.40	35.80	31.27	6.90	4.51	24.10	47.20
		Bottom	352.00	127.00	225.00	61.90	255.00	477.00	196.00	226.00	134.00	228.21	125.38	81.92	61.90	477.00
		Average	136.57	63.37	92.97	52.23	104.17	181.30	83.47	95.63	69.10	97.64			52.23	181.30
		SD	186.63	55.11	114.34	8.37	130.65	256.09	97.47	112.91	56.21		117.12			
		±95% CI	211.19	62.36	129.39	9.48	147.84	289.79	110.30	127.76	63.61			44.18		
Total PAH	0.05	Surface	239.2	15.2	32.9	138.2	18.4	20.2	13.9	7.5	24.0	56.6	79.3	51.8	7.5	239.2
		Mid	24.4	6.0	139.3	111.7	29.4	28.8	18.6	30.6	897.0	142.9	286.4	187.1	6.0	897.0
		Bottom	3099.1	946.7	2225.1	4140.8	2667.5	3140.3	1307.2	1691.4	1288.5	2278.5	1065.4	696.0	946.7	4140.8
		Average	1120.9	322.6	799.1	1463.6	905.1	1063.1	446.6	576.5	736.5	826.0			322.6	1463.6
		SD	1716.5	540.5	1236.1	2318.6	1526.3	1798.9	745.3	965.6	647.4		1213.8			
		±95% CI	1942.4	611.6	1398.8	2623.7	1727.1	2035.6	843.4	1092.7	732.6			457.8		

Table C-5. 2003 physical and chemical composition and summary statistics of surface, mid and bottom core layers collected from the NEIBP CAD site.

Heavy Metals	MDL (mg/Kg)	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI	MIN	MAX
Percent Fines (%)	0.1	Surface	14.4	26.8	11.6	16.0	17.5	44.6	18.7	7.6	16.5	19.30	10.84	7.08	7.58	44.59
		Mid	19.7	17.5	29.0	36.8	35.1	19.0	4.2	18.5	11.6	21.26	10.64	6.95	4.20	36.81
		Bottom	62.5	38.9	71.1	58.6	21.6	65.2	32.3	22.5	22.0	43.86	20.48	13.38	21.59	71.06
		Average	32.21	27.75	37.21	37.17	24.70	42.93	18.41	16.20	16.66	28.14			16.20	42.93
		SD	26.40	10.71	30.57	21.30	9.20	23.17	14.05	7.73	5.20		18.14			
		±95% CI	29.87	12.12	34.60	24.11	10.41	26.22	15.90	8.74	5.88			6.84		
Density (g/cm^3)	0.01	Surface	1.97	1.58	1.79	1.94	1.86	1.54	1.38	1.69	NS	1.72	0.21	0.14	1.38	1.97
		Mid	NS	1.51	1.93	1.39	1.44	1.77	1.55	1.48	NS	1.58	0.20	0.15	1.39	1.93
		Bottom	NS	1.51	1.18	1.37	1.21	1.5	1.82	NS	NS	1.43	0.24	0.19	1.18	1.82
		Average	1.97	1.53	1.63	1.57	1.50	1.60	1.58	1.59	-	1.59			1.50	1.97
		SD	-	0.04	0.40	0.32	0.33	0.15	0.22	0.15	-		0.23			
		±95% CI	-	0.05	0.45	0.37	0.37	0.16	0.25	0.17	-			0.10		
TOC (%)	0.01	Surface	0.92	0.33	0.00	0.18	0.45	0.20	0.27	0.48	0.42	0.36	0.26	0.17	0.00	0.92
		Mid	0.12	0.75	0.63	0.68	0.65	0.43	0.31	0.48	0.36	0.49	0.21	0.13	0.12	0.75
		Bottom	2.72	2.08	3.74	3.58	2.71	3.22	1.94	1.33	0.00	2.37	1.19	0.78	0.00	3.74
		Average	1.25	1.05	1.46	1.48	1.27	1.29	0.84	0.76	0.26	1.07			0.26	1.48
		SD	1.33	0.91	2.00	1.84	1.25	1.68	0.95	0.49	0.23		1.16			
		±95% CI	1.51	1.03	2.27	2.08	1.42	1.90	1.08	0.55	0.26			0.44		
Total Solids (%)	0.1	Surface	73.9	72.4	72.1	71.6	76.1	75.5	76.7	71.6	75.5	73.9	2.1	1.3	71.6	76.7
		Mid	82.3	73.3	72.3	76.7	76.0	79.7	78.0	77.5	81.2	77.4	3.3	2.2	72.3	82.3
		Bottom	67.3	62.8	58.8	59.9	65.8	62.9	69.9	69.9	68.5	65.1	4.2	2.7	58.8	69.9
		Average	74.5	69.5	67.7	69.4	72.6	72.7	74.9	73.0	75.1	72.2			67.7	75.1
		SD	7.5	5.8	7.7	8.6	5.9	8.7	4.4	4.0	6.3		6.2			
		±95% CI	8.5	6.6	8.8	9.7	6.7	9.9	4.9	4.5	7.2			2.3		
Aluminum	1.0	Surface	8540	10300	9490	10900	13200	68450	10600	10300	10600	16931	19360	12648	8540	68450
		Mid	10000	9580	14900	17500	14700	8420	9550	13100	7590	11704	3437	2245	7590	17500
		Bottom	22700	14700	26500	30400	17100	18800	15700	16300	7900	18900	6739	4403	7900	30400
		Average	13747	11527	16963	19600	15000	31890	11950	13233	8697	15845			8697	31890
		SD	7788	2772	8691	9918	1967	32084	3290	3002	1656		11938			
		±95% CI	8813	3136	9834	11223	2226	36306	3723	3397	1873			4503		
Antimony	0.05	Surface	0.22	0.20	0.18	0.20	0.23	0.21	0.18	0.16	0.20	0.20	0.02	0.000	0.16	0.23
		Mid	0.27	0.32	0.25	0.26	1.25	0.19	0.25	0.25	0.14	0.35	0.34	0.000	0.14	1.25
		Bottom	1.17	0.88	1.41	0.98	0.58	1.05	0.70	0.71	0.47	0.88	0.30	0.196	0.47	1.41
		Average	0.55	0.47	0.61	0.48	0.69	0.48	0.38	0.37	0.27	0.48			0.27	0.69
		SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.39			
		±95% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.15		
Arsenic	0.05	Surface	3.59	4.02	3.77	3.50	4.91	4.15	4.47	5.35	4.19	4.22	0.61	0.40	3.50	5.35
		Mid	3.88	3.82	4.22	4.81	4.80	3.82	4.08	4.58	3.52	4.17	0.47	0.30	3.52	4.81
		Bottom	6.56	4.06	7.60	7.92	4.20	5.30	3.98	4.32	2.04	5.11	1.92	1.25	2.04	7.92
		Average	4.68	3.97	5.20	5.41	4.64	4.42	4.18	4.75	3.25	4.50			3.25	5.41
		SD	1.64	0.13	2.09	2.27	0.38	0.78	0.26	0.54	1.10		1.23			
		±95% CI	1.85	0.15	2.37	2.57	0.43	0.88	0.29	0.61	1.24			0.46		
Barium	0.05	Surface	99.40	92.60	89.70	108.00	134.00	128.00	104.00	91.40	87.90	103.89	16.83	10.99	87.90	134.00
		Mid	102.00	88.90	122.00	141.00	120.00	76.50	80.20	108.00	74.20	101.42	23.31	15.23	74.20	141.00
		Bottom	168.00	125.00	194.00	214.00	127.00	137.00	110.00	111.00	62.20	138.69	46.58	30.43	62.20	214.00
		Average	123.13	102.17	135.23	154.33	127.00	113.83	98.07	103.47	74.77	114.67			74.77	154.33
		SD	38.88	19.86	53.39	54.24	7.00	32.64	15.76	10.56	12.86		34.97			
		±95% CI	43.99	22.47	60.42	61.38	7.92	36.94	17.84	11.95	14.55			13.19		
Beryllium	0.01	Surface	0.26	0.28	0.26	0.3	0.37	0.36	0.29	0.31	0.325	0.31	0.04	0.03	0.26	0.37
		Mid	0.29	0.26	0.43	0.46	0.39	0.26	0.29	0.37	0.22	0.33	0.08	0.06	0.22	0.46
		Bottom	0.63	0.41	0.73	0.81	0.47	0.55	0.47	0.46	0.23	0.53	0.18	0.11	0.23	0.81
		Average	0.39	0.32	0.47	0.52	0.41	0.39	0.35	0.38	0.26	0.39			0.26	0.52
		SD	0.21	0.08	0.24	0.26	0.05	0.15	0.10	0.08	0.06		0.15			
		±95% CI	0.23	0.09	0.27	0.30	0.06	0.17	0.12	0.09	0.07			0.06		
Cadmium	0.01	Surface	0.11	0.10	0.09	0.09	0.15	0.13	0.10	0.10	0.14	0.11	0.02	0.01	0.09	0.15
		Mid	0.10	0.44	0.18	0.44	0.28	0.10	0.25	0.24	0.08	0.23	0.14	0.09	0.08	0.44
		Bottom	3.62	1.37	4.49	3.70	1.36	2.37	1.18	1.51	0.74	2.26	1.35	0.88	0.74	4.49
		Average	1.28	0.64	1.59	1.41	0.60	0.87	0.51	0.62	0.32	0.87			0.32	1.59
		SD	2.03	0.66	2.51	1.99	0.66	1.30	0.59	0.78	0.37		1.25			
		±95% CI	2.30	0.74	2.85	2.25	0.75	1.47	0.66	0.88	0.41			0.47		

Table C-5. Continued.

Heavy Metals	MDL (mg/Kg)	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI	MIN	MAX
Chromium	0.05	Surface	16.00	18.10	17.20	19.00	22.50	22.90	19.00	19.20	18.85	19.19	2.24	1.47	16.00	22.90
		Mid	19.20	19.10	24.20	30.90	25.00	16.00	17.90	23.10	14.40	21.09	5.17	3.38	14.40	30.90
		Bottom	47.90	31.70	62.20	61.20	33.30	40.10	28.40	30.10	14.50	38.82	15.77	10.30	14.50	62.20
		Average	27.70	22.97	34.53	37.03	26.93	26.33	21.77	24.13	15.92	26.37			15.92	37.03
		SD	17.57	7.58	24.21	21.76	5.65	12.41	5.77	5.52	2.54		12.94			
		±95% CI	19.88	8.58	27.40	24.62	6.40	14.04	6.53	6.25	2.88			4.88		
Copper	0.01	Surface	7.14	8.14	6.85	6.96	10.90	9.05	8.80	8.79	10.35	8.55	1.45	0.94	6.85	10.90
		Mid	8.22	16.20	13.50	20.80	15.10	7.19	12.00	14.00	6.18	12.58	4.73	3.09	6.18	20.80
		Bottom	89.60	41.20	108.00	84.80	42.30	61.20	36.30	41.30	23.50	58.69	28.92	18.89	23.50	108.00
		Average	34.99	21.85	42.78	37.52	22.77	25.81	19.03	21.36	13.34	26.61			13.34	42.78
		SD	47.30	17.24	56.58	41.53	17.05	30.66	15.04	17.46	9.04		28.32			
		±95% CI	53.52	19.51	64.02	46.99	19.29	34.70	17.02	19.76	10.23			10.68		
Iron	1.0	Surface	15000	16500	15950	17400	19600	20350	18000	17900	17300	17556	1681	1099	15000	20350
		Mid	18200	17700	22700	26900	22100	16100	17000	21400	14600	19633	3904	2551	14600	26900
		Bottom	29400	2380	35100	37900	26000	27700	24400	24400	13700	24553	10807	7061	2380	37900
		Average	20867	12193	24583	27400	22567	21383	19800	21233	15200	20581			12193	27400
		SD	7561	8520	9713	10259	3225	5869	4015	3253	1873		7102			
		±95% CI	8556	9641	10991	11609	3650	6641	4543	3681	2120			2679		
Lead	0.01	Surface	3.28	4.72	1.98	3.33	7.08	5.77	4.11	3.96	7.89	4.68	1.91	1.25	1.98	7.89
		Mid	3.95	26.00	7.96	34.00	14.30	5.33	12.10	10.50	3.62	13.08	10.45	6.82	3.62	34.00
		Bottom	143.00	66.80	169.00	170.00	60.20	102.00	58.20	76.00	37.40	98.07	50.51	33.00	37.40	170.00
		Average	50.08	32.51	59.65	69.11	27.19	37.70	24.80	30.15	16.30	38.61			16.30	69.11
		SD	80.47	31.55	94.75	88.71	28.81	55.69	29.20	39.84	18.40		51.65			
		±95% CI	91.06	35.70	107.22	100.38	32.60	63.01	33.04	45.08	20.82			19.48		
Mercury	0.005	Surface	0.000	0.040	0.015	0.050	0.130	0.030	0.090	0.040	0.025	0.047	0.040	0.000	0.000	0.130
		Mid	0.000	0.030	0.000	0.040	0.050	0.010	0.040	0.020	0.010	0.022	0.019	0.000	0.000	0.050
		Bottom	0.280	0.210	0.300	0.340	0.010	0.380	0.110	0.100	0.050	0.198	0.135	0.088	0.010	0.380
		Average	0.093	0.093	0.105	0.143	0.063	0.140	0.080	0.053	0.028	0.089			0.028	0.143
		SD	0.162	0.101	0.169	0.170	0.061	0.208	0.036	0.042	0.020		0.112			
		±95% CI	0.183	0.000	0.000	0.000	0.000	0.235	0.000	0.000	0.000			0.042		
Nickel	0.01	Surface	8.42	9.32	9.00	9.40	11.10	10.80	10.60	10.70	9.94	9.92	0.93	0.61	8.42	11.10
		Mid	10.10	10.60	12.70	15.30	12.30	8.39	9.94	12.50	7.73	11.06	2.37	1.55	7.73	15.30
		Bottom	29.60	18.30	36.20	34.30	18.80	24.30	18.00	19.40	10.70	23.29	8.48	5.54	10.70	36.20
		Average	16.04	12.74	19.30	19.67	14.07	14.50	12.85	14.20	9.46	14.76			9.46	19.67
		SD	11.77	4.86	14.75	13.01	4.14	8.58	4.48	4.59	1.54		7.88			
		±95% CI	13.32	5.50	16.70	14.72	4.69	9.70	5.06	5.20	1.74			2.97		
Selenium	0.05	Surface	0.58	0.45	0.38	0.36	0.54	0.45	0.25	0.32	0.33	0.41	0.11	0.00	0.25	0.58
		Mid	0.37	0.49	0.64	0.54	0.54	0.31	0.42	0.48	0.34	0.46	0.11	0.07	0.31	0.64
		Bottom	1.17	0.75	1.47	1.23	0.81	0.92	0.69	0.69	0.41	0.90	0.33	0.00	0.41	1.47
		Average	0.71	0.56	0.83	0.71	0.63	0.56	0.45	0.50	0.36	0.59			0.36	0.83
		SD	0.41	0.16	0.57	0.46	0.16	0.32	0.22	0.19	0.05		0.30			
		±95% CI	0.00	0.18	0.00	0.52	0.00	0.00	0.00	0.00	0.00			0.11		
Silver	0.01	Surface	0.00	0.00	0.00	0.00	0.03	0.06	0.07	0.06	0.07	0.03	0.03	0.02	0.00	0.07
		Mid	0.00	0.00	0.00	0.01	0.00	0.04	0.06	0.05	0.05	0.02	0.03	0.02	0.00	0.06
		Bottom	0.00	0.00	0.07	0.06	0.04	0.07	0.08	0.07	0.05	0.05	0.03	0.02	0.00	0.08
		Average	0.00	0.00	0.02	0.02	0.02	0.06	0.07	0.06	0.06	0.03			0.00	0.07
		SD	0.00	0.00	0.04	0.03	0.02	0.02	0.01	0.01	0.01		0.03			
		±95% CI	0.00	0.00	0.05	0.04	0.02	0.02	0.01	0.01	0.01			0.01		
Zinc	0.05	Surface	31.30	36.40	37.65	38.10	45.40	45.45	42.70	45.50	45.65	40.91	5.23	3.42	31.30	45.65
		Mid	39.50	73.50	48.00	91.00	69.60	37.30	58.00	60.40	32.90	56.69	19.22	12.56	32.90	91.00
		Bottom	397.00	264.00	537.00	442.00	209.00	321.00	199.00	214.00	126.00	301.00	133.99	87.54	126.00	537.00
		Average	155.93	124.63	207.55	190.37	108.00	134.58	99.90	106.63	68.18	132.86			68.18	207.55
		SD	208.81	122.11	285.36	219.52	88.30	161.49	86.16	93.28	50.47		142.71			
		±95% CI	236.29	138.18	322.91	248.41	99.92	182.74	97.50	105.55	57.12			53.83		
Total PAH	0.05	Surface	0.00	3.10	0.00	0.00	12.50	20.50	2.10	87.00	78.60	22.64	34.86	22.78	0.00	87.00
		Mid	3.10	225.40	0.00	296.10	431.60	6.90	403.60	128.80	0.00	166.17	178.81	116.82	0.00	431.60
		Bottom	3528.60	3252.70	3829.70	5117.70	2202.50	2774.70	1759.30	2170.90	3813.00	3161.01	1052.23	687.44	1759.30	5117.70
		Average	1177.23	1160.40	1276.57	1804.60	882.20	934.03	721.67	795.57	1297.20	1116.61			721.67	1804.60
		SD	2036.34	1815.39	2211.08	2873.05	1162.46	1594.08	920.77	1191.26	2179.10		1588.91			
		±95% CI	2304.30	2054.27	2502.02	3251.10	1315.42	1803.84	1041.93	1348.01	2465.84			599.33		

Table C-6. 2002 physical and chemical composition and summary statistics **normalized to % fine sediments** for surface, mid and bottom core layers collected from the NEIBP CAD site.

Heavy Metals	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI
% Fines	Surface	19.9	4.1	7.1	7.8	5.4	5.7	16.0	4.9	5.4	8.5	5.6	3.6
	Mid	7.5	7.6	26.2	3.5	40.7	2.2	3.8	20.6	17.0	14.3	13.0	8.5
	Bottom	68.1	60.9	54.2	20.9	44.9	59.9	33.3	50.0	15.8	45.3	18.3	12.0
	Average	31.9	24.2	29.2	10.7	30.3	22.6	17.7	25.2	12.7	22.7		
	SD	32.0	31.8	23.7	9.1	21.7	32.3	14.9	22.9	6.4		20.9	
	±95% CI	36.2	36.0	26.8	10.2	24.6	36.6	16.8	25.9	7.2			7.9
Aluminum	Surface	56187	258871	108944	158369	163333	176471	49125	238356	186335	155110	72763	47538
	Mid	127067	110724	32484	370755	22279	394545	222478	49272	74706	156034	142068	92816
	Bottom	29795	19551	26758	53589	31602	39421	44100	38374	78316	40167	17466	11411
	Average	71016	129715	56062	194237	72405	203479	105234	108667	113119	117104		
	SD	50303	120785	45886	161597	78884	179096	101567	112446	63433		104913	
	±95% CI	56922	136679	51924	182860	89264	202663	114932	127242	71780			39573
Antimony	Surface	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Bottom	0.00	0.00	0.00	0.00	0.56	0.82	0.00	0.00	0.00	0.15	0.31	0.20
	Average	0.00	0.00	0.00	0.00	0.19	0.27	0.00	0.00	0.00	0.05		
	SD	0.00	0.00	0.00	0.00	0.32	0.47	0.00	0.00	0.00		0.19	
	±95% CI	0.00	0.00	0.00	0.00	0.36	0.53	0.00	0.00	0.00			0.07
Arsenic	Surface	19	96	50	58	76	85	23	78	80	63	27	18
	Mid	50	58	12	188	9	185	116	19	24	73	72	47
	Bottom	9	9	8	22	9	12	13	11	19	12	5	3
	Average	26	54	23	89	32	94	51	36	41	50		
	SD	21	44	23	87	38	87	57	37	34		51	
	±95% CI	24	49	26	98	43	98	64	42	39			19
Barium	Surface	522	2903	1244	1442	1789	2153	510	2507	2311	1709	849	555
	Mid	4507	1572	368	4811	229	5045	2631	505	759	2270	2030	1326
	Bottom	286	169	244	522	302	388	390	328	695	369	158	103
	Average	1772	1548	618	2258	773	2529	1177	1113	1255	1449		
	SD	2372	1367	545	2258	880	2352	1261	1210	915		1469	
	±95% CI	2684	1547	617	2556	996	2661	1426	1369	1035			554
Beryllium	Surface	1.71	7.26	3.31	4.51	4.81	5.47	1.44	6.16	5.59	4.47	1.97	1.29
	Mid	4.53	3.88	0.96	10.47	0.64	11.82	6.11	1.33	2.12	4.65	4.11	2.69
	Bottom	0.79	0.59	0.78	1.53	0.87	1.04	1.20	1.08	2.21	1.12	0.49	0.32
	Average	2.34	3.91	1.68	5.50	2.11	6.11	2.91	2.86	3.31	3.41		
	SD	1.95	3.33	1.41	4.55	2.35	5.42	2.77	2.86	1.98		3.04	
	±95% CI	2.21	3.77	1.60	5.15	2.66	6.13	3.13	3.24	2.24			1.14
Cadmium	Surface	0.90	3.39	1.90	2.45	2.59	2.65	0.75	2.88	2.98	2.28	0.92	0.60
	Mid	2.93	1.91	0.50	5.38	0.32	5.91	3.72	0.73	0.88	2.47	2.13	1.39
	Bottom	4.92	1.38	2.80	1.82	4.14	6.31	4.32	3.64	5.87	3.91	1.69	1.11
	Average	2.92	2.23	1.73	3.21	2.35	4.96	2.93	2.41	3.25	2.89		
	SD	2.01	1.04	1.16	1.90	1.92	2.01	1.91	1.51	2.51		1.76	
	±95% CI	2.27	1.18	1.32	2.15	2.17	2.27	2.16	1.71	2.84			0.66
Chromium	Surface	83	387	194	251	254	281	71	349	326	244	111	72
	Mid	201	213	50	662	34	650	348	79	108	261	244	160
	Bottom	67	35	47	90	70	78	408	66	116	109	115	75
	Average	117	212	97	335	119	336	276	165	184	204		
	SD	73	176	84	295	118	290	180	160	124		176	
	±95% CI	83	199	95	334	133	328	203	181	140			66

Table C-6. Continued.

Heavy Metals	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI
Copper	Surface	25	80	68	64	54	86	15	86	89	63	27	18
	Mid	47	49	8	173	10	200	76	14	29	67	71	47
	Bottom	108	43	76	53	105	155	120	86	177	103	44	29
	Average	60	58	50	97	56	147	70	62	98	78		
	SD	43	20	37	66	48	57	53	41	75		52	
	±95% CI	49	23	42	75	54	65	60	47	85			20
Iron	Surface	77258	375000	340845	236910	259259	278824	76250	324658	298137	251904	107734	70385
	Mid	181333	209868	48535	602830	33443	659091	366372	72330	102353	252906	237826	155376
	Bottom	35959	25794	37645	81340	44844	50445	65100	49567	115579	56253	27662	18072
	Average	98183	203554	142342	307027	112515	329453	169241	148852	172023	187021		
	SD	74912	174689	171995	267723	127212	307465	170812	152677	109418		173463	
	±95% CI	84770	197675	194627	302951	143951	347923	193288	172767	123816			65429
Lead	Surface	26	107	47	64	69	78	23	90	80	65	28	19
	Mid	45	51	14	152	10	162	88	21	29	64	58	38
	Bottom	263	51	121	77	209	244	194	141	239	171	77	50
	Average	111	70	60	98	96	161	101	84	116	100		
	SD	131	32	55	47	102	83	86	60	110		76	
	±95% CI	149	36	62	54	116	94	97	68	124			29
Mercury	Surface	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Bottom	0.04	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.02	0.01
	Average	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00		
	SD	0.03	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00		0.01	
	±95% CI	0.03	0.00	0.00	0.00	0.00	0.02	0.00	#NUM!	0.00			0.00
Nickel	Surface	32	140	72	102	94	112	22	119	136	92	42	28
	Mid	60	85	16	271	12	263	132	27	41	101	102	66
	Bottom	35	16	26	40	36	49	289	36	61	65	85	55
	Average	42	80	38	138	48	141	148	61	79	86		
	SD	15	63	30	120	42	110	134	51	50		79	
	±95% CI	17	71	34	136	48	125	151	58	56			30
Selenium	Surface	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mid	0.00	5.66	0.00	20.94	0.00	0.00	0.00	0.00	0.00	2.96	7.00	4.57
	Bottom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Average	0.00	1.89	0.00	6.98	0.00	0.00	0.00	0.00	0.00	0.99		
	SD	0.00	3.27	0.00	12.09	0.00	0.00	0.00	0.00	0.00		4.13	
	±95% CI	0.00	3.70	0.00	13.68	0.00	0.00	0.00	0.00	0.00			1.56
Silver	Surface	0.00	0.24	0.00	0.77	0.00	0.53	0.19	0.00	0.00	0.19	0.28	0.18
	Mid	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.80	0.52
	Bottom	0.91	0.35	0.76	0.10	1.65	1.97	0.75	0.72	0.82	0.89	0.59	0.38
	Average	1.10	0.20	0.25	0.29	0.55	0.83	0.31	0.24	0.27	0.45		
	SD	1.21	0.18	0.44	0.42	0.95	1.02	0.39	0.42	0.47		0.65	
	±95% CI	1.37	0.20	0.49	0.48	1.08	1.15	0.44	0.47	0.54			0.25
Zinc	Surface	169	779	382	613	580	616	159	647	699	516	226	148
	Mid	321	407	102	1336	64	1455	770	143	211	534	533	348
	Bottom	517	209	415	296	568	797	588	452	846	521	210	137
	Average	336	465	300	748	404	956	506	414	585	524		
	SD	174	290	172	533	294	441	314	254	333		342	
	±95% CI	197	328	194	603	333	499	355	288	377			129

Table C-7. 2003 physical and chemical composition and summary statistics **normalized to % fine sediments** for surface, mid and bottom core layers collected from the NEIBP CAD site.

Heavy Metals	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI
% Fines	Surface	14.4	26.8	11.6	16.0	17.5	44.6	18.7	7.6	16.5	19.3	10.8	7.1
	Mid	19.7	17.5	29.0	36.8	35.1	19.0	4.2	18.5	11.6	21.3	10.6	7.0
	Bottom	62.5	38.9	71.1	58.6	21.6	65.2	32.3	22.5	22.0	43.9	20.5	13.4
	Average	32.2	27.8	37.2	37.2	24.7	42.9	18.4	16.2	16.7	28.1		
	SD	26.4	10.7	30.6	21.3	9.2	23.2	14.1	7.7	5.2		18.1	
	±95% CI	29.9	12.1	34.6	24.1	10.4	26.2	15.9	8.7	5.9			6.8
Aluminum	Surface	59298	38418	81805	67939	75576	153496	56625	135906	64401	81496	38116	24902
	Mid	50778	54608	51426	47547	41928	44361	227169	70708	65605	72681	58692	38345
	Bottom	36295	37779	37292	51837	79212	28822	48600	72441	35972	47583	17513	11442
	Average	48790	43602	56841	55774	65572	75559	110798	93018	55326	67253		
	SD	11630	9537	22745	10751	20557	67940	100861	37152	16772		42611	
	±95% CI	13160	10792	25738	12166	23262	76880	114132	42041	18979			16073
Antimony	Surface	1.53	0.75	1.55	1.25	1.32	0.46	0.96	2.11	1.18	1.23	0.48	0.00
	Mid	1.37	1.82	0.86	0.71	3.57	1.00	5.95	1.35	1.21	1.98	1.71	0.00
	Bottom	1.87	2.26	1.98	1.67	2.69	1.61	2.17	3.16	2.14	2.17	0.49	0.32
	Average	1.59	1.61	1.47	1.21	2.52	1.02	3.03	2.21	1.51	1.80		
	SD	0.26	0.78	0.57	0.48	1.13	0.58	2.60	0.91	0.54		1.10	
	±95% CI	0.00	0.00	0.00	0.00	1.28	0.65	0.00	0.00	0.00			0.42
Arsenic	Surface	25	15	32	22	28	9	24	71	25	28	17	11
	Mid	20	22	15	13	14	20	97	25	30	28	26	17
	Bottom	10	10	11	14	19	8	12	19	9	13	4	3
	Average	18	16	19	16	20	13	44	38	22	23		
	SD	7	6	12	5	7	7	46	28	11		19	
	±95% CI	8	6	13	6	8	7	52	32	13			7
Barium	Surface	690	345	773	673	767	287	556	1206	534	648	271	177
	Mid	518	507	421	383	342	403	1908	583	641	634	488	319
	Bottom	269	321	273	365	588	210	341	493	283	349	120	78
	Average	492	391	489	474	566	300	935	761	486	544		
	SD	212	101	257	173	213	97	850	388	184		346	
	±95% CI	240	114	291	196	241	110	961	439	208			131
Beryllium	Surface	1.81	1.04	2.24	1.87	2.12	0.81	1.55	4.09	1.97	1.94	0.94	0.61
	Mid	1.47	1.48	1.48	1.25	1.11	1.37	6.90	2.00	1.90	2.11	1.82	1.19
	Bottom	1.01	1.05	1.03	1.38	2.18	0.84	1.45	2.04	1.05	1.34	0.48	0.31
	Average	1.43	1.19	1.58	1.50	1.80	1.01	3.30	2.71	1.64	1.80		
	SD	0.40	0.25	0.61	0.33	0.60	0.31	3.12	1.20	0.52		1.21	
	±95% CI	0.45	0.28	0.69	0.37	0.68	0.36	3.53	1.35	0.58			0.46
Cadmium	Surface	0.76	0.37	0.78	0.56	0.86	0.29	0.53	1.32	0.82	0.70	0.31	0.20
	Mid	0.51	2.51	0.62	1.20	0.80	0.53	5.95	1.30	0.69	1.57	1.76	1.15
	Bottom	5.79	3.52	6.32	6.31	6.30	3.63	3.65	6.71	3.37	5.07	1.47	0.96
	Average	2.35	2.13	2.57	2.69	2.65	1.48	3.38	3.11	1.63	2.44		
	SD	2.98	1.61	3.25	3.15	3.16	1.87	2.72	3.12	1.51		2.31	
	±95% CI	3.37	1.82	3.67	3.57	3.57	2.11	3.07	3.53	1.71			0.87
Chromium	Surface	111	68	148	118	129	51	101	253	115	122	58	38
	Mid	97	109	84	84	71	84	426	125	124	134	111	73
	Bottom	77	81	88	104	154	61	88	134	66	95	31	20
	Average	95	86	106	102	118	66	205	171	102	117		
	SD	17	21	36	17	42	17	191	72	31		73	
	±95% CI	20	24	41	20	48	19	216	81	35			28

Table C-7. Continued.

Heavy Metals	Core Depth	2	3	4	5	6	7	8	9	10	Avg	SD	95% CI
Copper	Surface	50	30	59	43	62	20	47	116	63	55	27	18
	Mid	42	92	47	57	43	38	285	76	53	81	79	51
	Bottom	143	106	152	145	196	94	112	184	107	138	36	23
	Average	78	76	86	81	100	51	148	125	74	91		
	SD	56	40	58	55	83	38	123	55	29		61	
	±95% CI	64	46	65	62	94	43	139	62	32			23
Iron	Surface	104154	61543	137491	108453	112219	45634	96155	236187	105108	111882	54078	35330
	Mid	92415	100893	78347	73086	63034	84823	404385	115508	126197	126521	106122	69332
	Bottom	47008	6117	49395	64626	120439	42466	75531	108439	62382	64045	34663	22646
	Average	81192	56184	88411	82055	98564	57641	192024	153378	97896	100816		
	SD	30181	47615	44902	23249	31043	23594	184200	71802	32513		73986	
	±95% CI	34152	53880	50811	26309	35128	26698	208437	81250	36791			27907
Lead	Surface	23	18	17	21	41	13	22	52	48	28	15	10
	Mid	20	148	27	92	41	28	288	57	31	81	88	57
	Bottom	229	172	238	290	279	156	180	338	170	228	64	42
	Average	90	112	94	134	120	66	163	149	83	113		
	SD	120	83	125	139	138	79	134	164	76		105	
	±95% CI	135	94	141	158	156	89	151	185	86			40
Mercury	Surface	0.00	0.15	0.13	0.31	0.74	0.07	0.48	0.53	0.15	0.28	0.25	0.00
	Mid	0.00	0.17	0.00	0.11	0.14	0.05	0.95	0.11	0.09	0.18	0.30	0.00
	Bottom	0.45	0.54	0.42	0.58	0.05	0.58	0.34	0.44	0.23	0.40	0.18	0.12
	Average	0.15	0.29	0.18	0.33	0.31	0.23	0.59	0.36	0.16	0.29		
	SD	0.26	0.22	0.22	0.24	0.38	0.30	0.32	0.22	0.07		0.25	
	±95% CI	0.29	0.00	0.00	0.00	0.00	0.34	0.00	0.25	0.00			0.10
Nickel	Surface	58	35	78	59	64	24	57	141	60	64	33	22
	Mid	51	60	44	42	35	44	236	67	67	72	63	41
	Bottom	47	47	51	58	87	37	56	86	49	58	17	11
	Average	52	47	57	53	62	35	116	98	59	64		
	SD	6	13	18	10	26	10	104	38	9		41	
	±95% CI	6	15	20	11	29	11	118	43	10			15
Selenium	Surface	4.03	1.68	3.23	2.24	3.09	1.00	1.34	4.22	1.97	2.53	1.16	0.00
	Mid	1.88	2.79	2.21	1.47	1.54	1.63	9.99	2.59	2.94	3.00	2.68	1.75
	Bottom	1.87	1.93	2.07	2.10	3.75	1.41	2.14	3.07	1.87	2.24	0.72	0.00
	Average	2.59	2.13	2.50	1.94	2.79	1.35	4.49	3.29	2.26	2.59		
	SD	1.24	0.59	0.64	0.41	1.14	0.32	4.78	0.84	0.59		1.70	
	±95% CI	0.00	0.66	0.00	0.47	0.00	0.00	0.00	0.00	0.00			0.64
Silver	Surface	0.00	0.00	0.00	0.00	0.17	0.13	0.37	0.79	0.39	0.21	0.27	0.18
	Mid	0.00	0.00	0.00	0.03	0.00	0.21	1.43	0.27	0.43	0.26	0.46	0.30
	Bottom	0.00	0.00	0.10	0.10	0.19	0.11	0.25	0.31	0.23	0.14	0.11	0.07
	Average	0.00	0.00	0.03	0.04	0.12	0.15	0.68	0.46	0.35	0.20		
	SD	0.00	0.00	0.06	0.05	0.10	0.05	0.65	0.29	0.11		0.31	
	±95% CI	0.00	0.00	0.06	0.06	0.12	0.06	0.73	0.33	0.12			0.12
Zinc	Surface	217	136	325	237	260	102	228	600	277	265	143	94
	Mid	201	419	166	247	199	197	1380	326	284	380	383	250
	Bottom	635	678	756	754	968	492	616	951	574	714	162	106
	Average	351	411	415	413	476	264	741	626	378	453		
	SD	246	271	305	295	428	204	586	313	169		312	
	±95% CI	278	307	345	334	484	230	663	355	191			118

Table C-8. 2002 physical and chemical composition of burrow mounds (n = 6) collected on the NEIBP CAD site.

Heavy Metals	MDL (mg/Kg)	1B	2B	3B	4B	5B	6B	Avg	SD	95% CI	MIN	MAX
Percent Fines (%)	0.10	11.2	65.8	55.4	56.6	56.6	23.6	44.86	21.95	17.56	11.2	65.80
Denisty (g/cm^3)	0.01	2.63	2.19	2.35	2.51	2.55	2.56	2.47	0.16	0.13	2.19	2.63
TOC (%)	0.01	0.72	1.13	1.01	0.58	0.59	0.36	0.73	0.29	0.23	0.36	1.13
Total Solids (%)	0.1	29.6	23.0	25.7	24.1	33.9	42.4	29.8	7.4	5.9	23.0	42.4
Aluminum	1.0	20200	39600	40200	24100	23200	23650	21717	10085	8070	20200	40200
Antimony	0.05	0.52	0.48	0.52	0.29	0.30	0.29	0.00	0.00	0.00	0.29	0.52
Arsenic	0.05	5.38	9.23	8.70	5.78	6.00	5.89	6.83	1.68	1.34	5.38	9.23
Barium	0.05	128.00	198.00	199.00	145.00	147.00	146.00	160.50	30.26	24.21	128.00	199.00
Beryllium	0.01	0.67	1.09	1.10	0.64	0.65	0.65	0.80	0.23	0.18	0.64	1.10
Cadmium	0.01	0.29	0.48	0.48	0.24	0.24	0.24	0.33	0.12	0.10	0.24	0.48
Chromium	0.05	24.70	53.00	54.10	31.20	30.80	31.00	37.47	12.70	10.16	24.70	54.10
Copper	0.01	11.90	40.10	41.70	21.20	20.50	20.85	26.04	12.03	9.63	11.9	41.70
Iron	1.0	23100	40800	40500	26300	26000	26150	30475	7971	6378	23100	40800
Lead	0.01	11.00	40.10	41.10	17.30	17.50	17.40	24.07	13.05	10.44	11.00	41.10
Mercury	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nickel	0.01	10.90	27.70	28.60	16.80	16.80	16.80	19.60	7.01	5.61	10.9	28.60
Selenium	0.05	0.41	0.92	0.91	0.78	0.75	0.76	0.75	0.18	0.00	0.41	0.92
Silver	0.01	0.37	0.25	0.26	0.15	0.11	0.13	0.21	0.10	0.08	0.109	0.37
Zinc	0.05	54.00	119.00	122.00	65.90	66.30	66.10	82.22	30.04	24.03	54.00	122.00
Total PAH	1	85	283	306	102	131	151	176	95	76	85	306

Table C-9. 2002 physical and chemical composition of burrow mounds (n = 6) **normalized to % fine sediments** collected on the NEIBP CAD site.

Heavy Metals	1B	2B	3B	4B	5B	6B	Avg	SD	95% CI
% Fines	11.2	65.8	84.3	22.1	56.6	23.6	43.9	29.1	23.3
Aluminum	180357	60182	47687	109050	41014	100212	89750	52365	41900
Antimony	4.64	0.72	0.61	1.29	0.52	1.23	1.50	1.57	1.26
Arsenic	48.0	14.0	10.3	26.2	10.6	25.0	22.4	14.4	11.5
Barium	1143	301	236	656	260	619	536	350	280
Beryllium	5.98	1.66	1.30	2.91	1.15	2.74	2.62	1.80	1.44
Cadmium	2.61	0.73	0.57	1.08	0.42	1.00	1.07	0.80	0.64
Chromium	220.5	80.5	64.2	141.2	54.4	131.4	115.4	62.5	50.0
Copper	106.3	60.9	49.5	95.9	36.2	88.3	72.9	28.0	22.4
Iron	206250	62006	48043	119005	45963	110805	98679	61351	49090
Lead	98.2	60.9	48.8	78.3	30.9	73.7	65.1	23.6	18.9
Mercury	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nickel	97.3	42.1	33.9	76.0	29.7	71.2	58.4	27.1	21.7
Selenium	3.68	1.40	1.08	3.51	1.32	3.22	2.37	1.22	0.98
Silver	3.26	0.37	0.31	0.68	0.19	0.55	0.89	1.17	0.94
Zinc	482	181	145	298	117	280	251	135	108

Table C-10. 2003 physical and chemical composition of burrow mounds collected on the NEIBP CAD site (n = 6), CAD site surface sediments (n = 6), Harbor burrows (n = 3) and Harbor surface sediments (n = 3). Metals in mg/Kg dry weight, PAH's in ug/Kg dry weight.

Analyte	CAD Burrow		CAD Surface		Harbor Burrow		Harbor Surface	
	AVG	95% CI	AVG	95% CI	AVG	95% CI	AVG	95% CI
Fine Sediment %	61.05	1.32	55.05	7.74	22.87	2.71	23.95	3.23
TOC (%)	8.24	3.04	6.20	1.97	1.75	1.03	2.73	1.51
Density (g/cm^3)	0.78	0.13	0.86	0.13	1.02	0.06	1.00	0.08
Total Solids (%)	36.48	15.65	47.70	13.46	49.23	14.49	53.87	8.59
Aluminum	30725	10963	27783	3766	22500	2322	27433	364
Antimony	0.47	0.09	0.33	0.05	0.22	0.04	0.23	0.06
Arsenic	8.33	1.57	7.58	1.21	5.17	0.29	5.87	0.19
Barium	141.58	13.56	130.92	18.28	76.23	4.09	86.73	1.31
Beryllium	0.96	0.39	0.82	0.11	0.68	0.06	0.83	0.01
Cadmium	0.48	0.11	0.37	0.09	0.21	0.00	0.24	0.01
Chromium	48.23	12.75	43.55	5.89	31.83	2.46	37.13	0.85
Copper	35.50	10.08	29.03	5.27	17.80	1.33	20.30	0.78
Iron	36758	8419	33722	4104	27100	2037	31100	1132
Lead	30.88	7.94	24.59	5.78	15.63	1.16	17.93	0.13
Mercury	0.040	0.017	0.037	0.010	0.023	0.024	0.007	0.013
Nickel	23.33	5.69	20.68	2.74	15.67	0.91	17.53	0.36
Selenium	0.83	0.20	0.73	0.12	0.47	0.06	0.52	0.18
Silver	0.15	0.17	0.03	0.04	0.00	0.00	0.00	0.00
Zinc	134.28	31.98	109.47	15.33	78.33	6.05	89.60	1.33
Total PAH	563.66	251.62	377.32	263.89	40.87	80.10	58.33	37.20

APPENDIX D – BENTHIC INFAUNA

Table D-1. 2002 taxa list for the NEIBP CAD site monitoring program. All organisms collected on 1.0 mm screen.

Phylum	Class	Species	StationID																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Annelida	Capitellidae	Anotomastus gordiodes																20				
		Capitella capitata Cmplx									1		1									
Total Annelids 10141		Mediomastus sp	48	51	32	131	75	83	12	7	4	194	1			15	80	66	165	13	24	7
% of Population 86%		Notomastus sp														7						
		Notomastus sp A	1						1							3	1		1			
	Maldanidae	Euclymeninae															1	3	4			
		Euclymeninae sp A																26				
		Petaloclymene pacifica									1	1				34	10	1	16			
		Praxillella pacifica														3	1	2	1			
	Cossuridae	Cossura candida										153	850	608	1206					1197	876	596
		Cossura sp A	6	6	8	1	3	2	14	4	4					9	1	5	15			
	Dorvilleidae	Dorvillea (Schistomeringos) longicornis		2	2	1		2	2	1	3	2										
	Eunicidae	Marphysa disjuncta														1						
	Lumbrineridae	Lumbrineris limicola																1				
		Scoletoma sp	3			1	3			2		2				1	4	30	4			
		Scoletoma sp A		1												16	19	5	22			
		Scoletoma sp C	1	1	1		1	1	4		1	8					3	13	18	1	2	
	Onuphidae	Diopatra ornata										1					3		2			
		Diopatra sp	2		2										1			2				
		Onuphis sp 1				1																
	Flabelligeridae	Diplocirrus sp SD1														1		1				
		Pherusa neopapillata										2										
		Pherusa sp	5																			
	Opheliidae	Armandia brevis		1		4	1			1	3	1					1	9	5			
	Orbiniidae	Leitoscoloplos pugettensis		5	1	6	5	9	1	1	1	51				6	29	7	22	2		6
		Scoloplos acmeceps					1											1	1			
	Paraonidae	Aricidea (Acmira) catherinae														1	1					
		Aricidea (Acmira) horikoshii															1		1			
		Aricidea (Acmira) sp															1					
		Levinsenia gracilis															14		10		1	
		Levinsenia multibranchiata																		1		
	Oweniidae	Owenia collaris																2	2			
	Glyceridae	Glycera americana				1						2					1					
		Glycera macrobranchia														1	2		2			
		Glycera nana														1	1		1			
	Goniadidae	Glycinde armigera															1		2			
		Goniada littorea														3	1	13	2			
		Goniada maculata			1	1	1	1														
	Hesionidae	Podarkeopsis glabrus		3			1			1	2	6					1	2	1	1		1
	Nephtyidae	Nephtys caecoides															2	3				
		Nephtys cornuta	2		3		1	4			2	4				1	4		2		2	1
		Nephtys ferruginea									1	1				1						
	Nereididae	Nereis procera			1	1		1				7			1		9		1			
	Pholoidae	Pholoe glabra																1				
	Phyllodocidae	Eteone sp															1					
		Eteone sp II										2										
		Eumida longicornuta										3										
		Phyllodoce hartmanae																3				
		Phyllodoce longipes														1	2	2	1			
	Pilargidae	Parandalia fauveli				1																
		Parandalia ocularis								1												
		Sigambra tentaculata	1		1						1	21	37	12	28		1			65	67	
	Polynoidae	Tenonia priops	1	2	1	1	2			2		1					1			1	1	
	Sigalionidae	Sthenelais tertiaglabra																	1			
	Syllidae	Exogone lourei																26	2			
		Exogone molesta																1				
	Sabellidae	Chone mollis														2			4			
		Chone sp															1		1			
		Euchone limnicola										17				2	8	8	14			
		Megalomma pigmentum																	1			
	Chaetopteridae	Spiochaetopterus costarum			1	6	3	2				7	1				2	11	11		1	53
	Cirratulidae	Aphelochaeta monilaris							2	1		18								1	2	1
		Chaetozone corona	1	3	6	21	1	2		4	1	6	1				8	1	1	1		

Table D-1. Continued.

Phylum	Class	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			StationID																			
		Chaetozone setosa Cmplx																2				
		Cirratulidae					2															
		Monticellina cryptica	1	1	4	2	2	1		1		3					1	2	1		1	
		Monticellina siblina	5	4	6	33	7	7	12	5		109				7	15	5	32		1	
	Spionidae	Apoprionospio pygmaea				4						6				1	16	10	12			
		Laonice cirrata										5					2		2			
		Paraprionospio pinnata	73	124	62	72	109	151	127	51	87	110	29	6	7	7	15	1	5	98	108	91
		Polydora cirrosa																1				
		Polydora cornuta																	1			
		Polydora sp	1		1		4					1						2				
		Prionospio (Minuspio) lighti		7			1	1	1	1	1	14				2	1	2	1			
		Prionospio (Prionospio) heterobranchia															1	59	6			
		Prionospio (Prionospio) jubata										8					4					
		Pseudopolydora paucibranchiata														4	8	140	23			
		Rhynchospio glutaea																11				
		Scolelepis bullibranchia																1				
		Spionidae		1														1				
		Spiophanes berkeleyorum		1		5						35				3	3		1			
		Spiophanes bombyx															3		2			
		Spiophanes duplex		1	2	6	4		5		9	34				8	41	69	64		2	
	Ampharetidae	Ampharete labrops										7					3	1	8	1		
		Ampharetidae																1				
		Amphicteis scaphobranchiata										9					9		4			
		Melinna oculata										1							2			
	Pectinariidae	Pectinaria californiensis		1			1					3				2	1	3	2		1	1
	Terebellidae	Amaeana occidentalis										2					1	2				
		Nicolea sp A										1						1				
		Pista disjuncta										1				1	3	3				
		Polycirrus sp																1				
		Streblosoma sp B														5	5		2			
Arthropoda	Ampeliscidae	Ampelisca cristata microdentata														21	15		11		1	
		Ampelisca sp		1																		
	Amphilochidae	Apolochus barnardi																1				
Total Arthropods 998	Aoridae	Aoroides sp																1				
% of Population 8%		Paramicrodeutopus schmitti	1		3							3				4	5		1		1	
	Caprellidae	Caprella californica																1				
	Corophiidae	Monocorophium acherusicum					1					1				17	3	18	1		1	1
		Sinocorophium cf. heteroceratum			2			1	4	1	1					5	1			8		
	Isaeidae	Amphideutopus oculatus	3		3	2	1	3	1	1	1	7			1	51	217	24	68	3	7	4
		Photis bifurcata														1		16	3		2	
		Photis brevipes														3		16	4			
		Photis sp					1											8	1	1		
	Ischyroceridae	Cerapus tubularis Cmplx																2				
		Ericthonius brasiliensis																4	1		1	
	Liljeborgiidae	Listriella diffusa														1						
		Listriella goleta															1	1				
	Lysianassidae	Hippomedon zetesimus															3					
	Melphidippidae	Melphisana bola Cmplx																	1			
	Oediceroditae	Americhelidium shoemakeri																2	1		1	
		Eochelidium sp A				1										64	10	1	4	1	2	
	Phoxocephalidae	Rhepoxynius bicuspidatus				1																
	(blank)	Amphipoda				3																
	Diastylidae	Oxyurostylis pacifica															1		1			
	Callianassidae	Neotrypaea gigas														1						
		Neotrypaea sp	1	3	2			2	2	2	10	12	2					2	1	2	1	3
	Majidae	Majidae				1										1						
		Pyromaia tuberculata							3	1		3						4	3			
	Pinnotheridae	Pinnixa sp															1					
		Pinnixa tubicola														9		2				

Table D-1. Continued.

			StationID																			
Phylum	**Class**	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
		Scleroplax granulata															1					
	(blank)	Caridea								3												
	Arcturidae	Neastacilla californica																2				
	Gnathiidae	Caecognathia crenulatifrons														6	6	3				
		Caecognathia sp			1											4	5	4				
	Mysidae	Alienacanthomysis macropsis		1																		
		Metamysidopsis elongata	1	3			2									10	9	2				
		Mysidopsis intii																	1	4		
	Leptocheliidae	Leptochelia dubia														1	8	2	54			3
	Tanaidae	Synaptotanais notabilis																9				
	Cylindroleberididae	Asteropella slatteryi																1				
		Leuroleberis sharpei																	1			
	Philomedidae	Euphilomedes carcharodonta					1		1							14	32		30			1
	Rutidermatidae	Rutiderma lomae																		1		
Mollusca	Nuculanidae	Nuculana taphria														1		5	2			
	Lyonsiidae	Lyonsia californica														2						
	Periplomatidae	Periploma discus															1					
Total Mollusks 150	Thraciidae	Asthenothaerus diegensis																1				
% of Population 1%		Cyathodonta pedroana																	1			
	Lasaeidae	Rochefortia grippi																1				
		Rochefortia tumida																1				
	Lucinidae	Parvilucina tenuisculpta															1	1				
	Mactridae	Mactridae											1									
		Mactrotoma californica														11	3					
	Petricolidae	Cooperella subdiaphana														5			1			
	Semelidae	Cumingia californica															1	4				
		Theora lubrica										2				1	6	1	1			
	Solecurtidae	Tagelus subteres														1	2	1	3			
	Solenidae	Solen sicarius														2						
	Tellinidae	Macoma nasuta														2	1					
		Macoma sp															1		1			
		Macoma yoldiformis														3	5	4	5			
		Tellina modesta														1	3	1	4			
	Thyasiridae	Thyasira flexuosa																				1
	Ungulinidae	Diplodonta sericata																12				
	Veneridae	Compsomyax subdiaphana	1		2												2				1	
		Protothaca staminea																	1			
	(blank)	Bivalvia														7						
	Acteonidae	Rictaxis punctocaelatus				2																
	Cylichnidae	Cylichna diegensis														1						
	Haminaeidae	Haminaea sp																		1		
	Scaphandridae	Acteocina eximia																1				
	Pyramidellidae	Turbonilla sp																1				
	Columbellidae	Decipifus penicillata																1				
	Conidae	Kurtziella plumbea				1													1			
	Olividae	Olivella baetica				3												3	1			
	Barleeidae	Barleeia haliotiphila																5				
	Caecidae	Caecum californicum																2				
	(blank)	Aeolidoida	1																			
	(blank)	Gastropoda																		2		
	Gadilidae	Cadulus aberrans															1		2			

Table D-1. Continued.

Phylum	Class	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
			StationID																			
Echinodermata	Synaptidae	Leptosynapta sp																	3			
	Amphiuridae	Amphiodia occidentalis																1				
Total Echinoderms 14		Amphiodia psara														1	1	4				
% of Population 0.12%		Amphiodia urtica														2			1			
		Amphiuridae		1																		
Misc Phyla																						
Total Misc Phyla 439																						
% of Population 4%																						
Chordata	Molgulidae	Molgula sp															2		3			
Cnidaria	Edwardsiidae	Edwardsia californica	1	1	2	1	3	2													1	
		Scolanthus sp A	1				1					2										
	Isanthidae	Zaolutus actius																			2	
	Cerianthidae	Pachycerianthus fimbriatus																1				
Ectoprocta	Alcyonidiidae	Alcyonidium sp A																	1			
Nemertea	Lineidae	Cerebratulus californiensis	1					1				1										
		Lineidae		1		1				1									1			
	Valenciniidae	Zygeupolia rubens															1					
	Tubulanidae	Tubulanus cingulatus										1				1						
		Tubulanus frenatus															1					
		Tubulanus nothus										1										
		Tubulanus polymorphus			1	1		2		1		2				2	3	1	2			
	(blank)	Palaeonemertea						1								1	2	1	1			
	Amphiporidae	Amphiporus sp		1													1					
	Emplectonematida	Paranemertes californica										1				2	2	1	2			
Phorona	Phoronidae	Phoronis sp	57	51	25	28	26	22	41	24	30	13	5	1	1	1	1	4	1	12	13	10
Platyhelminthes	Stylochidae	Imogine exiguus	1															2	1			
Sipuncula	Phascolosomatida	Apionsoma misakianum																	2			

Table D-2. 2003 taxa list for the NEIBP CAD site monitoring program. All organisms collected on 1.0 mm screen.

Phylum	Class	Species	StationID 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Annelida	Polychaeta	Capitella capitata Cmplx	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		Decamastus gracilis	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Mediomastus sp	14	14	7	5	37	14	15	3	43	55	0	0	0	8	5	32	35	2	2	3	17	0
Total Annelids	8156	Notomastus lineatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	3	0	0	0	0	0
% of Population	73%	Notomastus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Notomastus sp A	0	0	0	0	5	0	0	0	0	1	0	0	0	2	7	0	0	0	0	0	0	0
		Notomastus sp SD1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
		Axiothella rubrocincta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Euclymeninae	0	1	0	0	4	0	0	1	0	0	0	0	0	29	8	0	2	0	0	0	0	0
		Euclymeninae sp A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Maldanidae	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
		Petaloclymene pacifica	0	0	0	0	2	0	0	0	0	3	0	0	0	13	0	0	0	0	0	0	1	0
		Praxillella pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	3	0	1	0	0	0
		Cossura candida	0	2	0	8	0	0	0	0	6	5	634	611	320	18	5	0	2	1074	974	1034	9	23
		Cossura sp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Cossura sp A	9	11	12	20	0	11	2	16	18	18	0	0	0	1	0	0	3	0	128	168	14	0
		Dorvillea (Schistomeringos) longicornis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
		Lumbrineris latreilli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
		Lumbrineris sp	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
		Scoletoma sp	5	1	2	4	3	3	0	0	1	6	0	0	0	3	4	5	5	0	0	0	2	1
		Scoletoma sp A	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1
		Scoletoma sp B	1	3	5	1	32	4	0	1	3	9	1	0	0	12	24	2	21	0	0	0	5	1
		Scoletoma sp C	0	0	0	0	0	0	1	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0
		Diopatra ornata	0	0	0	0	3	0	0	0	0	1	0	0	0	0	2	2	0	0	0	0	0	0
		Diopatra sp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Diopatra tridentata	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Onuphis geophiliformis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Diplocirrus sp SD1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Flabelligeridae	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Pherusa neopapillata	0	0	0	2	0	2	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0
		Piromis sp A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Armandia brevis	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Leitoscoloplos pugettensis	4	10	7	5	12	4	1	0	5	8	0	0	0	5	8	0	6	0	0	0	0	0
		Scoloplos acmeceps	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
		Aricidea (Acmira) catherinae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
		Aricidea (Acmira) horikoshii	0	0	3	0	6	0	0	0	0	8	0	0	0	0	3	0	1	0	0	0	0	0
		Cirrophorus furcatus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Levinsenia gracilis	0	0	0	0	0	0	0	0	0	0	1	0	0	5	2	0	13	0	0	0	0	0
		Owenia collaris	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Glycera americana	0	1	1	0	1	1	3	0	1	5	0	1	0	0	3	5	3	0	0	1	1	1
		Glycera macrobranchia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Glycera robusta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Glycinde armigera	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Goniada littorea	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Goniada maculata	1	1	0	1	0	0	5	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
		Podarkeopsis glabrus	2	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Podarkeopsis sp A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
		Nephtys caecoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Nephtys cornuta	0	7	3	1	5	2	0	0	3	2	0	0	0	2	0	0	0	0	4	2	1	0
		Nephtys sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Nereis procera	0	1	1	1	6	1	0	1	1	6	0	0	0	0	0	0	2	0	0	0	2	1
		Pholoe glabra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Phyllodoce hartmanae	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0
		Ancistrosyllis groenlandica	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Parandalia fauveli	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Pilargidae	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Pilargis berkeleyae	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Sigambra tentaculata	0	0	0	0	0	0	0	0	0	10	48	40	29	0	1	0	0	85	65	43	1	0
		Malmgreniella macginitiei	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Malmgreniella sp	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0
		Tenonia priops	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	1	0
		Sthenelais tertiaglabra	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Table D-2. Continued.

Phylum	Class	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Exogone lourei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
		Odontosyllis phosphorea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Proceraea sp	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
		Chone mollis	0	0	0	0	13	0	0	0	0	2	0	0	0	0	0	6	11	0	0	0	0	0
		Euchone limnicola	0	0	0	0	2	0	0	0	0	2	0	0	0	4	3	0	3	0	0	0	0	0
		Spiochaetopterus costarum	3	0	1	0	3	2	1	1	1	0	0	0	0	0	1	0	1	0	0	0	2	1
		Aphelochaeta glandaria	1	2	6	1	0	2	0	0	2	9	0	0	0	0	0	0	0	0	1	0	0	1
		Aphelochaeta monilaris	3	5	1	6	1	4	0	0	28	45	0	0	0	0	0	0	0	0	3	4	14	5
		Caulleriella pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Chaetozone corona	26	33	46	20	6	35	19	3	12	41	0	0	0	0	6	1	5	0	1	0	8	6
		Chaetozone setosa Cmplx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Cirratulidae	7	3	2	5	2	0	1	0	1	15	0	0	0	0	0	0	0	0	0	0	2	0
		Cirriformia sp B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
		Cirriformia sp SD1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Cirriformia sp SD2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
		Monticellina cryptica	4	6	4	2	1	1	2	0	1	2	0	0	0	3	2	0	1	2	1	0	3	0
		Monticellina siblina	33	38	47	27	29	20	26	4	28	53	0	0	0	8	11	0	9	0	0	0	72	3
		Monticellina sp SD4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
		Apoprionospio pygmaea	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
		Dipolydora socialis	0	0	0	0	0	0	0	1	0	3	0	0	0	1	1	0	0	0	0	0	0	0
		Laonice cirrata	0	1	3	0	1	2	0	0	0	4	0	0	0	0	0	0	2	0	0	0	1	0
		Microspio pigmentata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
		Paraprionospio pinnata	12	5	14	5	6	6	9	6	43	17	0	0	0	5	5	0	6	0	8	3	26	17
		Polydora sp	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Prionospio (Minuspio) lighti	2	0	0	0	0	2	0	0	0	10	0	0	0	0	0	3	0	0	1	0	6	0
		Prionospio (Prionospio) heterobranchia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	38	23	0	0	0	0	0
		Prionospio (Prionospio) jubata	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
		Pseudopolydora paucibranchiata	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2	2	2	0	0	0	0	0
		Spionidae	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0
		Spiophanes berkeleyorum	6	1	2	0	5	3	1	1	0	17	0	0	0	0	0	0	0	0	0	0	5	4
		Spiophanes bombyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Spiophanes duplex	3	10	3	2	41	4	2	1	2	13	0	0	0	13	5	269	6	0	0	0	1	1
		Spiophanes sp	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Ampharete finmarchica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Ampharete labrops	0	1	0	0	12	0	0	0	0	8	0	0	0	2	0	21	15	0	0	1	0	0
		Ampharetidae	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
		Amphicteis scaphobranchiata	4	0	1	0	7	0	0	1	0	2	0	0	0	0	0	2	5	0	0	0	0	0
		Melinna oculata	0	0	0	0	3	1	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0
		Paramage scutata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
		Pectinaria californiensis	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		Neosabellaria cementarium	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Amaeana occidentalis	0	0	0	0	4	0	0	0	0	6	0	0	0	0	1	4	5	0	0	0	0	0
		Pista disjuncta	0	0	0	0	7	0	2	0	1	8	0	0	0	0	1	13	8	0	0	0	0	1
		Pista percyi	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	1	0	0	0	0	0
		Streblosoma sp B	11	7	7	11	3	6	5	0	3	1	0	0	0	5	4	0	6	0	0	0	0	0
		Terebellidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Terebellides californica	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	**Copepoda**	Copepoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
	Malacostraca	Ampelisca brachycladus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Ampelisca brevisimulata	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1	0	0	0	0	0	0	0
Total Arthropods	**1833**	Ampelisca cristata cristata	0	0	0	0	15	0	1	0	0	0	0	0	0	23	12	0	12	0	0	0	0	0
% of Population	**17%**	Ampelisca cristata microdentata	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
		Ampelisca sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Paramicrodeutopus schmitti	0	0	0	0	3	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	0
		Rudilemboides stenopropodus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	1	0	0	0	0	0
		Argissa hamatipes	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Caprella californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Caprella mendax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
		Caprella natalensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0
		Caprella pilidigita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0

Table D-2. Continued.

Phylum	Class	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Caprella sp	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
		Corophiidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Monocorophium acherusicum	0	0	0	0	1	0	0	0	1	0	0	0	0	6	1	0	1	0	0	0	0	0
		Sinocorophium cf. heteroceratum	0	0	0	1	0	0	0	0	0	0	0	0	0	43	7	0	1	0	0	0	0	0
		Amphideutopus oculatus	0	4	0	0	188	6	7	0	0	12	0	0	0	182	216	105	480	0	1	0	6	0
		Photis bifurcata	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
		Photis brevipes	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	4	0	0	0	0	0
		Photis californica	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	0	0
		Photis sp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Cerapus tubularis Cmplx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Ericthonius brasiliensis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	14	1	0	0	0	0	0
		Ericthonius sp	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Listriella goleta	0	0	0	0	2	0	0	0	4	5	0	0	0	2	1	0	0	1	0	0	0	0
		Hippomedon zetesimus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
		Orchomene anaquelus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Melphisana bola Cmplx	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Americhelidium rectipalmum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
		Deflexilodes norvegicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Eochelidium sp A	0	0	0	0	0	1	0	0	0	0	0	0	0	8	2	0	0	0	0	0	0	0
		Leptostylis calva	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Oxyurostylis pacifica	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0
		Campylaspis rubromaculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
		Neotrypaea gigas	0	0	0	0	0	0	0	0	1	0	2	1	0	6	0	0	0	1	3	0	0	0
		Neotrypaea sp	0	3	1	0	3	1	0	3	0	18	0	2	0	0	1	0	0	0	0	0	0	0
		Majidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		Pyromaia tuberculata	1	0	0	0	3	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	1	0
		Pinnixa franciscana	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Pinnixa tubicola	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Pinnotheridae	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0
		Scleroplax granulata	0	0	1	0	0	0	0	5	0	0	0	0	0	3	2	0	0	0	0	0	6	0
		Idarcturus allelomorphus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
		Caecognathia crenulatifrons	0	1	0	0	9	0	0	0	0	0	0	0	0	2	3	0	8	0	0	0	1	0
		Caecognathia sp	0	0	0	0	1	0	0	0	0	2	0	0	0	2	5	3	6	0	0	0	0	0
		Heteroserolis carinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Alienacanthomysis macropsis	0	0	0	0	0	0	1	0	0	0	0	1	1	0	2	2	1	2	2	1	0	0
		Metamysidopsis elongata	0	0	0	0	1	0	0	0	0	0	0	0	0	1	6	0	2	0	0	0	0	0
	Ostracoda	Asteropella slatteryi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Leuroleberis sharpei	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Euphilomedes carcharodonta	2	4	0	3	65	3	1	0	0	2	0	0	0	51	21	2	22	1	1	2	3	1
Mollusca	**Bivalvia**	Cryptomya californica	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
		Nuculana taphria	5	10	3	1	4	0	1	0	1	0	0	0	0	5	5	1	0	0	0	0	1	3
		Nucula carlottensis	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Mollusks	**510**	Leptopecten latiauratus	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
% of Population	**5%**	Lyonsia californica	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	0	1	0	0	0	0	0
		Periploma discus	2	2	0	1	0	0	0	0	0	4	0	0	0	1	2	1	0	0	0	0	1	2
		Asthenothaerus diegensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Cyathodonta pedroana	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Thracia trapezoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Laevicardium substriatum	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	4	0	0	0	0	0	0
		Rhamphidonta retifera	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
		Rochefortia coani	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	0	0	0	0
		Rochefortia grippi	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Rochefortia tumida	0	0	0	1	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0
		Parvilucina tenuisculpta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Mactridae	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Mactrotoma californica	0	0	0	0	0	0	0	0	0	0	0	0	0	24	13	0	0	0	0	0	0	0
		Cooperella subdiaphana	0	0	0	0	0	0	0	0	0	0	0	0	0	17	10	0	2	0	0	0	0	0
		Ensis myrae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Siliqua lucida	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Cumingia californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Table D-2. Continued.

			StationID																					
Phylum	**Class**	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
		Theora lubrica	2	0	0	0	5	0	0	0	0	3	0	0	0	7	4	0	3	0	0	0	0	0
		Tagelus subteres	0	0	0	0	1	0	0	0	0	0	0	0	0	4	4	63	5	0	0	0	0	0
		Solen sicarius	0	0	0	0	1	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0
		Leporimetis obesa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
		Macoma nasuta	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	2	0
		Macoma sp	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
		Macoma yoldiformis	1	0	2	0	9	0	0	1	0	5	0	0	0	5	5	2	7	0	0	0	2	0
		Tellina modesta	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
		Axinopsida serricata	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		Thyasira flexuosa	0	4	1	0	0	0	0	0	1	2	0	0	0	1	1	0	2	0	0	0	0	1
		Diplodonta sericata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0
		Compsomyax subdiaphana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0
		Protothaca staminea	0	0	0	0	1	0	0	0	0	1	0	0	0	1	2	0	1	0	0	0	1	0
		Bivalvia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0
	Gastropoda	Rictaxis punctocaelatus	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		Cylichna diegensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
		Philine auriformis	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
		Philine sp A	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Acteocina culcitella	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
		Acteocina inculta	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Odostomia sp	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1
		Turbonilla sp	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9	0
		Turbonilla sp A	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Kurtziella plumbea	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Olivella baetica	1	0	1	1	0	0	0	0	0	0	0	0	0	4	1	1	0	0	2	0	0	0
		Crepidula norrisiarum	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vitrinella oldroydi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Scaphopoda	Cadulus aberrans	13	18	14	7	0	8	10	1	2	0	0	0	0	2	0	0	2	0	0	0	2	0
Echinodermata	**Holothuroidea**	Leptosynapta sp	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	0	0	0	0	0
	Ophiuroidea	Amphiodia digitata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Amphiodia sp	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Total Echinoderms	**27**	Amphiodia urtica	0	0	2	0	3	0	0	0	0	1	0	0	0	0	1	3	0	0	0	0	1	0
% of Population	**0.24%**	Amphipholis squamata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Amphiuridae	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Misc Phyla																								
Total Misc	**332**																							
% of Population	**2.99%**																							
	Chordata	Porichthys notatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Cnidaria	Edwardsia californica	1	1	0	1	1	3	0	1	1	1	0	0	0	0	0	0	1	0	0	0	5	0
		Scolanthus sp A	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Anthozoa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Nemertea	Cerebratulus californiensis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		Lineidae	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	1	0	1	1
		Carinoma mutabilis	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	1	3	0	0	0	0	0
		Tubulanus cingulatus	2	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
		Tubulanus nothus	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
		Tubulanus polymorphus	9	7	10	5	13	11	1	0	1	4	0	0	0	3	6	3	7	0	0	0	4	2
		Palaeonemertea	1	0	0	2	3	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	0
		Amphiporus sp	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Paranemertes californica	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Phorona	Phoronis sp	11	8	8	6	1	12	17	4	22	7	0	0	0	0	1	17	1	1	4	1	40	18
	Platyhelminthes	Imogine exiguus	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Sipuncula	Apionsoma misakianum	0	0	1	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0

Table D-3. 2002 taxa list for the NEIBP CAD site monitoring program. All Organisms collected on 0.5 mm screen.

			StationID				
Phylum	**Family**	**Species**	**1**	**17**	**19**	**7**	**8**
Annelida			0	0	0	2	0
	Capitellidae	Capitella capitata Cmplx	0	0	0	0	1
		Mediomastus sp	92	168	23	58	26
	Maldanidae	Petaloclymene pacifica	0	1	0	0	0
	Cossuridae	Cossura candida	6	20	339	22	11
		Cossura sp A	1	1	2	2	0
	Dorvilleidae	Dorvillea (Schistomeringos) longicornis	2	0	0	6	2
	Lumbrineridae	Scoletoma sp A	1	0	0	0	0
	Flabelligeridae	Pherusa neopapillata	0	0	0	1	0
	Opheliidae	Armandia brevis	1	1	0	3	0
	Orbiniidae	Leitoscoloplos pugettensis	5	6	2	17	4
	Paraonidae	Aricidea (Acmira) sp	0	3	0	0	0
		Levinsenia gracilis	0	17	0	0	0
	Hesionidae	Podarkeopsis glabrus	1	2	1	5	3
	Nephtyidae	Nephtys caecoides	1	0	0	0	0
		Nephtys cornuta	6	6	11	7	3
	Nereididae	Nereis procera	1	0	0	3	1
	Phyllodocidae	Phyllodoce longipes	0	0	1	0	0
	Pilargidae	Pilargidae	0	1	0	0	0
		Sigambra tentaculata	0	2	27	1	0
	Polynoidae	Tenonia priops	1	0	1	1	1
	Syllidae	Exogone lourei	0	2	0	0	0
	Sabellidae	Euchone limnicola	0	4	0	0	0
	Chaetopteridae	Spiochaetopterus costarum	0	1	1	3	0
	Cirratulidae	Aphelochaeta monilaris	2	0	6	22	1
		Chaetozone corona	9	0	0	6	0
		Cirratulidae	3	1	0	0	0
		Monticellina cryptica	2	0	1	1	0
	Spionidae	Apoprionospio pygmaea	0	51	0	0	0
		Dipolydora socialis	2	0	0	0	0
		Paraprionospio pinnata	3	1	3	7	5
		Polydora sp	0	0	0	1	0
		Prionospio (Minuspio) lighti	1	11	4	29	32
		Prionospio (Prionospio) heterobranchia	0	1	0	0	0
		Spiophanes duplex	3	4	0	22	1
Arthropoda	Ampeliscidae	Ampelisca cristata microdentata	0	6	0	0	0
	Aoridae	Paramicrodeutopus schmitti	3	10	0	0	1
		Rudilemboides stenopropodus	0	11	0	0	0
	Argissidae	Argissa hamatipes	0	0	1	0	0
	Corophiidae	Monocorophium acherusicum	4	1	0	3	4
		Sinocorophium cf. heteroceratum	0	0	5	0	0
	Isaeidae	Amphideutopus oculatus	4	198	4	3	3
		Photis bifurcata	0	111	3	0	0
		Photis sp	2	12	0	0	0
	Liljeborgiidae	Listriella goleta	0	1	0	0	0
	Lysianassidae	Hippomedon zetesimus	0	1	0	0	0
	Melphidippidae	Melphisana bola Cmplx	1	0	0	0	0
	Oedicerotidae	Americhelidium shoemakeri	0	4	0	0	0
		Eochelidium sp A	1	10	1	1	0
	Diastylidae	Oxyurostylis pacifica	3	0	2	0	0
	Nannastacidae	Cumella californica	1	0	1	0	0
	Callianassidae	Neotrypaea sp	0	0	3	6	6
	Gnathiidae	Caecognathia sp	0	2	1	0	0
	Mysidae	Mysidopsis intii	1	0	0	0	0
	(blank)	Mysidacea	0	0	1	0	0
	Leptocheliidae	Leptochelia dubia	0	114	1	0	0
	Philomedidae	Euphilomedes carcharodonta	1	31	0	0	2
	Rutidermatidae	Rutiderma lomae	0	57	3	0	1
	Sarsiellidae	Eusarsiella thominx	0	1	0	0	0
Cnidaria	Edwardsiidae	Edwardsiidae	0	0	0	1	0
			0	0	2	0	0
			0	0	0	1	0
Mollusca	Lyonsiidae	Lyonsia californica	0	1	0	0	0
	Semelidae	Cumingia californica	0	1	0	0	0
	Tellinidae	Tellina modesta	1	1	0	0	0
	Olividae	Olivella baetica	0	1	0	0	0
	Lineidae	Lineidae	1	0	0	2	1
Nemertea	Tubulanidae	Tubulanus polymorphus	1	1	1	1	0
		Palaeonemertea	0	0	0	0	2
		Hoplonemertea	1	0	0	0	0
Phorona	Phoronidae	Phoronis sp	11	0	1	3	6
Platyhelminthes	Callioplanidae	Discosolenia burchami	0	1	0	0	0

Table D-4. 2003 taxa list for the NEIBP CAD site monitoring program. All Organisms collected on 0.5 mm screen.

			StationID					
Phylum	**Family**	**Species**	**1**	**17**	**19**	**21**	**7**	**9**
Annelida	Capitellidae	Mediomastus sp	8	65	9	69	8	12
	Maldanidae	Petaloclymene pacifica	0	0	0	1	0	0
		Praxillella pacifica	1	0	0	0	0	1
	Cossuridae	Cossura candida	2	5	109	3	0	0
		Cossura sp	3	2	0	0	0	0
		Cossura sp A	4	6	152	6	3	2
	Lumbrineridae	Scoletoma sp A	0	0	1	0	0	0
		Scoletoma sp B	0	0	3	0	0	0
	Orbiniidae	Leitoscoloplos pugettensis	7	9	1	3	1	3
		Scoloplos sp	0	0	0	0	1	0
	Paraonidae	Aricidea (Acmira) catherinae	0	3	0	0	0	0
		Aricidea (Acmira) horikoshii	0	0	0	0	0	1
		Aricidea (Aricidea) wassi	0	1	0	0	0	0
		Cirrophorus furcatus	0	0	1	0	0	0
		Levinsenia gracilis	0	7	0	0	0	0
	Glyceridae	Glycera americana	0	1	0	0	1	0
		Glycera sp	0	1	0	0	0	0
	Hesionidae	Podarkeopsis glabrus	1	1	0	0	0	0
	Nephtyidae	Nephtys cornuta	21	6	31	2	5	0
	Phyllodocidae	Phyllodoce hartmanae	0	0	0	1	0	0
	Pilargidae	Sigambra tentaculata	0	0	4	0	0	0
	Polynoidae	Malmgreniella sp	0	0	0	0	1	0
		Tenonia priops	0	0	1	0	1	0
	Syllidae	Exogone lourei	0	1	0	0	0	0
	Sabellidae	Chone mollis	1	1	0	0	0	0
		Euchone limnicola	0	2	0	0	0	0
	Chaetopteridae	Spiochaetopterus costarum	0	0	1	0	0	1
	Cirratulidae	Aphelochaeta glandaria	9	0	1	1	0	0
		Aphelochaeta monilaris	2	0	15	10	1	14
		Aphelochaeta sp	0	0	0	1	0	4
		Cirratulidae	48	2	0	9	0	0
		Monticellina cryptica	1	0	7	5	0	0
		Monticellina siblina	40	0	0	11	9	0
	Spionidae	Apoprionospio pygmaea	0	4	0	3	0	0
		Paraprionospio pinnata	0	0	1	0	2	2
		Prionospio (Minuspio) lighti	1	0	4	26	0	0
		Prionospio (Prionospio) heterobranchia	0	1	0	0	0	0
		Prionospio (Prionospio) jubata	0	3	0	0	0	1
		Spionidae	0	0	3	0	0	0
		Spiophanes duplex	0	1	0	4	0	0
		Spiophanes sp	1	0	0	0	0	0
	Ampharetidae	Ampharetidae	0	0	0	1	0	0
	Terebellidae	Amaeana occidentalis	0	1	0	0	0	0
		Streblosoma sp B	0	0	0	0	2	0
Arthropoda		Copepoda	0	0	12	2	0	5
	Ampeliscidae	Ampelisca cristata cristata	0	1	0	0	0	0
	Aoridae	Paramicrodeutopus schmitti	0	2	0	0	1	0
	Corophiidae	Monocorophium acherusicum	0	1	0	0	0	0
	Isaeidae	Amphideutopus oculatus	1	294	1	1	1	0
		Photis bifurcata	0	4	0	0	0	0
		Photis brevipes	0	1	0	0	0	0
		Photis californica	0	2	0	0	0	0
		Photis sp	0	12	0	0	0	0
	Ischyroceridae	Ericthonius brasiliensis	0	1	0	0	0	0
	Oedicerotidae	Deflexilodes norvegicus	0	1	0	0	0	0
		Eochelidium sp A	0	0	0	0	1	0
	Diastylidae	Leptostylis calva	1	0	1	1	1	0
		Oxyurostylis pacifica	0	1	0	0	0	0
	Callianassidae	Neotrypaea sp	0	0	1	0	0	0
	Gnathiidae	Caecognathia sp	0	3	0	1	1	0
	Leptocheliidae	Leptochelia dubia	0	3	0	0	0	0
	Typhlotanaidae	Typhlotanais crassus	0	1	0	0	0	0
	Cylindroleberididae	Asteropella slatteryi	0	1	0	0	0	0
		Xenoleberis californica	0	1	0	0	0	0
	Philomedidae	Euphilomedes carcharodonta	0	64	0	0	0	0
	Rutidermatidae	Rutiderma lomae	0	6	0	0	0	1
	Sarsiellidae	Eusarsiella thominx	0	1	0	0	0	0
Mollusca	Lasaeidae	Rochefortia tumida	0	2	0	0	0	0
	Petricolidae	Cooperella subdiaphana	0	1	0	0	0	0
	Semelidae	Theora lubrica	0	1	0	0	0	0
	Solecurtidae	Tagelus subteres	0	5	0	0	0	0
	(blank)	Bivalvia	0	2	0	0	0	0
	Olividae	Olivella baetica	0	0	1	0	0	0
	Vitrinellidae	Vitrinella oldroydi	0	0	0	0	0	1
Nemertea	Tubulanidae	Tubulanus polymorphus	0	1	0	0	0	0
		Palaeonemertea	1	0	0	0	1	0
Phorona	Phoronidae	Phoronis sp	1	1	0	1	0	0