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DRAFT ENVIRONMENTAL IMPACT REPORT
ALAMITOS BAY MARINA REHABILITATION PROJECT
CITY OF LONG BEACH

APPENDIX F

**TIER III SEDIMENT CHARACTERIZATION,
SUPPLEMENTAL SAMPLING AND ANALYSIS REPORT,
AND BEST MANAGEMENT PRACTICES**

**Results of a Tier III
Sediment Characterization
Performed with Samples from
Alamitos Bay Marina
Long Beach, California**

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°C	degrees Celsius
µg/kg	microgram per kilogram
µm	micrometer
ASTM	American Society for Testing and Materials
BP	bioaccumulation potential
cm	centimeter
COC	chain of custody
DGPS	Differential Global Positioning System
EC ₅₀	effective concentration for 50 percent of population
ERED	environmental residue-effects database
ER-L	effects range-low
ER-M	effects range-median
GC-FPD	gas chromatography – flame photometric detector
GC-MS	gas chromatography – mass spectrometry
IC ₅₀	inhibition (sublethal) concentration for 50 percent of population
ITM	Inland Testing Manual
L	liter
LC ₅₀	lethal concentration for 50 percent of population
LOEC	lowest-observed-effect concentration
LPC	Limiting permissible concentration
m	meter
MDL	method detection limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL	milliliter
MLLW	mean lower low water
mm	millimeter
MRL	method reporting limit
NOEC	no-observed-effect concentration
OTM	Ocean Testing Manual
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pH	hydrogen ion concentration
ppt	part per thousand
QA	quality assurance
QC	quality control
RPD	relative percent difference
SAP	sampling and analysis plan
sec	second
SIM	selective ion method
SOP	standard operating procedure
SP	solid phase
SPP	suspended particulate phase
STFATE	short term fate
TOC	total organic carbon
TRPH	total recoverable petroleum hydrocarbon
U.S.	United States
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UV	ultraviolet
Vol	volume
yd ³	cubic yard

CASE NARRATIVE

Full Tier III sampling and analysis procedures were conducted in accordance with the *Sampling and Analysis Plan (SAP), Alamitos Bay Marina Dredged Material Evaluation* (Weston Solutions 2007). Samples were collected from the Alamitos Bay Marina and LA-2 Reference site on 2 - 5 April 2007. Testing was conducted with the reference sample and composites of the project samples following guidance in *Evaluation of Dredged Material Proposed for Ocean Disposal* (USEPA/USACE 1991) otherwise known as the Ocean Testing Manual (OTM); *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual* (USEPA/USACE 1998), otherwise known as the Inland Testing Manual (ITM); and the *Regional Implementation Agreement (RIA) for the Evaluation of Dredged Material for Ocean Disposal* (USACE/USEPA 1993). After collection, samples were stored in a secured area at 4 ± 2°C. Samples were processed, and then shipped to the analytical laboratories in coolers on blue ice. All chemical analyses and bioassays were performed within required holding times from sample collection. Initial BP testing was also initiated within required holding times. However, following a laboratory error involving the inadvertent compositing of replicate tissue samples, BP testing exposures were re-initiated 11 July 2007. Composite tissue analysis results are reported in this report, and the retest results will be reported in an addendum to this document.

The analytical chemistry results showed that metals associated with urban run-off (i.e. copper, lead, mercury and zinc) were detected at nominally elevated concentrations across all docking basins. The only metal detected at a level significantly different from other sample areas was mercury measured in the Basin 1 sample at 0.8 mg/kg. Organic constituents, with the exception of DDT and a few PAH compounds, were below acceptable levels of detection. ΣDDT was detected at concentrations consistent throughout all docking basins, but at relatively low levels (up to 13.8 µg/kg). The total PAH concentrations were substantially lower than levels of ecological concern. The only significant toxicity observed among the five bioassays performed with the Alamitos Bay sediments was with the solid phase organism, *Rhepoxinius abronius*. The reduction in survival observed with this organism was relatively consistent throughout all basins, with a mean survival rate of 33.6% (52.4% lower than the LA-2 treatment survival). Because there were no other significant effects and no correlation with sediment contaminants, the causal agent of the observed toxicity can not be identified with the available data. If follow-up testing is performed to address the issues of elevated mercury concentrations in the Basin 1 sample and the reduction in *Rhepoxinius* survival across all docking basins, the results will be provided a supplement to this report. Table 1 summarizes sample identifications and participating laboratories involved with sample collection and analysis.

TABLE 1
Sample Collection and Analysis Summary

SAMPLE IDENTIFICATION			SAMPLING AND ANALYSIS DELEGATION			
Individual Core I.D.s	Sample Composite I.D.	WESTON Laboratory I.D.	Sample Collection & Project Management	Sediment and Tissue Chemical Analysis	BP Testing Exposures	TOC, Grain Size & Bioassays
LA-2 Reference	LA-2	C070411.01	Weston Solutions Oakland, CA	EnviroMatrix Analytical San Diego, CA	Weston Solutions Port Gamble, WA	Weston Solutions Carlsbad, CA
B1-1,2,3,4,5	B1	C070411.02				
B2-1,2,3,4,5,6	B2	C070411.03				
B1-1,2,3,4	B3	C070411.04				
B1-1,2,3,4,5	B4	C070411.05				
B1-1,2,3,4	B5	C070411.06				
B1-1,2,3,4,5	B6	C070411.07				
B1-1,2,3	B7	C070411.08				

1 INTRODUCTION

As part of a 6 to 10 year phased construction program aimed at rehabilitating berthing slips and access features throughout the Alamitos Bay Marina (AB Marina), the City of Long Beach is proposing to dredge shoaled material from within all seven of the Marina's docking basins. The proposed disposal site for all phases of this project is the U.S. Environmental Protection Agency (USEPA) designated offshore disposal site, LA-2. The AB Marina is located in the southeastern corner of Los Angeles County at the intersection of Pacific Coast Highway and Second Street, just north of the San Gabriel River. A vicinity map depicting the relative locations of the proposed project location and sediment disposal site is provided as Figure 1.

The proposed dredging episode involves the removal of accumulated sediment in order to return each of the Marina's seven basins to the previously permitted depth that will allow unencumbered maneuvering of recreational vessels. The AB Marina construction program involves dredging Basins 2 through 7 to a target depth of 10 feet below Mean Lower Low Water (-10 ft MLLW). Basin 1 will be bisected and deepened to two different target depths: -12 and -15 ft MLLW. The estimated total volume of dredged material to be removed from the seven basins is 117,000 cubic yards (CY). Including an additional two feet of overdredge, the total volume represented by the proposed sampling depth is 287,000 CY. Dredge volumes for individual AB Marina docking basins are provided in Table 2. A project area map showing all seven basins is provided as Figure 2.

TABLE 2
Summary Individual Basin Dredge Volumes

Sample Area	Estimated Volume to Target Depth (CY)	1-ft Overdredge Volume (CY)	2-ft Overdredge Volume (CY)	Totals
Basin 1	28,400	12,400	12,900	53,700
Basin 2	37,700	21,200	31,000	89,900
Basin 3	19,200	13,200	23,500	55,900
Basin 4	19,600	14,700	31,000	65,300
Basin 5	1,320	1,100	1,450	3,870
Basin 6N	7,800	1,950	2,500	12,250
Basin 6S	2,000	900	1,200	4,100
Basin 7	1,000	500	600	2,100
Total	117,020	65,950	104,150	287,120

In accordance with the SAP, all material proposed for dredging including two feet of overdredge was evaluated for ocean disposal suitability following federal and regional guidelines outlined in the Ocean Testing Manual (USEPA/ACE 1991) and the Draft Regional Implementation Agreement (RIA) for the Evaluation of Dredged Material for Ocean Dumping (USACE/EPA 1993). Results of the sampling and analysis procedures performed under this study are assessed to determine whether sediment from the AB Marina will be suitable for aquatic disposal at LA-2, and to provide baseline sediment quality data for making decisions on additional testing requirements during the later years of the marina rehabilitation process.



Figure 1. Vicinity Map of Proposed Dredging and Disposal Area

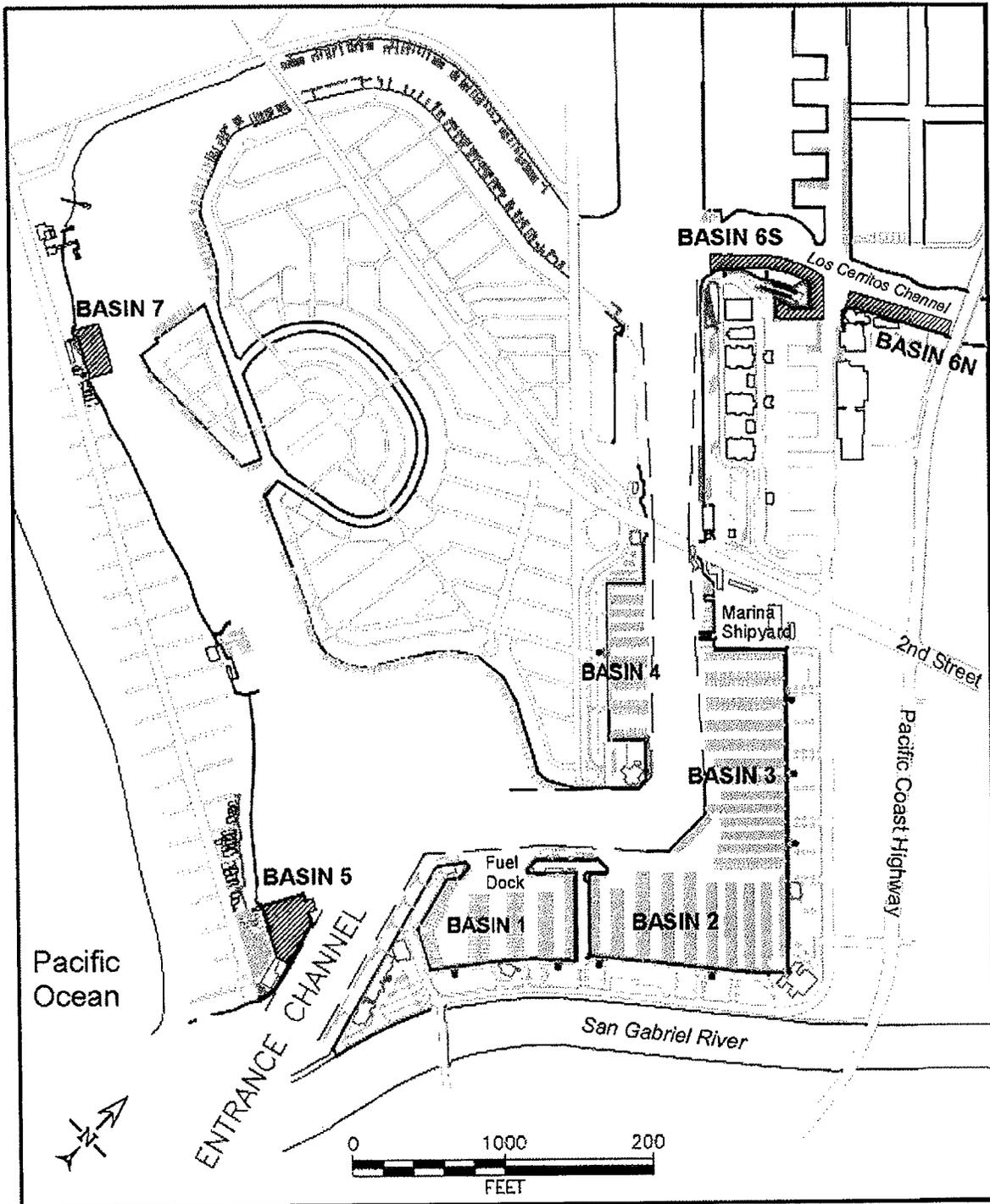


Figure 2. Project Area: Alamitos Bay Marina Docking Basins

The Tier III study was comprised of the analyses outlined in Table 3 and included the following:

Chemical analyses. The test and reference materials were analyzed for polycyclic aromatic hydrocarbons (PAHs), organotins, organochlorine pesticides, polychlorinated biphenyls (PCBs), and metals.

Conventional analyses. Materials were also analyzed for total organic carbon (TOC) and total and dissolved sulfides.

Physical analyses. Testing included analyses of percent solids, and grain size.

Biological analyses. Biological evaluation included three suspended particulate phase (SPP) bioassays (bivalve larvae, fish, and mysid shrimp), two solid phase (SP) bioassays (amphipod and polychaete worm), and two bioaccumulation potential (BP) bioassays (bivalve and polychaete worm) with tissue analyses. Tissues from bioaccumulation tests were analyzed for organochlorine pesticides and metals.

TABLE 3
Physical, Chemical, and Biological Analyses.

PHYSICAL	CHEMICAL		BIOLOGICAL	
	Chemical Analyses	General Chemistry	Bioassays	Tissue Chemistry for BP Tests
<ul style="list-style-type: none"> • Grain size • % Solids 	<ul style="list-style-type: none"> • Metals • OC Pesticides • PCBs • PAHs • Organotins 	<ul style="list-style-type: none"> • Total and dissolved sulfides • Pore water Ammonia • TOC 	SPP bioassays: <ul style="list-style-type: none"> • Bivalve larvae • Fish • Mysid SP bioassays: <ul style="list-style-type: none"> • Amphipod • Polychaete BP Tests: <ul style="list-style-type: none"> • Bivalve • Polychaete 	<ul style="list-style-type: none"> • Metals • OP Pesticides

1.1 BACKGROUND AND HISTORY

The AB Marina, which includes seven basins and a total of 1,991 slips, has been in operation since the early 1960's. The AB Marina is home to four yacht clubs: the Alamos Bay Yacht Club, the Navy Yacht Club, the Long Beach Yacht Club, and the Seal Beach Yacht Club. In the 1930's a major beach nourishment project was completed with the dredging of Alamos Bay, and further expansion of the AB Marina and the AB Marina Jetty in the 1950's added to the stability of the surrounding beaches, although erosion and the resulting siltation continue to be problematic.

1.2 PREVIOUS INVESTIGATIONS

Sediments collected from docking basins within the AB Marina have been assessed for chemical contaminants twice since 1999 (Tetra Tech 1999 and 2003). Results of these studies are discussed below and contrasted with results of the most recent sediment assessments performed in Newport Harbor. Results of the three Newport Harbor sediment investigations performed since 2001 (MEC 2001 and 2003, and Weston 2005) are discussed because of proximity and similarities between the two Bay/Harbor complexes. See Figure 1 (page 2) for the relative locations of these two project sites. Table 1 shows

TABLE 4
Historic and Reference Sediment Data: Alamitos Bay Marina

Analyte	Alamitos Bay Marina		Newport Harbor (MEC 2001, 2003, & Weston 2005)	LA 2 Reference (Weston 2007)	Reference Values	
	Tetra Tech 2003	Tetra Tech 1999			ER-L	ER-M
Conventional Analytes						
Grain Size (%)						
Gravel	0.1 - 25.6	NT	0.0 - 3.5	0	NA	NA
Sand	5.5 - 62.9	NT	3.6 - 85.4	59.4	NA	NA
Clay	10.6 - 44.3	NT	4.9 - 53.1	32.2	NA	NA
Silt	11.4 - 53.1	NT	6.8 - 48.1	8.3	NA	NA
TOC %	0.7 - 1.7	0.1-0.4	0.2 - 1.7	0.59	NA	NA
Total Solids (%)	47.2 - 73.3	75.0-83.0	46.9 - 82.2	74.4	NA	NA
Sulfides (mg/kg)	<0.2	NA	<0.2 - 1100	1.35	NA	NA
Metals (mg/kg) Dry Weight						
Arsenic	2.9 - 8.3	1.7 - 4.5	2.9 - 10.9	2.5	8.2	70.0
Cadmium	0.5 - 1.9	0.16 - 0.29	<0.1 - 2.0	0.2	1.2	9.6
Chromium	13.1 - 43.0	16 - 31	8.0 - 43.0	24.4	81.0	370
Copper	8.1 - 31.8	9.3 - 41	8.1 - 91.0	10.5	34.0	270
Lead	4.8 - 27.3	13 - 37	4.8 - 31.0	4.4	46.7	218
Mercury	<0.03 - 0.12	0.02 - 0.07	<0.03 - 0.8	0.02	0.2	0.71
Nickel	7.5 - 25.0	9.0-21	5.0 - 25.0	12.1	20.9	51.6
Selenium	0.4 - 1.7	ND - 0.14	0.4 - 1.7	0.5	NG	NG
Silver	<0.2	ND - 0.26	<0.2 - 0.5	0.7	1.0	3.7
Zinc	31.6 - 136	45 - 120	30.0 - 207	43.3	150	410
Organochlorine Pesticides (µg/kg)						
Total DDT	<3 - 10.8	NT	<3.0 - 69.0	6.9	1.6	46.1
Total Chlordane	<7 - <11	NT	0.0 - 6.0	<1	NA	NA
Toxaphene	NA	NT	<200	<10	NA	NA
Other Pesticides	NA	NT	<3.0	ND	NA	NA
Other Organic Constituents (µg/kg)						
Total PAH ^a	<14 - 33	NT	0.0 - 1179	30.7	4022	44792
Total PCB Aroclors	ND	NT	<33.0	0	22.7	NA
Total Organotins	NT	NT	<3.3 - 27.4	NA	NA	NA
Solid Phase Bioassays (% Survival)						
<i>A. abdita</i>	NT	NT	86 - 84	NT	NA	NA
<i>E. estuaris</i>	NT	NT	NT	84	NA	NA
<i>M. nasuta</i>	NT	NT	NT	82	NA	NA
<i>R. abronius</i>	NT	NT	NT	93	NA	NA
<i>N. virens</i>	NT	NT	NT	98	NA	NA
<i>M. bahia</i>	NT	NT	90 - 94	NT	NA	NA
Suspended Particulate Phase Bioassays (LC50)						
<i>M. edulis</i>	NT	NT	67 - >100	22.5 - >100	NA	NA
<i>M. beryllina</i>	NT	NT	>100	29.6 - >100	NA	NA

^aTotal = Detected +Undetected at the achieved MDL.
 < indicates concentrations are less than the corresponding method detection limit (MDL).
 NA = Not Available
 NT = Not Tested
 ND = Not Detected

the ranges of contaminant concentrations reported for the recent AB Marina and Newport Harbor sediment investigations. Bioassay data is also provided if available. Contaminant concentrations reported for recently collected sediments from the LA-2 reference disposal site (33°37'6"N by 118°17'24"W) as well as established sediment quality reference values (ER-L and ER-M values) are also provided in Table 1.

1.2.1 Alamitos Bay Marina

The two AB Marina studies were performed in 1999 and 2003. The 1999 study involved analysis of heavy metals only. In general, results of the two studies did not show significant deviations in metals concentrations with respect to each other. Minor exceptions to these otherwise consistent contaminant levels were arsenic, cadmium, copper and lead. Arsenic and cadmium, reported in 1999 at concentrations up to 4.5 and 0.3 mg/kg, respectively, were detected at 8.3 and 1.9 mg/kg in 2003. Although the 2003 levels of these constituents were elevated relative to 1999 AB Marina levels, they were only nominally higher than the ER-L (effects range - low) values and recently measured LA-2 concentrations, and within the range of levels recently reported for Newport Harbor sediments. The high end of the copper and lead concentration ranges reported for AB Marina sediments in 1999 fell from 41 and 37 mg/kg, respectively, to 32 and 27 mg/kg in 2003. These concentrations are lower than all reference values cited in Table 1. Nickel, reported at levels up to 25 mg/kg, was the only other metal constituent that exceeded both the recently measured LA-2 concentration and the ER-L value. It should be noted that the range of total organic carbon (TOC) values varied significantly between the two studies, rising from 0.11 - 0.39% in 1999 to 0.70 - 1.67% in 2003.

The polyaromatic hydrocarbon (PAH) analytes measured in the 2003 AB Marina sediments were detected at concentrations substantially lower than the ER-L value. With the exception of total DDT, all other organic contaminants of ecological concern (PCB's and other pesticides) were not detected in 2003. It should be noted that organotin compounds were not measured for the 2003 AB Marina study. Concentrations of the organochlorine pesticide, DDT measured in 2003 ranged from below detection up to 10 ug/kg. Although present above the DDT ER-L, several biological impact study results reported by Weston bioassay laboratories have demonstrated that the high end of this range is not considered a bioaccumulation threat or high enough to elicit acute sediment toxicity among organisms commonly present in benthic environments off the California coast.

1.2.2 Newport Harbor

Results of the Newport Harbor sediment quality investigations provide data useful for predicting contaminant concentrations and biological impacts of AB Marina sediments based on use and geographical similarities between the two project areas. Newport Harbor is located approximately 16 miles south of AB Marina. The Newport data presented in Table 1 is a composite of the three different sediment quality assessment projects, each one representative of a different portion of the Harbor. Like the AB Marina studies, the Newport Harbor sediment assessments also showed ER-L exceedences for arsenic, cadmium, and nickel, but also exhibited significant exceedences in copper, mercury and zinc. Although copper and zinc concentrations were less than the detected concentrations in the cited LA-2 sample, the highest mercury concentration (0.8 mg/kg) exceeded the LA-2 level as well as the ER-M (0.71 mg/kg). Total DDT was detected in Newport Harbor at concentrations (ND to 69.0 ug/kg) up to seven times greater than those measured in AB Marina sediments. Other organochlorine pesticides, PAH, PCB and organotin constituents were either undetected or present at innocuous concentrations.

2 MATERIALS AND METHODS

2.1 FIELD COLLECTION PROGRAM FOR SEDIMENT CORE SAMPLES

Sampling was conducted at thirty-one designated sampling locations spread among seven basins within the AB Marina dredging footprint in Alamitos Bay, Long Beach, California. The SAP target and final Individual sample locations are depicted in Figures 3a-g. Cores from within each designated area were composited into single samples for subsequent testing and analysis.

Sampling began on April 2, 2007 and was completed on April 5, 2007. The weather was mostly cloudy with moderate wind. The sea was generally calm in the morning with mild chop in the afternoons. To collect sufficient sediment for analysis, multiple core samples were collected at all sample stations. The number of cores, their locations, their target lengths and the water and sampling depths at each station are provided in Table 5.

2.1.1 Core Collection Equipment

Cores were collected by using a P-3 electric vibracore (Figure 4) or a pushcore sampler (Figure 5). The vibracore was deployed from the *RV Early Bird II* and was equipped with a pre-cleaned 10-centimeter (4-inch) diameter aluminum barrel coupled to a stainless steel cutter head. The standard vibracore system is capable of collecting cores up to 15 ft in length and can be equipped to handle greater depths up to an additional 10 feet of material if necessary. The push-core device consisted of a 10-foot long, 2-inch diameter lexan core barrel, a brass flapper valve, and a 10-foot long PVC push handle.

2.1.2 Navigation

Geographic coordinates for each sample location within AB Marina were determined by pre-plotting the SAP specified locations onto a NOAA nautical chart. The sampling vessel attained position over each location using a Garmin® Global Positioning System (GPS) that uses U.S. Government Wide Angle Augmentation System (WAAS) differential correction data. Vessel position over sample location was typically maintained during coring operations by deployment of a stern anchor and adjusting vessel position to account for current and wind. Final geographical coordinates for each sample location were recorded with the GPS in customized log sheets upon collection of each sample, and are shown in Table 5.

2.1.3 Sediment Collection

2.1.3.1 Core Retrieval

Twenty-four sampling locations attempted by vibracore were positioned in five separate areas (Basins 1-5), with four to five core locations within each area. Five stations were sampled in Basin 6, three samples were collected by vibracore and two were collected by pushcore. In Basin 7, all three stations were collected by a pushcore sampler. LA-2 reference material was collected using a stainless steel pipe dredge.

Once the sampling vessel was positioned over the SAP prescribed sample location, water depth was measured using the vessel mounted fathometer and confirmed with a metered lead line. In certain locations the actual mudline elevations were not consistent with the initial condition survey used to plot the sample locations (See Table 3). This issue was most noticeable in Basin 2 where the actual elevations of the five stations sampled were 1.6 - 2.7 feet lower than indicated on the survey. In most cases, the mudline at the sample location or within five meters of the sample location was still higher than the proposed dredge depth, and the vessel was positioned over the highest shoaled spot near the initially plotted station. However, the observed water depth at station B2-3 as well as the entire fairway and adjacent fairways were below dredge depth. After consulting with

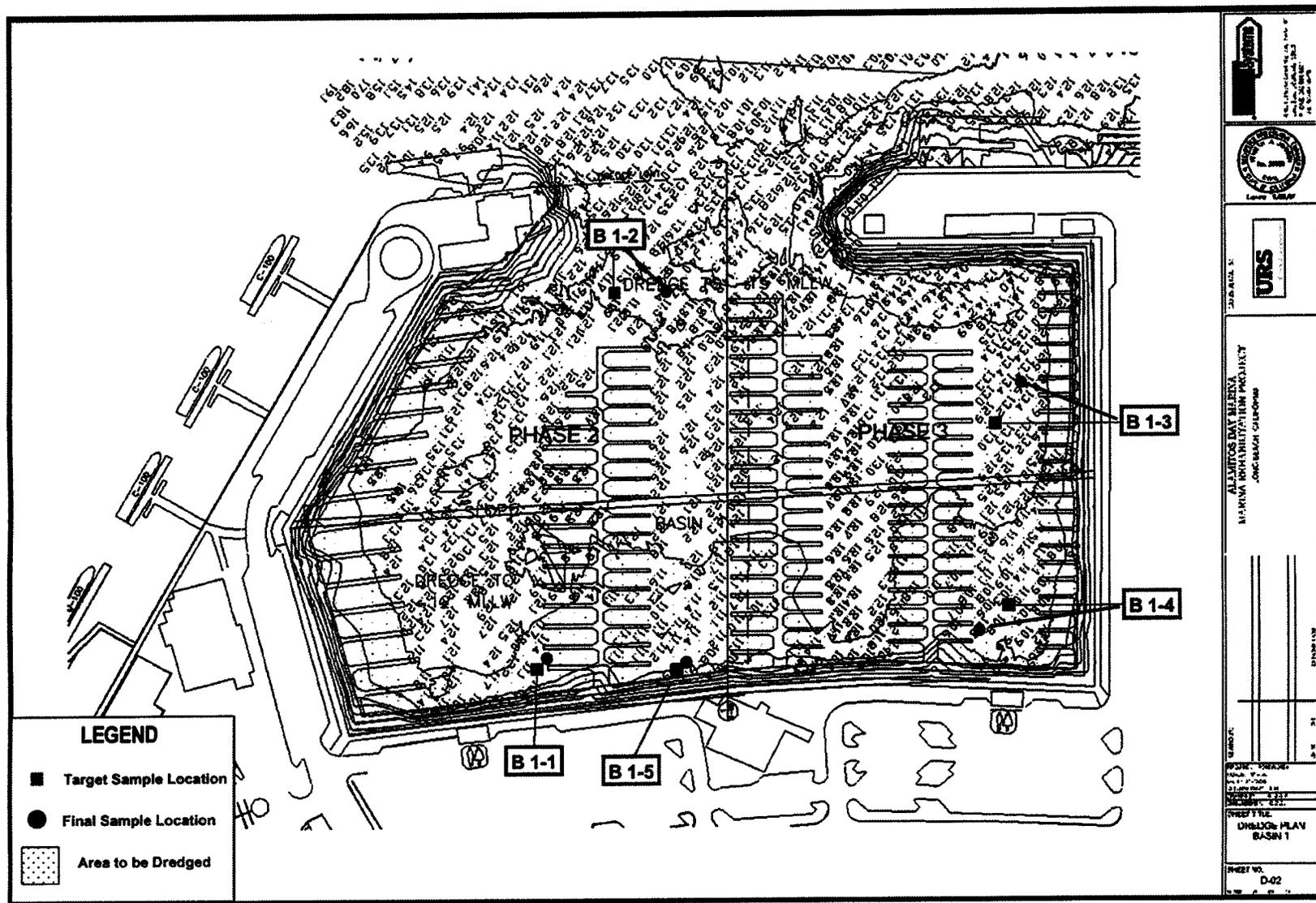


Figure 3a. Sample Locations Basin 1: Alamitos Bay Marina 2007

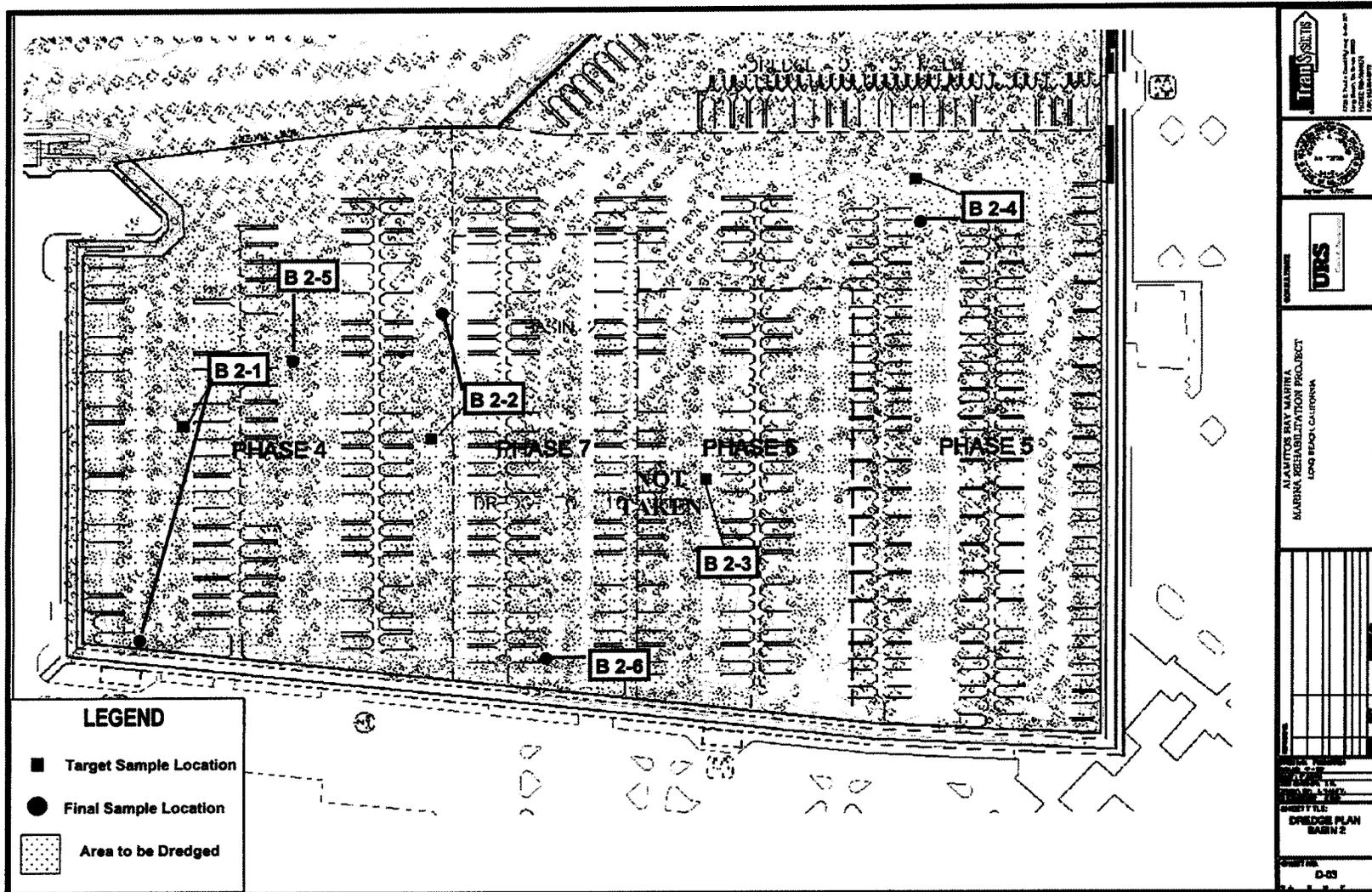


Figure 3b. Sample Locations Basin 2: Alamitos Bay Marina 2007

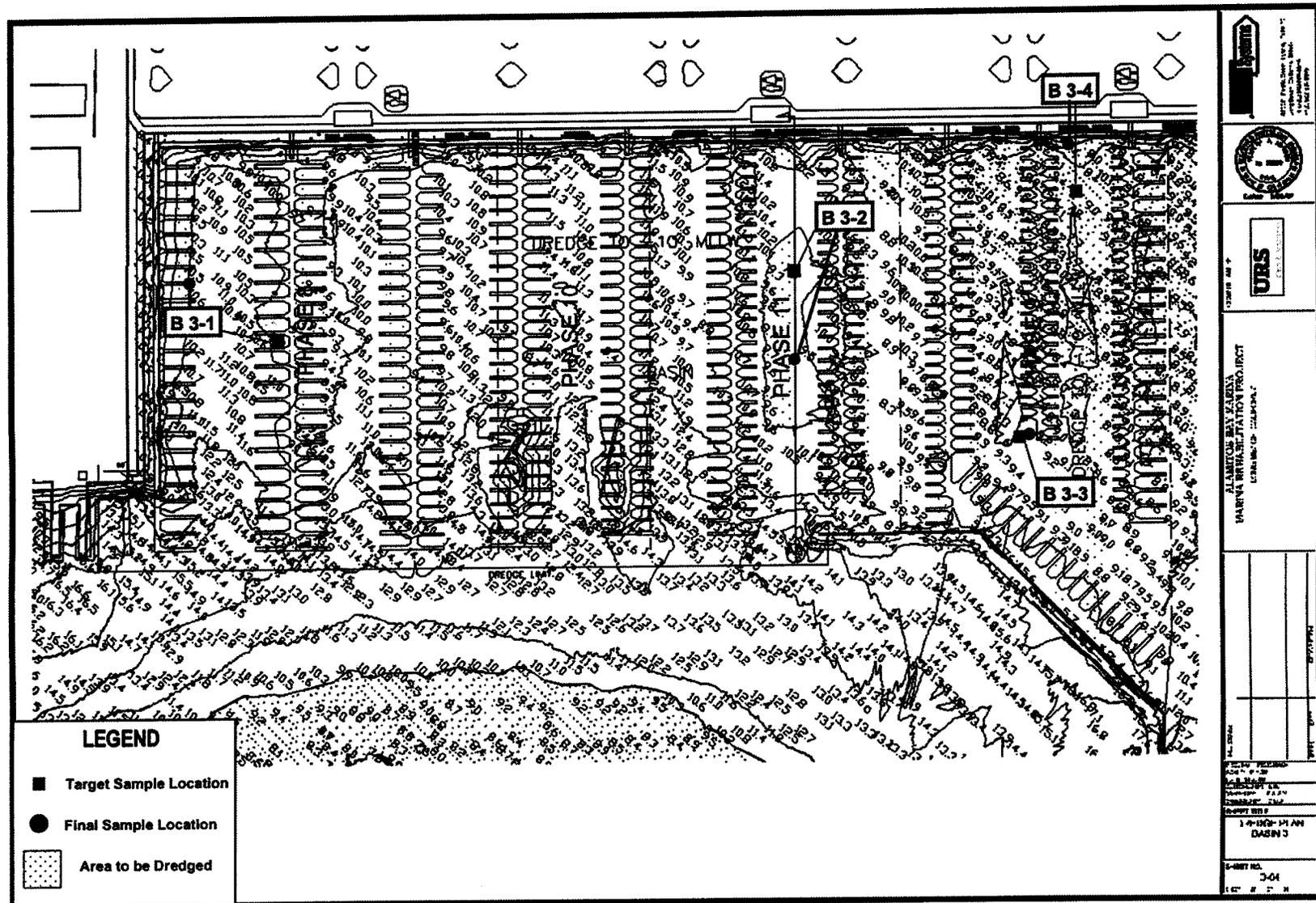


Figure 3c. Sample Locations Basin 3: Alamitos Bay Marina 2007

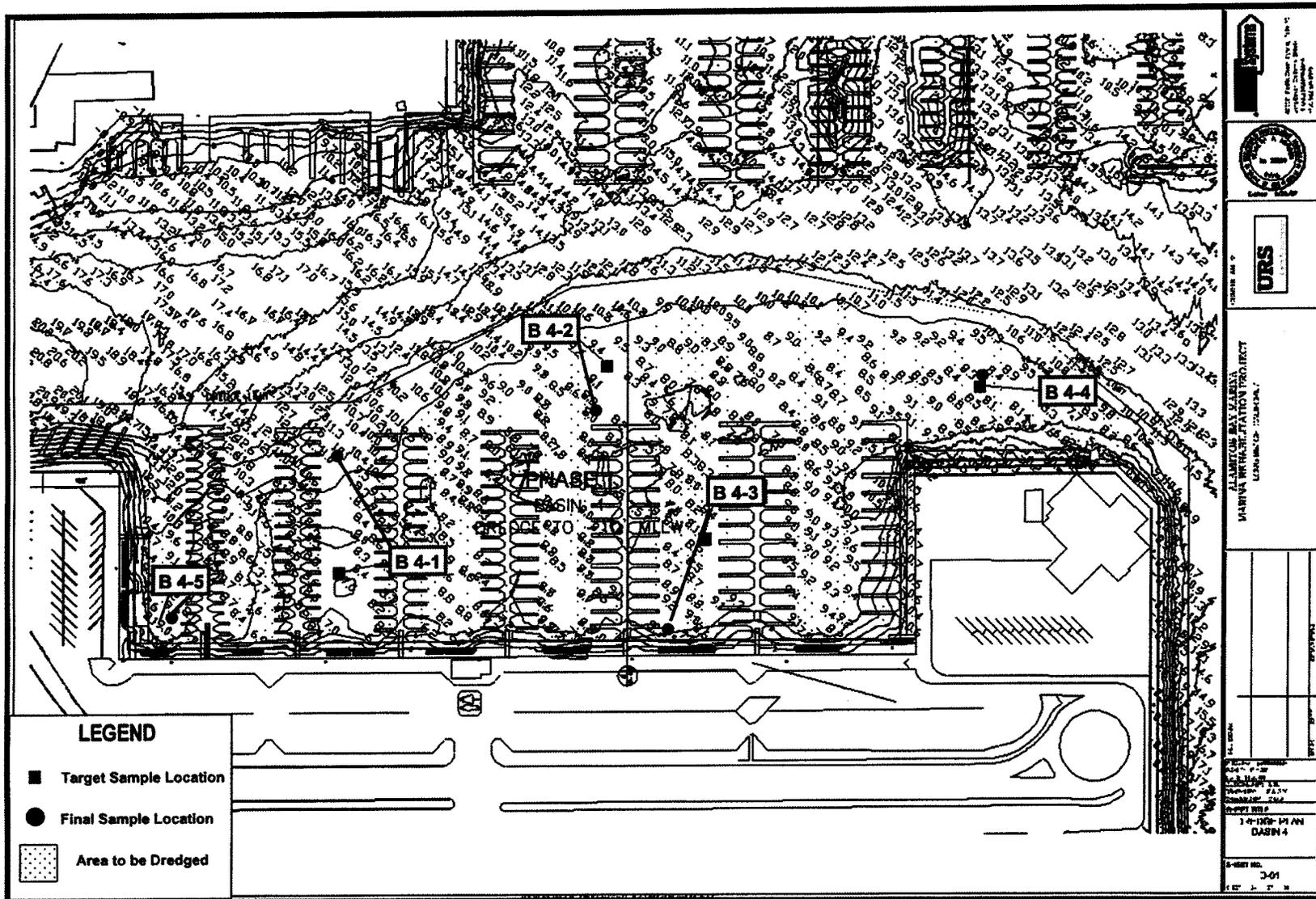


Figure 3d. Sample Locations Basin 4: Alamitos Bay Marina 2007

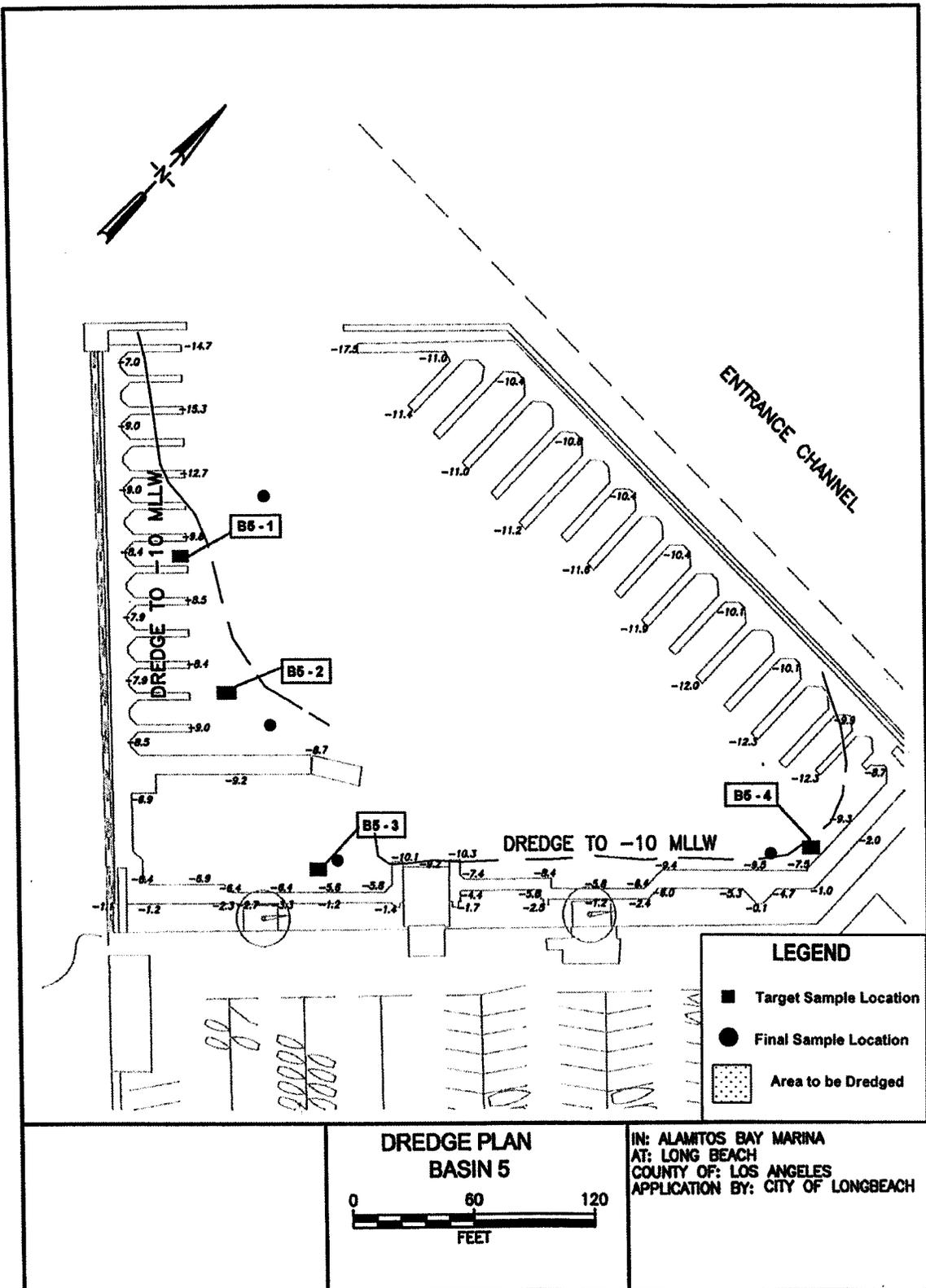


Figure 3e. Sample Locations Basin 5: Alamitos Bay Marina 2007

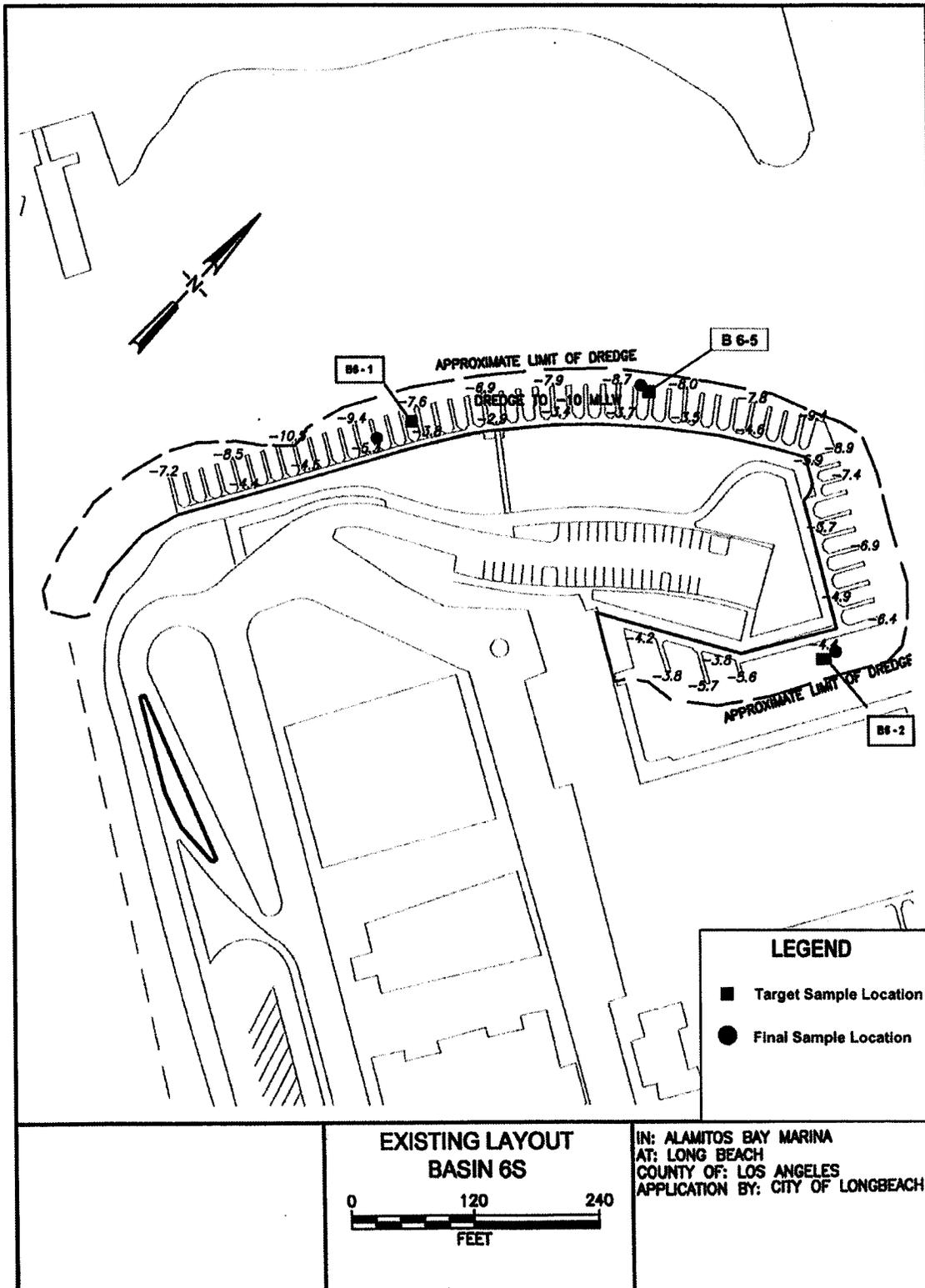


Figure 3f. Sample Locations Basin 6S: Alamitos Bay Marina 2007

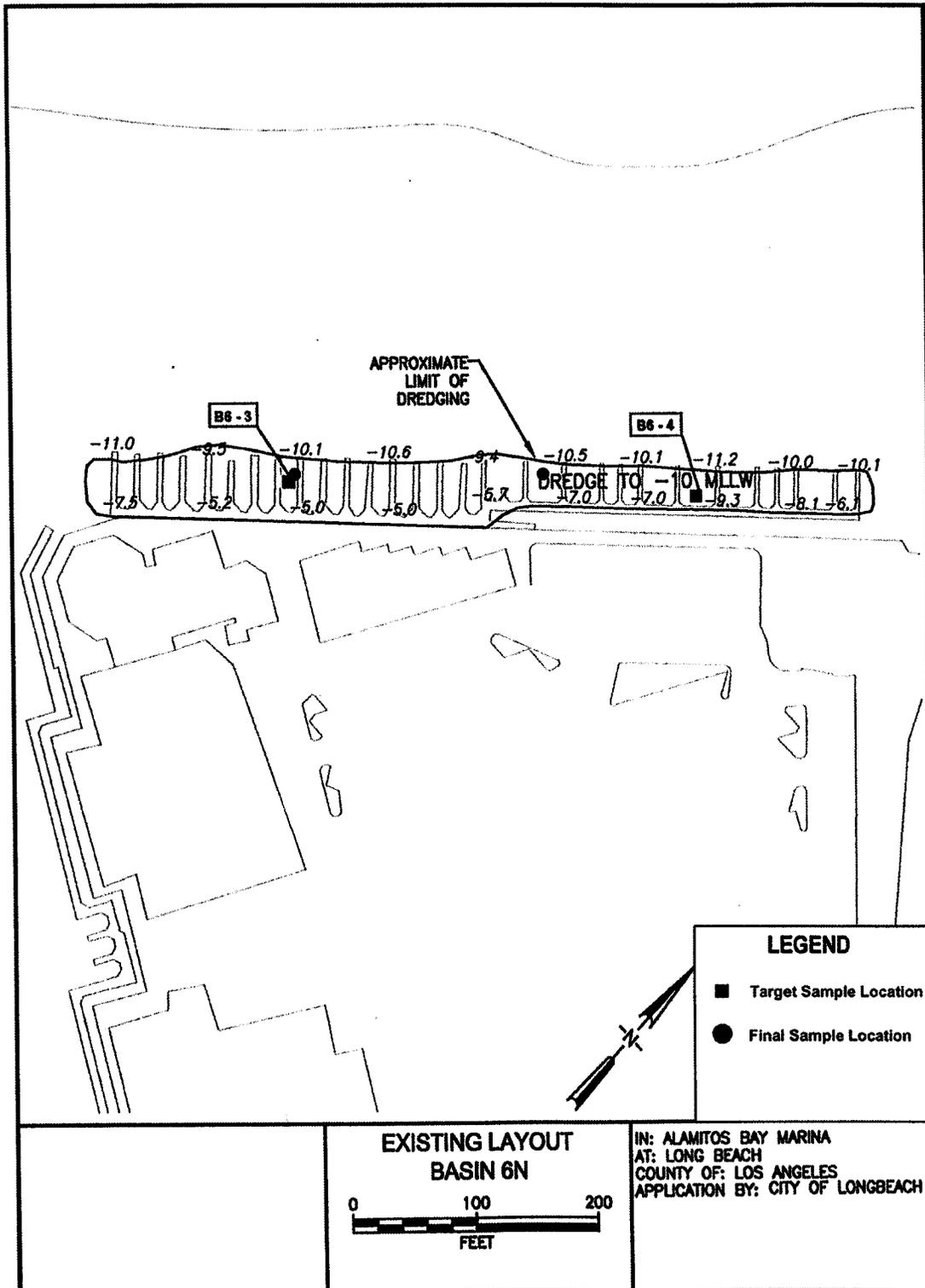


Figure 3g. Sample Locations Basin 6N: Alamitos Bay Marina 2007

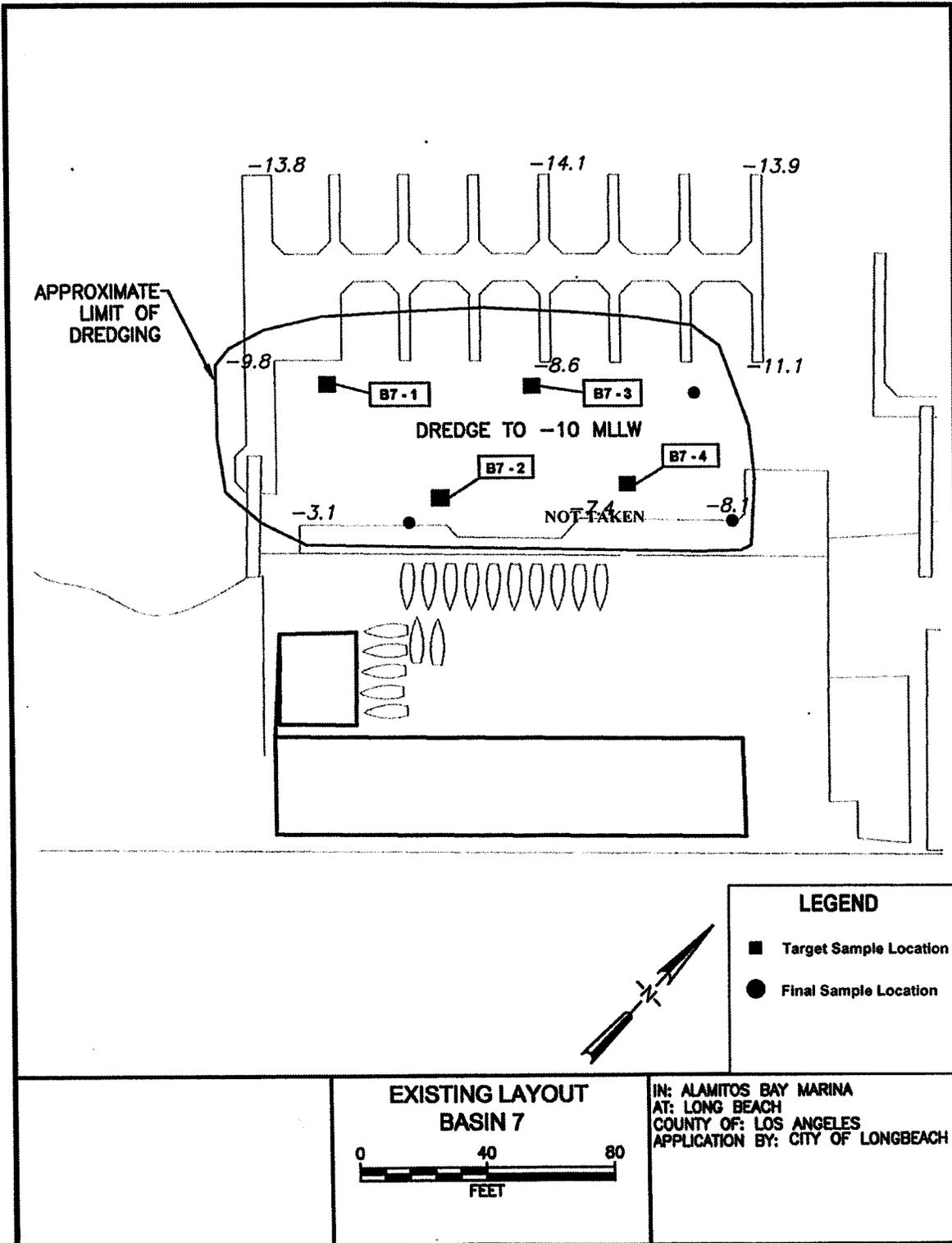


Figure 3h. Sample Locations Basin 7: Alamitos Bay Marina 2007

TABLE 5
Alamitos Bay Marina Core Log

Sample Station	Station Coordinates (NAD 83)	Mudline Depth (ft MLLW)		Target Sample Depth* (ft MLLW)	Target Core Length (ft)	Core Length Retrieved (ft)
		Expected	Actual			
B1 - 1	33°44.910N by 188°06.835W	11.1	10.9	14	3.1	3.3
B1 - 2	33°44.985N by 188°06.868W	11.8	11.7	17	5.3	5.3
B1 - 3	33°45.033N by 118°06.796W	13.2	13.5	17	3.5	3.5
B1 - 4	33°44.975N by 118°06.749W	10.9	11.0	14	3.0	4.5
B1 - 5	33°44.927N by 118°06.806W	10.8	9.8	14	4.2	4.5
B2 - 1	33°45.012N by 118°06.707W	7.4	9.1	12	2.9	4.3
B2 - 2	33°45.107N by 118°06.669W	7.0	9.4	12	2.6	3.5
B2 - 3	Not Sampled	8.0	NA	12	NA	NA
B2 - 4	33°45.177N by 118°06.610W	7.1	9.8	12	2.2	3.0
B2 - 5	33°45.063N by 118°06.706W	7.9	9.5	12	2.5	4.0
B2 - 6	33°45.077N by 118°06.601W	7.3	9.5	12	2.5	3.0
B3 - 1	33°45.363N by 118°06.818W	9.2	9.0	12	3.0	4.0
B3 - 2	33°45.266N by 118°06.722W	7.9	9.8	12	2.2	3.5
B3 - 3	33°45.205N by 118°06.705W	7.5	9.0	12	3.0	3.0
B3 - 4	33°45.248N by 118°06.642W	7.8	8.7	12	3.3	4.5
B4 - 1	33°45.286N by 118°06.931W	8.5	9.4	12	2.6	4.0
B4 - 2	33°45.270N by 118°06.898W	8.3	9.4	12	2.6	4.0
B4 - 3	33°45.234N by 118°06.919W	8.6	8.7	12	3.3	5.0
B4 - 4	33°45.228N by 118°06.832W	8.4	10.0	12	2.0	2.5
B4 - 5	33°45.304N by 118°06.994W	8.4	8.7	12	3.3	4.5
B5 - 1	33°44.821N by 118°07.046W	8.9	9.3	12	2.7	3.8
B5 - 2	33°44.808N by 188°07.055W	8.5	9.5	12	2.5	2.9
B5 - 3	33°44.796N by 118°07.057W	7.8	8.5	12	3.5	4.4
B5 - 4	33°44.779N by 118°07.020W	7.8	9.6	12	2.4	2.7
B6 - 3	33°45.735N by 118°07.006W	7.5	8.5	12	5.5	5.5
B6 - 4	33°45.752N by 118°06.966W	8.2	8.9	12	3.1	4.0
B6 - 1	33°45.678N by 118°07.170W	5.2	7.5	12	4.5	4.4
B6 - 2	33°45.683N by 118°07.074W	5.0	6.8	12	5.2	6.0
B6 - 5	33°45.706N by 118°07.128W	5.0	7.7	12	4.3	4.3
B7 - 1	33°45.127N by 118°07.738W	7.5	8.5	12	3.5	3.4
B7 - 2	33°45.129N by 118°07.722W	7.9	8.5	12	3.5	4.2
B7 - 3	33°45.120N by 118°07.722W	7.9	8.7	12	3.3	3.3
B7 - 4	Not Sampled	NA	NA	12	NA	NA

* Target core length includes two-foot overdredge depth tolerance



Figure 4. Vibracore Operations

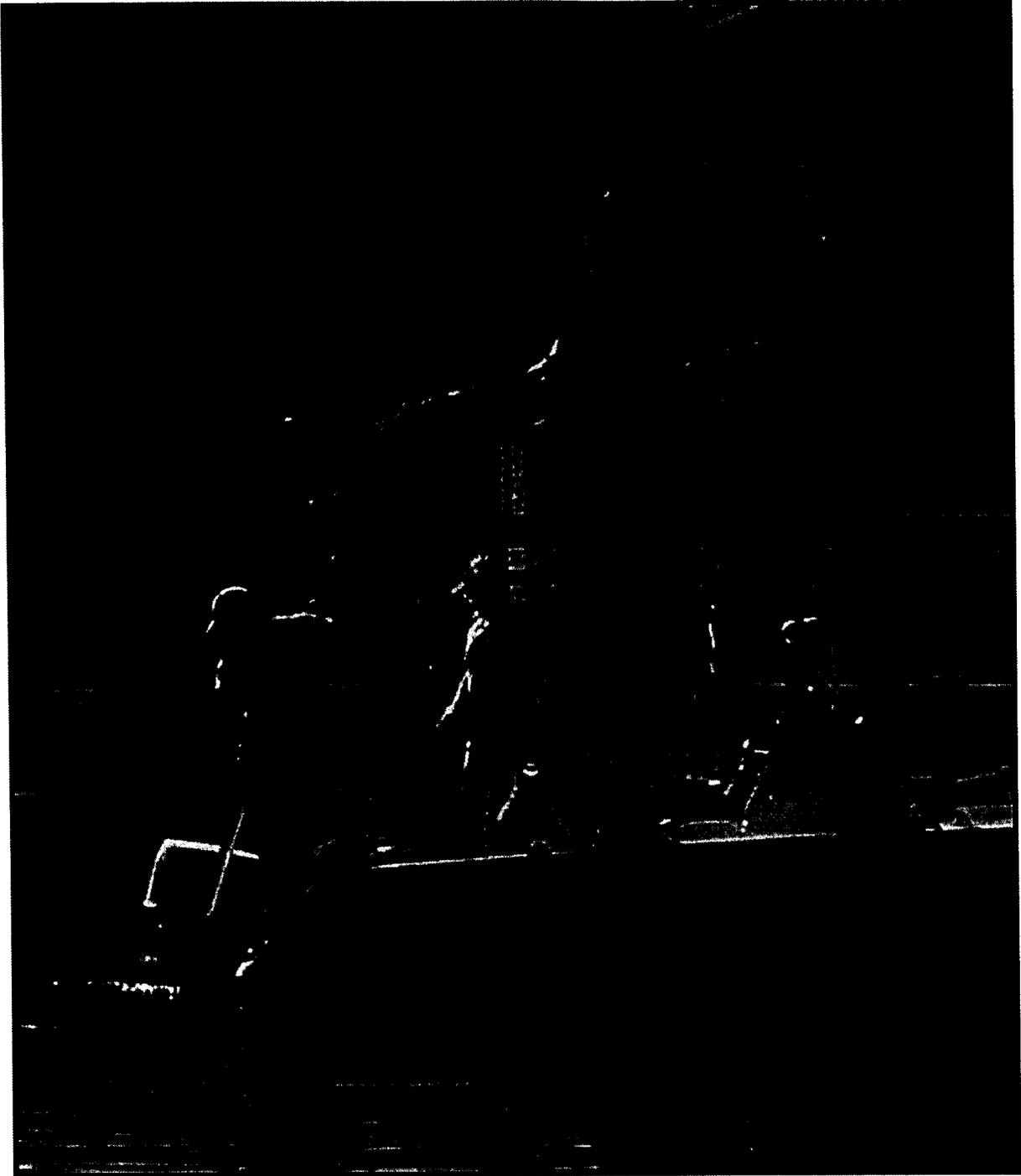


Figure 5. Pushcore Operations

the U.S. EPA, it was agreed that five samples as opposed to six samples would sufficiently represent the material proposed for dredging within Basin 2. Consequently station B2-3 was eliminated from the sampling plan. A similar USEPA guided decision was made with sample B7-4. A minimum of two vibracore samples or three pushcore samples were collected at each site in order to provide sufficient material for all required physical and chemical testing and archival purposes. Sediment cores were collected to sample depth, unless refusal was encountered.

2.1.3.2 Core Handling and Geologic Description

Each vibracore sample was retrieved to the vessel platform, where the sediment sample was extruded from the core barrel onto polyethylene-lined collection trays. Each core was then photographed and examined by a qualified scientist for texture, odor, color, length, approximate grain size distribution, and any evident stratification of the sediment. All core profile data excluding photographs are provided in custom log sheets in Appendix B. Core photos are available upon request.

Sediment for environmental testing was placed into clean food-grade plastic bags, labeled, logged into a field chain of custody (COC), and placed into a cooler. Core samples remained on ice and were shielded from light until delivered by Weston Solutions personnel to the Weston Solutions laboratory in Carlsbad, California, for processing.

2.1.4 Shipping

After processing and prior to shipping, subsample containers were placed in re-sealable plastic bags, wrapped in bubble wrap, and securely packed inside the cooler with ice packs or crushed ice. COC forms were completed, and the original signed COC forms were inserted in a re-sealable plastic bag and placed inside the cooler. The cooler lids were securely taped shut. Samples were delivered to the analytical labs listed in Table 6.

TABLE 6
Analytical Laboratories, Point of Contact, and Shipping Information

Laboratory	Analyses Performed	Point of Contact	Shipping Information
Weston Solutions, Inc. Carlsbad	Bioassays, Grain Size	Chris Osuch	2433 Impala Dr. Carlsbad, CA. 92008
Weston Solutions, Inc. Port Gamble	Bioaccumulation Exposure Treatments	Brian Hester	4729 NE View Dr. Port Gamble, WA. 98364
Enviromatrix Analytical, Inc.	Sediment Chemistry, Tissue Chemistry	Dan Verdon	414 Pontius Ave North Seattle, WA. 98109
Applied Marine Sciences, Inc.	TOC	K. S. Denis	502 N. Highway 3 Suite B League City, TX. 77573

2.1.5 Sample Processing and Storage

Sediment cores, reference sediment, soil cores, and dredge site water were stored at 4 degrees Celsius (°C) until processed. Testing began within 14 days from the time of collection. For analyses, the sediment cores representing each of the project areas were combined and thoroughly homogenized to a uniform consistency at the laboratory using a stainless steel mixing apparatus. Subsamples for chemical analysis were collected from each of the dredged material sampling area composites. Samples to undergo chemical analysis were placed into certified clean glass jars with Teflon-lined lids. A sub-sample from each core location as well as each of the area composites used in testing was frozen in case further delineation of chemical contamination was required.

2.1.6 Documentation and Chain-of-Custody

Samples were considered to be in custody if they were (1) in the custodian's possession or view, or (2) retained in a secured place (under lock) with restricted access. The principal documents used to identify samples and to document possession were COC records, field logbooks, and field tracking forms. COC procedures were used for all samples throughout the collection, transport, and analytical process and for all data and data documentation, whether in hard copy or electronic format. COC forms are reproduced in Appendix A.

COC procedures were initiated during sample collection. A COC record was provided with each sample or sample group. Each person who had custody of the samples signed the form and ensured that the samples were not left unattended unless properly secured. Documentation of sample handling and custody included the following:

- Sample identifier
- Sample collection date and time
- Any special notations on sample characteristics
- Initials of the person collecting the sample
- Date the sample was sent to the laboratory
- Shipping company and waybill information

The completed COC form was placed in a plastic envelope that traveled inside the ice chest containing the listed samples. The COC form was signed by the person transferring custody of the samples. The condition of the samples was recorded by the receiver. COC records were included in the final analytical report prepared by the laboratory, and were considered an integral part of that report.

2.1.7 Decontamination of Field and Laboratory Equipment

All vibracore and pushcore equipment was cleaned prior to sampling. Between stations, the core barrel and deck of the vessel were rinsed with site water. Before creating each composite, all stainless steel utensils (stainless steel bowls, spoons, spatulas, mixers, and other utensils) were cleaned with soapy water, rinsed with tap water, and then rinsed three times with deionized water.

2.2 PHYSICAL AND CHEMICAL ANALYSIS

Physical and chemical parameters measured in this testing program were selected to provide data on potential chemicals of concern in proposed dredge material from AB Marina. Method detection limits (MDLs) for target analytes are described in the SAP (Weston Solutions 2007) and provided in Table 7 along with the achieved method detection limits.

2.2.1 Physical Analyses

Physical analyses of the sediment included grain size and total solids. Grain size was analyzed to provide data on the grain size distributions of project and reference sediment (e.g., gravel, sand, silt, and clay) using the sieve-pipette method (Plumb 1981). The frequency distribution of the size ranges (reported in micrometers [μm]) of the dredged material is reported in the data report. Total solids were measured to convert concentrations of the chemical parameters from a wet-weight to a dry-weight basis. Percent solids were determined by SM 2540G (Clesceri et al. 2000).

TABLE 7
Analytical Methods and Detection Limits

ANALYTE	SAP SPECIFIED METHOD	METHOD USED	TARGET RLS	ACHIEVED MDLS	ACHIEVED RLS
Sediment Organics (µg/kg)					
PAHs	EPA 8270	GC/MS SIMS	20	14.5 - 17.7	14.5 - 17.7
PCBs	EPA 8082	EPA 8082	20	3.39 - 4.13	14.5 - 17.7
Sediment Pesticides (µg/kg)					
Aldrin	EPA 8081A	EPA 8081	2	0.76 - 0.92	1.45 - 1.77
Alpha-BHC	EPA 8081A	EPA 8081	2	1.45 - 1.77	1.45 - 1.77
Beta-BHC	EPA 8081A	EPA 8081	2	0.88 - 1.08	1.45 - 1.77
Gamma-BHC	EPA 8081A	EPA 8081	2	0.91 - 1.11	1.45 - 1.77
Delta-BHC	EPA 8081A	EPA 8081	2	0.88 - 1.08	1.45 - 1.77
Chlordane	EPA 8081A	EPA 8081	20	3.45 - 4.20	3.70 - 4.51
2,4-DDD	EPA 8081A	EPA 8081	2	0.88 - 1.08	1.45 - 1.77
4,4-DDD	EPA 8081A	EPA 8081	2	0.88 - 1.08	1.45 - 1.77
2,4-DDE	EPA 8081A	EPA 8081	2	0.78 - 0.95	1.45 - 1.77
4,4-DDE	EPA 8081A	EPA 8081	2	0.78 - 0.95	1.45 - 1.77
2,4-DDT	EPA 8081A	EPA 8081	2	1.45 - 1.77	1.45 - 1.77
4,4-DDT	EPA 8081A	EPA 8081	2	1.45 - 1.77	1.45 - 1.77
Dieldrin	EPA 8081A	EPA 8081	2	0.94 - 1.15	1.45 - 1.77
Endosulfan I	EPA 8081A	EPA 8081	2	1.19 - 1.45	1.45 - 1.77
Endosulfan II	EPA 8081A	EPA 8081	2	1.23 - 1.50	1.45 - 1.77
Endosulfan Sulfate	EPA 8081A	EPA 8081	2	1.04 - 1.27	1.45 - 1.77
Endrin	EPA 8081A	EPA 8081	2	1.10 - 1.34	1.45 - 1.77
Endrin Aldehyde	EPA 8081A	EPA 8081	2	1.17 - 1.43	1.45 - 1.77
Heptachlor	EPA 8081A	EPA 8081	2	1.22 - 1.48	1.45 - 1.77
Heptachlor Epoxide	EPA 8081A	EPA 8081	2	1.20 - 1.47	1.45 - 1.77
Toxaphene	EPA 8081A	EPA 8081	20	12.8 - 15.5	18.0 - 21.9
Sediment Metals (mg/kg)					
Arsenic	EPA6020	EPA 6020	2.0	0.290 - 0.353	0.725 - 0.883
Cadmium	EPA 6020	EPA 6020	0.3	0.145 - 0.177	0.145 - 0.177
Chromium	EPA 6020	EPA 6020	5.0	0.580 - 0.707	1.45 - 1.77
Copper	EPA 6020	EPA 6020	5.0	0.580 - 0.707	0.725 - 0.883
Lead	EPA 6020	EPA 6020	5.0	0.72 - 0.88	0.72 - 0.88
Mercury	EPA 7471A	EPA 7471	0.02	0.03 - 0.04	0.07 - 0.09
Nickel	EPA 6020	EPA 6020	5.0	0.290 - 0.353	1.45 - 1.77
Selenium	EPA 7742	HGAA	0.1	0.1	0.1
Silver	EPA 6020	EPA 6020	0.2	0.14 - 0.18	0.14 - 0.18
Zinc	EPA 6020	EPA 6020	1.0	3.19 - 3.89	14.5 - 17.7
Conventionals					
Grain Size (%)	Plumb, 1981	Plumb, 1981	0.1	0.1	0.1
Total Organic Carbon (%)	EPA 415.1	ASTM D2579M	0.1	0.1	0.1
Total Solids (%)	SM 2540G	SM 2540G	0.1	0.1	0.1
Total Sulfides (mg/kg)	Plumb, 1981	Plumb, 1981	NA	3.6 - 4.4	3.6 - 4.4
Soluble Sulfides (mg/kg)	SMEWW 4500S2D	SMEWW 4500 SD	0.1	0.72 - 0.88	0.72 - 0.88

2.2.2 Dredged Material Chemistry

To minimize salt interference, the following chemical analyses were performed as recommended by the OTM (USEPA/USACE 1991). Analyses for priority pollutant metals (with the exception of mercury and selenium) were conducted in accordance with USEPA SW-846 Methods 3050/6020. Mercury analysis was performed using USEPA SW-846 Method 7471, and selenium analysis was performed using a proprietary modification of USEPA 7742 that include hydride generation coupled with atomic absorption spectrometry. The analysis for total sulfides followed Plumb (1981) and dissolved sulfides followed SM 4500 SD. Organotin compounds were measured using a gas chromatography- flame photometric detector (GC-FPD). Polynuclear aromatic compounds were measured by GC/MS using USEPA Method 8270. Organochlorine pesticides and PCBs were run using the USEPA Method 8270. The PCBs were identified on both an Aroclor and individual basis. TOC was determined using ASTM D2579M.

2.3 BIOASSAY TESTING

The project plan included eight treatments: one composite sample for each of the AB Marina composite samples, and one LA-2 reference sample representing clean resident material. Tier III testing for this project included three Suspended Particulate Phase (SPP) toxicity tests, two Solid Phase (SP) toxicity tests, and two BP tests. All testing and analysis was performed in accordance with the following guidance:

- The OTM (USEPA/USACE 1991)
- *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual* (the Inland Testing Manual, or ITM) (USEPA/USACE 1998)¹
- *Regional Implementation Agreement (RIA) for the Evaluation of Dredged Material for Ocean Disposal* (USACE, LA District/ USEPA Region IX, 1993)

Specific bioassays performed for this project are summarized in Table 8.

2.3.1 Suspended Particulate Phase Testing

The SPP bioassays were performed to estimate the potential impact of ocean disposal of dredged material to organisms that live in the water column. Elutriates were prepared for each composite sample by combining sediment from each area with AB Marina site seawater in a 1:4 ratio by volume, vigorously agitating for 30 minutes, and then allowing the material to settle for approximately 1 hour at room temperature (20°–23°C). Following settling, the supernatant was gently decanted. This supernatant represents the 100 percent test concentration and was used to create serial dilutions with clean seawater (Scripps Institute of Oceanography, ultraviolet (UV) sterilized, and filtered to 0.2 μm for the blue mussel larvae, 3 μm for the mysid shrimp and fish) for subsequent testing. SPP tests were conducted with three species (*Mytilus edulis*, *Mysidopsis bahia*, and *Menidia beryllina*) and were conducted in accordance with the procedures outlined in the ITM (USEPA/USACE 1998).

¹ While all evaluations were performed in accordance to guidance given in the OTM, specific methodologies and test conditions are provided in the ITM

TABLE 8
Bioassay Testing Performed on AB Marina Project Sediment

Type of Organism	Taxon	Project Materials	Native Control Sediment	Reference Sediment	Reference Toxicant	Ammonia Reference Toxicant
Suspended Phase Particulate Test (SPP Test)						
Bivalve larvae	<i>Mytilus edulis</i>	X	X	NA	X	X
Mysid shrimp	<i>Mysidopsis bahia</i>	X	X	NA	X	X
Fish	<i>Menidia beryllina</i>	X	X	NA	X	X
Solid Phase Test (SP Test)						
Amphipod	<i>Rhepoxinius abronius</i>	X	X	X	X	X
Polychaete	<i>Neanthes arenaceodentata</i>	X	X	X	X	X
Bioaccumulation Potential Test (BP Test)						
Mollusk	<i>Macoma nasuta</i>	X	X	X	NA	NA
Polychaete	<i>Nephtys caecoides</i>	X	X	X	NA	NA

NA: Not applicable

2.3.1.1 *Mytilus edulis* Test

Table 9 summarizes bioassay procedures and organism data for the *M. edulis* SPP test of AB Marina sediments. Bivalve larvae bioassay methods are from ASTM E724-98 (ASTM, 2005a). Three concentrations of the elutriate (100%, 50% and 10%) and a site water control were tested. Adult *M. edulis* were obtained from Carlsbad Aquafarms of Carlsbad, CA. Spawning was induced by temperature manipulation. Unfertilized eggs were separated from debris by filtering the suspension through an 80-um nitex mesh screen. Released gametes were then combined in individual containers of filtered seawater and allowed to fertilize for up to two hours under gentle aeration. Embryo stock density was estimated by counting an aliquot of dilute stock concentrate. Equal volumes of stock were then added to each test chamber to achieve an estimated density of 15-30 embryos/ml. The test was run using five replicates for each treatment and control at $16 \pm 2^\circ \text{C}$ under a 16-hr light: 8-hr dark photoperiod. Temperature, pH, dissolved oxygen (DO), and salinity were measured at test initiation and termination. At 48 hours each replicate was preserved using a 0.25 mL formaldehyde solution. All larvae in each replicate were counted in a Sedgwick-Rafter cell to determine the total number of normally and abnormally developed larvae. The test acceptability criterion is $\geq 70\%$ control survival (normal embryos based on initial inoculation). A reference toxicant test was conducted using copper sulfate as a positive control with concentrations of 2.5, 5.0, 10, 20, and 40 $\mu\text{g Cu}^{2+}/\text{L}$.

2.3.1.2 *Mysidopsis bahia* Test

Table 10 summarizes bioassay procedures and organism data for the *M. bahia* SPP test of the AB Marina sediments. Three elutriate concentrations (100%, 50% and 10%) and a site water control were tested. The *M. bahia* bioassay method is described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (USEPA 2002). Three-day-old mysids were obtained from Aquatic Biosystems of Fort Collins, CO. Five replicates containing 500 mL of the three elutriate concentrations in 1-L plastic chambers were used, each containing 10 mysids. The test was conducted at 20°C under a 16-hr light: 8-hr dark photoperiod. The organisms were fed twice daily (< 24-hour-old *Artemia nauplii*). Water quality measurements including salinity, DO, pH, and temperature were recorded daily for one replicate from each concentration, and measured in all replicates at test termination. Survival was recorded daily. Test acceptability criterion for the test is $\geq 90\%$ mean control survival. A reference toxicant test was conducted using copper chloride with concentrations of 62.5, 125, 250, 500, and 1,000 $\mu\text{g Cu}^{2+}/\text{L}$ to measure the relative sensitivity of the test organisms.

TABLE 9
Bioassay Procedure and Organism Data for the 48 Hour Suspended Particulate Phase
Bioassay using *Mytilus edulis*

SAMPLE IDENTIFICATION		
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7	
Dates Sampled	4/2-4/5/2007	
Date Received at Weston Lab	4/6/2007	
Volume Received	10 L	
Sample Storage Conditions	4 Degrees Celsius - dark	
Sample Treatment	1:4 sediment to site water elutriate preparation	
TEST SPECIES - <i>Mytilus edulis</i>		
Supplier	Carlsbad Aquafarm	
Date Acquired	4/17/2007	
Acclimation Time	Used immediately	
Age Group	Adult	
TEST PROCEDURES		
Test Location	WESTON Carlsbad lab; Room 2	
Test Type; Duration	Critical Life-Stage; 48 hours	
Test Dates	4/17 - 19/2007	
Control Water Source	0.2- μ m filtered, U.V. sterilized San Francisco Bay seawater and Paradise Cay site water	
Test Photoperiod	16 hours light; 8 hours dark	
Test Chamber	20mL scintillation vials	
Replicates/Treatment	5	
Organisms/Replicate	\bar{x} = 259	
Exposure Volume	10mL	
Feeding	None	
Water Renewal	None	
Test Temperature (°C)	Recommended: 16 \pm 2	Actual: 15.4 - 16.7
Test Salinity (ppt)	Recommended: 30 \pm 3	Actual: 29.8 - 33.8
Test Dissolved Oxygen (mg/L)	Recommended: > 5.0	Actual: 7.3 - 8.5
Test pH	Recommended: 7.8 \pm 0.5	Actual: 7.8 - 8.4
Deviations from Procedures	None	

TABLE 10

Bioassay Procedure and Organism Data for the 96-Hour Suspended Particulate Phase
Bioassay using *Mysidopsis bahia*

SAMPLE IDENTIFICATION		
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7	
Dates sampled	4/2-4/5/2007	
Date Received at Weston Lab	4/6/2007	
Approximate volume received	90L	
Sample storage conditions	4°C, dark, minimal head space	
TEST SPECIES - <i>Mysidopsis bahia</i>		
Supplier	Aquatic Biosystems, Fort Collins, Colorado	
Date acquired	4/17/2007	
Acclimation/holding time	1 day	
Age class	3 days old	
TEST PROCEDURES		
Test location	Weston Solutions Carlsbad lab, Room 3	
Test type/duration	Static - Acute SPP / 96 hours	
Test dates	4/18 - 22/2007	
Control water	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized	
Test temperature	Recommended: 20° ± 1°C	Actual: 18.7 - 20.9
Test salinity	Recommended: 32 ppt ± 2	Actual: 30.1 - 33.7 ppt
Test dissolved oxygen	Recommended: > 3.7 mg/L	Actual: 4.5 - 7.4mg/L
Test pH	Recommended: 7.8 ± 0.5	Actual: 7.7 - 8.4
Test total ammonia	Recommended: < NOEC (28.9	Actual: <0.5 - 5.11mg/L
Test photoperiod	16-hour light:8-hour dark	
Test chamber	1-L beakers	
Replicates/SPP concentration/Treatment	5	
SPP Concentrations	100%, 50%, 10%	
Organisms/Replicate	10	
Exposure Volume	500 mL	
Feeding	~ 1000 freshly hatched <i>Artemia nauplii</i> per replicate - twice daily	
Water Renewal	None	
Deviations from Test Protocol	None	

2.3.1.3 *Menidia beryllina* Test

Table 11 summarizes bioassay procedures and organism data for the larval *M. beryllina* SPP test of the AB Marina sediments. Sediment composite elutriates were prepared as described above. A 100% elutriate treatment and two dilutions (10 and 50% elutriate) created with AB Marina site water were tested for toxicity using larval inland silversides (*Menidia beryllina*). The inland silverside bioassay method is described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (USEPA 2002). Juvenile *Menidia beryllina* were obtained from Aquatic Biosystems of Fort Collins, CO. Ten organisms were exposed to 250 mLs of an elutriate dilution in each replicate. The test was conducted using five replicates for each treatment dilution, method control and site water control at $20 \pm 2^\circ\text{C}$ under a 16 hour light: 8 hour dark photoperiod. Organisms were fed 0.2mL of a concentrated solution of *Artemia nauplii* after 48 hours. Temperature, pH, dissolved oxygen, and salinity were measured daily. Total ammonia was measured daily in the 100 percent concentration. Measurements in other concentrations were performed if the readings in the 100 percent elutriate were greater than 4 ppm total NH_3 . Mortality and behavior observations were recorded and dead organisms were removed on a daily basis. A reference toxicant test were conducted employing copper as copper sulfate with concentrations of 50, 100, 200, 400 and 800 ug Cu^{2+}/L .

2.3.2 Solid Phase Testing

SP bioassays were performed to estimate the potential impact of ocean disposal of dredged sediment on benthic organisms that attempt to re-colonize the area. Dredged material was tested in 10-day SP tests using two species: a marine amphipod (*Rhepoxinius abronius*) and a polychaete worm (*Neanthes arenaceodentata*). *R. abronius* was selected over the amphipod *Ampelisca abdita* based on a relatively consistent grain size profile comprised of a moderate level of sand and less than 50% clays. Prior to testing, the reference, test, and control sediments were sieved to remove organisms. This was accomplished by press-sieving the sediment through a 2.0-millimeter (mm) mesh screen using only the water available in the sediment sample. Each sediment type (test, reference, and control) was run with five replicates.

2.3.2.1 *Rhepoxinius abronius* 10-Day Static Test

Bioassay methods for the infaunal amphipod bioassays follow ASTM E1367-99 (ASTM 2005b). Table 12 summarizes bioassay procedures and organism data for the *Rhepoxinius abronius* SP test using AB Marina test sediments. Test animals were supplied by Aquatic Environmental Science Inc. of Port Townsend, WA. Sediment was placed in replicate 1L glass jars to a depth of 2 cm to which was added approximately 900 mL of seawater. Additional surrogate replicates (i.e., w/out test organisms) for each treatment were set up to obtain measurements of pore water ammonia at test initiation and termination. After 24 hours, overlying water was renewed (80% by volume), and an initial set of water quality parameter measurements were taken from each replicate of each sediment treatment and recorded. The water quality parameters measured down, and sediment pore water was extracted via centrifugation for subsequent analysis of pH, salinity, and ammonia. Test organisms were then randomly distributed to test chambers (20 animals per chamber). Animals remaining in the water column and exhibiting abnormal behavior after one hour were replaced. The chambers were covered with watch glasses to minimize evaporation. The test was run under continuous light at a temperature of $20 \pm 2^\circ\text{C}$ with gentle aeration applied to each test chamber. Daily water quality measurements were taken from one chamber per treatment, and the number of dead and surfaced animals was noted for each replicate. Pore water was extracted from

TABLE 11
Bioassay Procedure and Organism Data for the 96-Hour Suspended Particulate Phase Bioassay using *M. beryllina*

SAMPLE IDENTIFICATION		
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7	
Date Sampled	4/2-4/5/2007	
Date Received at Weston Lab	4/6/2007	
Volume Received	35 - 40 L per composite	
Sample Storage Conditions	4°C, dark, minimal head space	
TEST SPECIES - <i>Manitida beryllina</i>		
Supplier	Aquatic Indicators, Fort Collins, CO	
Date Acquired	4/17/2007	
Acclimation Time	3 days	
Age Group	13 days old at test initiation	
TEST PROCEDURES		
Test Location	WESTON Carlsbad lab; 20 Degree Room	
Test Type; Duration	Critical Life-Stage; 96 hours	
Test Dates	4/19 - 23/2007	
Control Water Source	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized	
Test Photoperiod	16 hours light; 8 hours dark	
Test Chamber	500 mL beakers	
Replicates/Treatment	5	
Organisms/Replicate	10	
Exposure Volume	250 mL	
Feeding	0.2 mL Artemia at 48-hours	
Water Renewal	None	
Test Temperature (°C)	Recommended: 20 ± 2	Actual: 18.5 - 20.9
Test Salinity (ppt)	Recommended: 20-32 ± 2	Actual: 32.0 - 34.1
Test Dissolved Oxygen (mg/L)	Recommended: > 5.0	Actual: 2.6* - 8.5
Test pH	Recommended: > 5.0	Actual: 7.7 - 8.3
Deviations from Procedures	D.O. found to be low in some samples. All samples were aerated to resolve deviation.	

TABLE 12
Bioassay Procedure and Organism Data for the
10-Day Solid Phase Bioassay using *R. abronius*

SAMPLE IDENTIFICATION		
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7	
Date sampled	4/2-4/5/2007	
Date received at Weston Solutions-	4/6/2007	
Approximate volume received	35 - 40 L per composite	
Sample storage conditions	4 Degrees Celsius - dark	
TEST SPECIES - <i>R. abronius</i>		
Supplier	Aquatic Environmental Science Inc., Port Townsend, WA	
Date acquired	5/2/2007	
Acclimation/holding time	2 days	
Age / size class	3-5mm	
TEST PROCEDURES		
Test location	Weston Solutions, Inc. Carlsbad; 15°C room	
Test type/duration	10 day Solid Phase	
Test dates	5/4 - 14/2007	
Control water	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized	
Test temperature	Recommended: 15 ± 2°C	Actual: 13.0 - 16.7
Test salinity	Recommended: 28 ± 2 ppt	Actual: 27.5 - 30.2
Test dissolved oxygen	Recommended: > 6.0 mg/L	Actual: 7.2 - 8.3
Test pH	Recommended: 7.8 ± 0.5	Actual: 7.5 - 8.2
Test photoperiod	Continuous	
Test chamber	1L glass jars	
Replicates/treatment	5	
Organisms/replicate	10	
Exposure volume	2 cm sediment/900mL seawater	
pFeeding	None	
Water renewal	None	
Deviations from test protocol	ITM test conditions recommend a 12L:12D light cycle. WESTON SOP suggests continuous light cycle based on references cited in ITM that recommend continuous light as a measure to help ensure organism burrowing (ASTM indicates "no special requirement" for light cycle).	

test chamber surrogates for additional ammonia analysis upon completion of the bioassay. On the 10th and final day of the test, sediments from the chambers were sieved through a 0.5mm screen and the number of survivors was recorded. The test acceptability criterion for both *A. abdita* and *R. abronius* is 90% mean control survival. One reference toxicant test was conducted for *R. abronius*; a positive control using cadmium chloride with triplicate concentrations of 0.25, 0.50, 1.0, 2.0, and 4.0 mg Cd²⁺/L. Two reference toxicant tests were conducted for *A. abdita*: cadmium chloride and ammonia. Triplicate concentrations of 0.25, 0.5, 1.0, 2.0, and 4.0 mg/L of cadmium chloride were used, and triplicate concentrations of 5, 10, 20, 40, and 80 mg/L of ammonia were used.

2.3.2.2 *Neanthes arenaceodentata* 10-Day Static-Renewal Test

Bioassay methods for the marine polychaete bioassay are from the ITM (USEPA/USACE 1998). Juvenile worms were supplied by Don Reish of Long Beach, California. Table 13 summarizes bioassay procedures and organism data for the SP test with *Neanthes arenaceodentata*. Bioassay methods for the polychaete bioassay are from ASTM E1611-99

TABLE 13
Bioassay Procedure and Organism Data for 10-Day Solid Phase Bioassay using
N. arenaceodentata

SAMPLE IDENTIFICATION		
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7	
Dates Sampled	4/2-4/5/2007	
Date Received at WESTON	4/11/2007	
Volume Received	35 - 40 L per composite	
Sample Storage Conditions	4 Degrees Celsius - dark	
Sample Treatment	Press sieved (0.5 mm)	
TEST SPECIES - <i>Neanthes arenaceodentata</i>		
Supplier	Dr. Don Reish, Long Beach, CA	
Date Acquired	4/26/2007	
Acclimation Time	6 hours	
Age Group	2-3 weeks post emergence	
TEST PROCEDURES		
Test Location	WESTON Carlsbad lab; 15° Room	
Test Type; Duration	Acute/Static; 10 days	
Test Dates	4/27 - 5/07/2007	
Control Water Source	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized	
Test Photoperiod	Continuous light*	
Test Chamber	1L glass jars	
Replicates/Treatment	5	
Organisms/Replicate	5	
Exposure Volume	2 cm sediment/900mL seawater	
Feeding	None	
Water Renewal	None	
Test Temperature (°C)	Recommended: 20 ± 1	Actual: 18.8 - 21.3
Test Salinity (ppt)	Recommended: 28 - 34	Actual: 31.6 - 33.1
Test Dissolved Oxygen (mg/L)	Recommended: > 5.0	Actual: 6.1 - 8.7
Test pH	Recommended: 8.0 ± 0.5	Actual: 7.9 - 8.3
Deviations from Procedures	No significant deviations	

(ASTM 2004b). Juvenile worms were supplied by Brezina & Associates of Dillon Beach, CA. Sediment was placed in replicate 1L glass jars to a depth of 2 cm to which was added approximately 900 mL of seawater. Additional surrogate replicates (no animals) for each treatment were set up in order to obtain measurements of pore water ammonia at test initiation and termination. After 24 hours, overlying water was renewed (80% by volume) and an initial set of water quality parameters was measured: temperature, dissolved oxygen, pH, salinity, and overlying-water ammonia from each treatment were recorded. In addition, a surrogate replicate from each treatment was used to extract sediment pore water via centrifugation for subsequent analysis of pH, salinity, ammonia, and sulfides. Test organisms were then randomly distributed to test chambers (5 animals per chamber). The test was run under a photoperiod of continuous light at a temperature of $15 \pm 2^\circ\text{C}$ with gentle aeration. Daily water quality measurements were taken and the number of dead and surfaced animals was noted for each replicate. On day 10, the sediments from the chambers were sieved through a 0.5 mm screen and the number of survivors was recorded. Test acceptability criterion is 90% mean control survival. A reference toxicant test was conducted using cadmium chloride with triplicate concentrations of 1, 2, 4, 8, and 16 mg Cd^{2+}/L .

2.4 BIOACCUMULATION POTENTIAL TESTING

To determine the availability of the organochlorine pesticide DDT and heavy metals residues present in AB Marina sediments. Assessment of bioaccumulation potential (BP) was carried out using the polychaete worm *Nephtys caecoides* and the bivalve *Macoma nasuta* over a 28-day test period. *N. caecoides* and *M. nasuta* were both supplied by Brezina and Associates of Dillon Beach, CA. Bioaccumulation tests were conducted in accordance with those procedures outlined in USEPA (1994) and the ITM (USEPA/USACE 1998). Each of these tests was initiated using project samples and reference and control sediment in the same manner as the 10-day SP tests. Following the 28-day organism exposure process, tissues from each treatment replicate were frozen and shipped in individual glass containers to the analytical chemistry laboratory for analysis. However, instead of digesting and analyzing each tissue replicate individually, laboratory staff composited all five replicates per treatment prior to the digestion/analysis process. Table 14 summarizes bioassay procedures and organism data for the bioaccumulation study of the test sediments with *N. virens* and *M. nasuta*.

Although statistical deficiencies of this dataset prohibit discerning with certainty the potential for contaminant uptake, the tissue composite results will be presented and discussed in terms of screening for BP retesting. The BP retest was reinitiated with organism exposure treatments on 11 July 2007. If necessary, results of the subsequent tissue analysis will be reported in an addendum to this report.

Tissue chemistry concentrations of the organisms that were exposed to AB Marina sediments were nominally compared to LA-2 tissue chemistry concentrations. Contaminant concentrations found to be significantly elevated above reference were interpreted in light of criteria specified in the OTM (USEPA/USACE 1991), including a comparison to published residue-effects values using the USACE/USEPA (2003) Environmental Residue-Effects Database (ERED). Data generated by any additional BP testing will be statistically analyzed using analysis of variance, *t*-tests, or non-parametric tests, depending on the assumptions of the individual tests (i.e., homogeneity of variance) as specified in the OTM (USEPA/USACE 1991).

TABLE 14
Bioassay Procedure and Organism Data for the 28-Day Bioaccumulation Studies using
Nephtys caecoides* and *Macoma nasuta

SAMPLE IDENTIFICATION	
Sample ID(s)	LA - 2, B-1, B-2, B-3, B-4, B-5, B-6, B-7
Dates Sampled	4/2-4/5/2007
Date Received at MEC	4/6/2007
Volume Received	35 - 40 L per composite
Sample Storage Conditions	4 Degrees Celsius - dark
TEST SPECIES - <i>Macoma nasuta</i> ; <i>Nephtys caecoides</i>	
Supplier	Aquatic Research Organisms; Brezina and Associates
Date Acquired	4/16/2007; 4/19/2007
Acclimation Time	2 days; None
Age Group	Adult
TEST PROCEDURES	
Test Location	WESTON Port Gamble lab; 15° Room
Test Type; Duration	Flow-through/28 days
Test Dates	04/20 - 5/18/2007
Control Water Source	Scripps Institute of Oceanography seawater; 3 µm filtered, UV sterilized
Test Photoperiod	16 hour light: 8 hour dark
Test Chamber	22 L fiberglass trays with non-contaminating covers
Replicates/Treatment	5
Organisms/Replicate	25; 60
Exposure Volume	5 cm sediment (5 L)
Feeding	None
Water Renewal	Flow through (1.7 - 3.3 mL/sec)
Test Temperature (°C)	Recommended: 15 ± 2 Actual: 14.3 - 16.0
Test Salinity (ppt)	Recommended: > 25 Actual: 31 - 34
Test Dissolved Oxygen (mg/L)	Recommended: > 5.0 Actual: 5.9 - 9.9
Test pH	Recommended: 8.0 ± 0.5 Actual: 7.5 - 8.2
Deviations from Procedures	No significant deviations

2.5 SEAWATER FOR BIOASSAY TESTING

Seawater used in this study, including the flow-through studies, came from either the Hood Canal in Puget Sound, WA (BP tests) or the Scripps Institution of Oceanography (SPP and SP tests) in La Jolla, California. These control seawater sources have been used successfully on similar bioassay testing programs by Weston Solutions. Extensive testing on a variety of test species and biannual chemical analysis of this seawater source has shown that there is no significant potential for toxicity or bioaccumulation from these water supplies. Similarly, good survival of organisms in the control sediment utilized in this testing program has been achieved consistently in previous dredged material testing.

2.6 WATER QUALITY

Water quality was monitored daily as appropriate for each test and was recorded on data sheets. Dissolved oxygen was measured using YSI Model 57 and Orion Model 840 oxygen meters and probes; pH was measured using both the Beckman digital and Orion Model 230A pH meters and probes. Salinity and temperature were measured with Orion Models 140 and 142 conductivity/salinity meters. Ammonia was analyzed using an Orion 95-12

electrode and the Orion 720 digital ion analyzer with a three-point calibration curve (1, 10, and 100 mg/L).

2.7 QUALITY ASSURANCE PROCEDURES

2.7.1 Chemical Analysis

The quality assurance and quality control (QA/QC) objectives for analyses conducted by EMAS are designed to meet the accreditation requirements of the California DHS, USEPA, USACE, and other state and federal programs. Chemical analyses were performed using the following QA/QC applications:

- Quality Control Standard
- Analytical Blanks
- Surrogate Percent Recovery
- Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD) percent recoveries
- Matrix Spike Recovery/Matrix Spike Duplicate Recovery (MS/MSD) and/or
- Relative Percent Difference (RPD for LCS/LCSD, MS/MSD, and duplicates)

2.7.2 Biological Evaluation

Weston's Quality control staff performs periodic audits to ensure that test conditions, data collection, and test procedures are conducted in accordance with regulatory guidance and the Weston QAPP. Weston's SOPs has been audited and approved by an independent, EPA-approved laboratory and placed in the QAPP as well as laboratory files.

2.7.2.1 Test Organism Handling

All test organisms were shipped via overnight delivery service to Weston's laboratories in Carlsbad, CA and Port Gamble, WA. Organism container water was analyzed for dissolved oxygen, salinity temperature and pH upon receipt to ensure organisms were not exposed to water quality conditions dissimilar to test conditions. Organisms received at salinities different than the specified test conditions were acclimated to test salinity in accordance with approved SOPs for the laboratory. Animal receipt and maintenance log books were used to record the source and health of the test organisms.

2.7.2.2 Bioassay Testing

The quality assurance objectives for toxicity testing conducted by Weston Solutions are consistent with U.S. EPA guidance (USEPA 2002). These objectives for data quality include:

- Water sampling and handling
- Source and condition of test organisms
- Condition and maintenance of equipment
- Test conditions
- Instrument calibration
- Use of reference toxicants
- Record keeping
- Data evaluation

The bioassay methods employed for this study are detailed in USEPA (2002), and in Weston's internal laboratory Standard Operating Procedures (SOPs). These SOPs and protocols have been approved by the laboratory director. All data collected and produced are recorded on approved data sheets and included as part of the permanent project file. These data sheets and all subsequent statistical analyses were checked to ensure that required test conditions were within specifications cited in the standard operating procedures and the analysis performed

where appropriate. Any unforeseen circumstances that might have affected the integrity of the study were reported with the test results.

SOPs for each analytical instrument used in bioassay testing are maintained in the Maintenance and Calibration Log. Equipment is maintained under a regular schedule to prevent equipment failure and/or changes in operational parameters. Instruments used in support of testing are calibrated daily and calibration data are logged by the technician performing the calibration. Stock standard solutions are stored in at least two separate containers, so that fresh standard solution is available in the event that the stock standard currently in use becomes contaminated. Working standards that are in frequent contact with electrodes, pipettes, etc. are kept in separate working bottles to reduce the chance of contamination of stock standards. The laboratory seawater source is analyzed semi-annually for priority pollutants and results are kept on file in Weston's Carlsbad laboratory.

Reference toxicant tests are used as an internal quality check of the sensitivity of test organisms. The results of these tests are compared with laboratory database values for the reference toxicant used to verify that test animal performance was within acceptable limits. Similarly, water quality measurements were monitored to ensure that they complied with the prescribed limits, and corrective action was taken if necessary.

2.7.3 Data Analysis and Statistical Methods

Major deviations from prescribed protocols required approval of both the client and the QC manager. Circumstances or deviations that might affect the integrity of the study are reported with the results. The data, analyses, and report were also reviewed for accuracy by the QA manager. All data underwent a 100 percent QA check for accuracy and completeness, and an additional secondary check was performed on a minimum of 10 percent of the data.

3 RESULTS

3.1 CHEMICAL AND PHYSICAL CHARACTERISTICS OF DREDGED MATERIAL

Results of physical and chemical analyses for AB Marina project dredged materials are discussed below. All results are expressed in dry weight unless otherwise indicated. Summary results are presented in Table 15.

Results of chemical analyses of project dredged materials were compared to LA-2 reference material results as well as effects range-low (ER-L) and effects range-high (ER-M) values developed by Long et al. (1995). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., amphipod tests) and chemical analysis were available for individual samples. The ER-L was then calculated as the lower tenth percentile of the observed effects concentrations and the ER-M as the 50th percentile of the observed effects concentrations. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. The ER-L and ER-M sediment quality values are included in Table 15 for comparative purposes only.

For certain pesticide compounds (dieldrin and chlordane for example) the ER-L (0.02 µg/kg and 0.5 µg/kg, respectively) and ER-M levels (8 µg/kg and 6 µg/kg, respectively) are so low as to make it largely impractical to detect them in typical harbor sediments using standard analytical procedures. Accordingly, having non-detect results that are greater than the ER-L, ER-M, or MDLs would not require re-analysis.

3.1.1 Conventional and Metals Sediment Constituents

Project material collected from the AB Marina was mostly fine-grained in composition, but ranged widely from 52% (Basin 7) to 81% (Basin 1) silts and clays. Total solids measurements ranged from 59 to 68%. TOC levels were relatively low, ranging from 0.8 to 1.4%, and sulfides were not detected.

With the exception of nominal exceedances reported for mercury and zinc, all achieved detection limits were below SAP target reporting limits. Both metals were however detected in all samples at levels significantly higher than the achieved MDLs. Most metals constituents were present in AB Marina sediments at levels below or consistent with ER-L reference values. Metals commonly associated with urban run-off (i.e. copper, lead, mercury and zinc) however were detected at levels exceeding ER-Ls throughout the Marina complex although zinc was found at elevated levels in Basins 4, 5 and 6 only. Arsenic was also found in the Basin 1 sample at a concentration exceeding the ER-L for this contaminant by 10%. However, in general the observed exceedances did not exceed the ER-L values by any substantial degree, and with the exception of mercury detected in the Basin 1 sample, none of the metals concentrations approached ER-M levels. Mercury was detected in the finer grained sediments of Basin 1 at a concentration of 0.83 mg/kg, exceeding the ER-M by 0.12 mg/kg.

TABLE 15

Results of Chemical and Physical Analyses of Alamos Bay Marina Sediment

Analyte	Sample Identification							LA-2	ER-L	ER-M
	B1	B2	B3	B4	B5	B6	B7			
Conventionals										
Grain Size (%)										
Sand	19.10	22.62	36.85	19.63	20.74	25.39	42.52	43.83	NA	NA
Clay	30.10	22.17	17.27	22.18	26.70	27.40	24.18	11.38	NA	NA
Silt	50.49	54.07	44.85	57.88	52.31	45.97	27.29	44.59	NA	NA
Total Organic Carbon (%)	1.17	1.20	0.79	1.14	1.33	1.20	1.41	0.45	NA	NA
Total Solids (%)	57.2	63.1	69.0	65.4	56.6	56.9	69.6	68.2	NA	NA
Soluble Sulfides (mg/kg)	<0.87	<0.79	<0.72	<0.76	<0.88	<0.88	3.05	<0.73	NA	NA
Total Sulfides (mg/kg)	<4.4	<4.0	<3.6	<3.8	<4.4	<4.4	<4.2	<3.7	NA	NA
Metals (mg/kg)										
As	8.98	6.05	5.50	6.22	7.33	6.65	7.10	3.59	6.2	70.0
Cd	0.664	0.747	0.601	0.855	0.901	1.13	0.558	0.220	1.2	9.6
Cr	47.8	41.5	34.7	41.5	50.8	49.9	39.1	28.7	81.0	370
Cu	60.1	49.2	44.3	52.3	56.0	76.2	54.6	9.60	34.0	270
Pb	71.0	72.1	54.8	85.0	97.9	70.9	58.8	6.96	46.7	218
Hg	0.83	0.36	0.36	0.29	.031	0.18	0.28	0.04	0.2	0.71
Ni	22.5	18.9	17.6	20.2	22.7	22.4	18.6	13.1	20.9	51.6
Ag	0.33	0.34	0.23	0.35	0.46	0.58	0.50	ND	1.0	3.7
Zn	148	135	102	204	155	213	136	50.8	150	410
PAHs (ug/kg)										
<i>Acenaphthene</i>	<6.29	<5.71	<5.22	<5.50	<6.36	<6.33	<6.04	<5.28	NA	NA
<i>Acenaphthylene</i>	<8.18	<7.42	<6.78	<7.16	<8.27	<8.22	<7.85	<6.86	NA	NA
<i>Anthracene</i>	<11.0	<9.98	<9.13	<9.63	<11.1	<11.1	<10.6	<9.24	NA	NA
<i>Benzo (a) anthracene</i>	<11.7	<10.6	<9.67	11.1	<11.8	<11.7	20.5	<9.78	NA	NA
<i>Benzo (b) fluoranthene</i>	<15.5	<14.1	<12.9	<13.6	<15.7	<15.6	20.6	<13.0	NA	NA
<i>Benzo (k) fluoranthene</i>	<12.0	<10.8	<9.91	<10.5	<12.1	<12.0	11.5	<10.0	NA	NA
<i>Benzo (ghi) perylene</i>	<17.0	<15.4	<14.1	<14.9	<17.2	<17.1	<16.3	<14.3	NA	NA
<i>Benzo (a) pyrene</i>	<12.9	<11.7	<10.7	<11.3	<13.0	<13.0	14.9	<10.8	NA	NA
<i>Chrysene</i>	<6.92	6.78	<5.74	6.24	7.46	<6.96	17.1	<5.81	NA	NA
<i>Dibenz (ah) anthracene</i>	<16.0	<14.5	<13.3	<14.0	<16.2	<16.1	<15.4	<13.5	NA	NA
<i>Fluoranthene</i>	<10.1	10.0	<8.35	13.0	13.0	<10.1	25.2	<6.45	NA	NA
<i>Fluorene</i>	<8.18	<7.42	<6.78	<7.16	<8.27	<8.22	<7.85	<6.86	NA	NA
<i>Indeno (1,2,3-cd) pyrene</i>	<17.5	<15.8	<14.5	<15.3	<17.7	<17.6	<16.8	<14.7	NA	NA
<i>Naphthalene</i>	<3.34	<3.03	<2.77	<2.92	<3.37	<3.36	<3.20	<2.80	NA	NA
<i>Phenanthrene</i>	<7.33	<6.64	<6.07	<6.41	7.83	<7.36	7.75	<6.14	NA	NA
<i>Pyrene</i>	<10.6	11.0	<8.81	14.1	13.8	<10.7	24.1	<8.91	NA	NA
Total Detected LMW PAH	ND	ND	ND	ND	7.83	ND	7.75	ND	NA	NA
Total LMW PAH*	<11.0	<9.96	<9.13	<9.63	<11.1	<11.1	<10.6	<9.24	NA	NA
Total Detected HMW PAH	ND	17.78	ND	46.4	34.35	ND	122.25	ND	NA	NA
Total HMW PAH*	<17.5	17.78	<14.5	46.4	34.35	<17.5	122.25	<14.7	NA	NA
Total Detected PAH	ND	17.78	ND	46.4	42.1	ND	130	ND	NA	NA
Total PAH*	<17.5	17.78	<14.5	46.4	42.1	<17.5	130	<14.7	4022	44792

Italicized analytes indicate LMW PAHs.

< Indicates concentrations are less than the corresponding method detection limit (MDL)

ER-L = Effects Range- Low: Lower tenth percentile concentration of screened sediment toxicity data, at which toxicity may begin

ER-M = Effects Range-Median: Median concentration of a compilation of toxic samples. (Long 1995)

*Total=Detected+Undetected at the achieved MDL.

TABLE 15 (CONT.)
Results of Chemical and Physical Analyses of Alamitos Marina Sediment

Analyte	Sample Identification							LA-2	ER-L	ER-M
	B1	B2	B3	B4	B5	B6	B7			
PCB Aroclors (ug/kg)										
1016	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1221	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1232	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1242	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1248	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1254	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
1260	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	NA	NA
Total	<4.09	<3.71	<3.39	<3.58	<4.13	<4.11	<3.93	<3.43	22.7	NA
Pesticides (ug/kg)										
Aldrin	<0.91	<0.83	<0.76	<0.80	<0.92	<0.92	<0.88	<0.77	NA	NA
Alpha-BHC	<1.75	<1.58	<1.45	<1.53	<1.77	<1.76	<1.68	<1.47	NA	NA
Beta-BHC	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
Gamma-BHC	<1.10	<1.00	<0.91	<0.96	<1.11	<1.11	<1.06	<0.92	NA	NA
Delta-BHC	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
Chlordane	<4.16	<3.77	<3.45	<3.64	<4.20	<4.18	<3.99	<3.49	NA	NA
2,4-DDD	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
4,4-DDD	<1.07	<0.97	<0.88	<0.93	<1.08	<1.07	<1.02	<0.89	NA	NA
2,4 DDE	<0.94	<0.86	<0.86	<0.83	<0.95	<0.95	<0.91	<0.79	NA	NA
4,4 DDE	13.5	11.7	13.5	13.8	12.5	6.77	7.26	4.16	NA	NA
2,4 DDT	<1.75	<1.58	<1.45	<1.53	<1.77	<1.76	<1.68	<1.47	NA	NA
4,4 DDT	<17.5	<15.8	<14.5	<15.3	<17.7	<17.6	<16.8	<14.7	NA	NA
Total DDT	13.5	11.7	13.5	13.8	12.5	6.77	7.26	4.16	1.6	46.1
Dieldrin	<1.14	<1.03	<0.94	<0.99	<1.15	<1.14	<1.09	<0.85	NA	NA
Endosulfan I	<1.43	<1.30	<1.19	<1.25	<1.45	<1.44	<1.38	<1.20	NA	NA
Endosulfan II	<1.49	<1.35	<1.23	<1.30	<1.50	<1.49	<1.43	<1.25	NA	NA
Endosulfan sulfate	<1.26	<1.14	<1.04	<1.10	<1.27	<1.27	<1.21	<1.06	NA	NA
Endrin	<1.33	<1.20	<1.10	<1.16	<1.34	<1.34	<1.28	<1.11	NA	NA
Endrin aldehyde	<1.42	<1.28	<1.17	<1.24	<1.43	<1.42	<1.36	<1.19	NA	NA
Heptachlor	<1.47	<1.33	<1.23	<1.28	<1.48	<1.48	<1.41	<1.23	NA	NA
Heptachlor epoxide	<1.45	<1.32	<1.20	<1.27	<1.47	<1.46	<1.39	<1.22	NA	NA
Methoxychlor	<26.0	<23.6	<21.6	<22.8	<26.3	<26.2	<25.0	<21.8	NA	NA
Toxaphene	<15.4	<13.9	<12.8	<13.5	<15.5	<15.5	<14.8	<12.9	NA	NA
Organotins (ug/kg)										
Tetrabutyltin	<1.56	<1.41	<1.29	<1.36	<1.57	<1.57	<1.49	<1.30	NA	NA
Tributyltin	<1.73	<1.57	<1.43	<1.51	<1.75	<1.74	<1.66	<1.45	NA	NA
Dibutyltin	<2.01	<1.82	<1.67	<1.76	<3.06	<2.02	<1.93	<1.69	NA	NA
Monobutyltin	<0.96	<0.87	<0.80	<0.84	<3.06	<0.97	<0.92	<1.30	NA	NA

< Indicates concentrations are less than the corresponding method detection limit (MDL)
 ER-L = Effects Range- Low: Lower tenth percentile concentration of screened sediment toxicity data, at which toxicity may begin
 ER-M = Effects Range-Median: Median concentration of a compilation of toxic samples. (Long 1995)

3.1.2 Organic Sediment Constituents

As shown in Table 7, the achieved MDLs were lower than the SAP reporting limits for all organic constituents. Total PAH concentrations reported for AB Marina sediment samples, including undetected constituents at their MDLs, were under 150 µg/kg across all docking basins. With the exception of DDT, no other organic contaminants were measured above the achieved MDLs. ΣDDT was detected in all sediment samples including the LA-2 reference material sample at concentrations exceeding the ER-L value of 1.6 µg/kg. The LA-2 sample measured 4.2 µg/kg ΣDDT, and ΣDDT concentrations exhibited by the AB Marina composite samples ranged from 6.8 to 13.8 µg/kg, all substantially lower than the ER-M value of 46.1 µg/kg.

3.2 BIOASSAY TESTING

3.2.1 Suspended Particulate Phase Testing

To assess the potential water column impacts of AB Marina sediments dispersed within the LA-2 aquatic environment, three SPP bioassays were performed with elutriates created with project composite samples.

3.2.1.1 *Mytilus edulis* Test Results.

Results of the *M. edulis* bioassays performed with AB Marina sediments are summarized in Table 16. Water quality parameters in *M. edulis* water column tests were within the recommended limits prescribed for this test species. Mean percentage of normal surviving laboratory control embryos relative to the initial embryo density was 90.0%, meeting the passing criteria for this test (>70%). The site water mean survival rate was 90.4%. The only statistically significant effects observed across all AB Marina *M. edulis* tests relative to the site water results were detected for both survival rate (86.7%) and normal development rate (86.7%) calculated for the highest Basin 6 elutriate concentration. However the LC50 and EC50 values calculated for this treatment as well as for all AB Marina treatments evaluated with the *M. edulis* bioassay were >100%.

The copper chloride reference toxicant was tested at nominal concentrations of 2.5, 5.0, 10, 20 and 40 µg Cu²⁺/L. The calculated survival Cu LC50 of 15.1 µg Cu²⁺/L was within two standard deviations of the laboratory mean (20.7 ± 7.0 µg Cu²⁺/L). The calculated development Cu EC50 of 7.5 µg Cu²⁺/L was also within two standard deviations of the laboratory mean (8.4 ± 1.5 µg Cu²⁺/L), indicating that the sensitivity of the *M. edulis* used in the SPP assessment of AB Marina sediments fell within the normal range.

3.2.1.2 *Mysidopsis bahia* Test Results.

Test results for *Mysidopsis bahia* SPP bioassays performed with AB Marina sediment elutriates are summarized in Table 17. Water quality parameters in *M. bahia* SPP tests were within the recommended limits prescribed for this test species. The mean survival rate among laboratory control replicates was 100%, meeting the passing criteria for this test. The site water mean survival rate was also 100%. The mean survival rates calculated for the seven undiluted elutriates (100% treatments) ranged from 96 to 100%. Statistically significant effects were not detected among any of the AB Marina elutriate dilutions relative to the site-water control group. Consequently, the LC50 values were all >100%.

The copper sulfate reference toxicant was tested at nominal concentrations of 50, 100, 200, 400 and 800 µg Cu²⁺/L. The calculated LC50 was 222 µg Cu²⁺/L, which was within two standard deviations of the lab mean (413 ± 117 µg Cu²⁺/L), indicating normal *M. beryllina* sensitivity.

TABLE 16
Summary of *M. edulis* Water Column Toxicity Bioassay Results

Sample	Conc. (%)	Survival		Development	
		Mean % Survival	LC50 (%)	% Normal	EC50 (%)
Lab Control	-	90.0	NA	97.2	NA
Site Water	-	90.4	NA	96.3	NA
B1	10	92.2	> 100	97.4	> 100
	50	93.6		97.7	
	100	91.4		96.8	
B2	10	90.9	> 100	98.0	> 100
	50	94.6		97.4	
	100	90.7		96.9	
B3	10	92.9	> 100	96.7	> 100
	50	95.4		97.6	
	100	93.4		97.5	
B4	10	91.2	> 100	97.0	> 100
	50	93.1		97.1	
	100	89.8		96.9	
B5	10	95.0	> 100	97.7	> 100
	50	93.1		97.3	
	100	90.6		97.1	
B6	10	88.4	> 100	97.4	> 100
	50	91.2		97.6	
	100	86.7*		58.8*	
B7	10	94.4	> 100	96.7	> 100
	50	89.1		97.7	
	100	94.9		96.1	

* Statistically significant difference from the Site Water Control

Copper Sulfate Reference Toxicant				
Conc. (%)	Survival		Development	
	Mean % Survival	LC50 (µg/L)	% Normal	EC50(µg/L)
Control	95.3	15.136	97.5	7.519
2.5	88.1		92.2	
5.0	92.3		93.8	
10	86		4.9	
20	11.4		0	
40	0.1		0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

20.700
7.001
Normal

8.423
1.510
Normal

TABLE 17
Summary of *M. bahia* Water Column Toxicity Bioassay Results

Sample	Conc. (%)	Mean % Survival	LC50 (%)
Lab Control	-	100	NA
Site Water	-	100	NA
B1	10	100	> 100
	50	100	
	100	98.0	
B2	10	100	> 100
	50	100	
	100	100	
B3	10	100	> 100
	50	100	
	100	98.0	
B4	10	100	> 100
	50	98.0	
	100	96.0	
B5	10	100	> 100
	50	100	
	100	100	
B6	10	100	> 100
	50	98.0	
	100	98.0	
B7	10	100	> 100
	50	100	
	100	98.0	

Reference Toxicant					
Copper Sulfate Survival			Ammonia Survival		
Conc. (%)	Mean % Survival	LC50 (µg/L)	Conc. (%)	Mean % Survival	EC50(µg/L)
Control	100	222.133	Control	96.7	52.255
62.5	100		7.18	100	
125	100		14.3	100	
250	33.3		28.1	100	
500	16.7		55.3	43.3	
1000	3.3		106	0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

412.827
117.494
Normal

39.718
8.457
Normal

3.2.1.3 *Menidia beryllina* Test Results.

Test results for *Menidia beryllina* SPP bioassays performed with AB Marina sediment elutriates are summarized in Table 18. Water quality parameters in *M. beryllina* SPP tests were within the recommended limits prescribed for this test species. The mean survival rate among laboratory control replicates was 100%, meeting the passing criteria for this test. The site water mean survival rate was also 98%. The mean survival rates calculated for the seven undiluted elutriates (100% treatments) ranged from 86 to 100%. The only statistically significant effect detected among any of the elutriate dilutions relative to the site-water control group was observed with the 100% B4 elutriate (86% survival). However the LC50 and EC50 values calculated for this treatment as well as for all AB Marina treatments evaluated with the *M. edulis* bioassay were >100%.

The copper sulfate reference toxicant was tested at nominal concentrations of 50, 100, 200, 400 and 800 $\mu\text{g Cu}^{2+}/\text{L}$. The calculated LC50 was 798.8 $\mu\text{g Cu}^{2+}/\text{L}$, which fell outside two standard deviations of the lab mean ($197 \pm 87.6 \mu\text{g Cu}^{2+}/\text{L}$), indicating that *M. beryllina* sensitivity was lower than normal and detailed in Appendix D.

3.2.1.4 Limiting Permissible Concentration (LPC).

Due to the absence of significant effects in the water column toxicity tests performed with the AB Marina sediment elutriates, the LC and EC50 values were all >100%. Consequently, the toxicity threshold, or Limiting Permissible Concentration (LPC), for the AB Marina sediment fluid phase is not calculable but assumed to be >1%. Therefore, the concentration of the dredged material's fluid phase at the edge of the LA-2 mixing zone is expected to be substantially lower than the LPC, meeting the SPP criteria for aquatic disposal.

3.2.2 Solid Phase Testing

To assess the potential benthic impacts of AB Marina sediments deposited within the LA-2 aquatic environment, two SP bioassays were performed with project composite samples.

3.2.2.1 *Rhepoxinius abronius* 10-Day Test Results.

Results of this SP test conducted with *R. abronius* are summarized in Table 19. Required water quality parameters were monitored daily in each treatment and were consistently acceptable for the protocol. Mean control survival for the 10-day *R. abronius* test was 95%, meeting the ITM test acceptability criterion of 90%. The mean LA-2 reference site survival rate was 86%. The mean survival rate calculated for the AB Marina composite samples ranged from 26 to 40%. All seven AB Marina treatment survival rates were significantly different from the LA-2 survival rate.

The positive control reference toxicant used was cadmium chloride, tested at nominal concentrations of 0.25, 0.5, 1.0, 2.0, and 4.0 $\text{mg Cd}^{2+}/\text{L}$. The calculated Cd LC50 was 0.83 $\text{mg Cd}^{2+}/\text{L}$, which was not within two standard deviations of the laboratory mean ($0.75 \pm 0.33 \text{ mg Cd}^{2+}/\text{L}$), indicating that *R. abronius* sensitivity was within the normal range. The ammonia LC50 (69.6 $\text{mg NH}_3/\text{L}$) was also within the normal range of organism sensitivity.

TABLE 18
Summary of *M. beryllina* Water Column Toxicity Bioassay Results

SAMPLE	Conc. (%)	Mean % Survival	LC50 (%)
Lab Control	-	100	NA
Site Water	-	98	NA
B1	10	100	> 100
	50	98	
	100	100	
B2	10	98	> 100
	50	94	
	100	100	
B3	10	98	> 100
	50	98	
	100	92	
B4	10	98	> 100
	50	98	
	100	86*	
B5	10	98	> 100
	50	100	
	100	98	
B6	10	100	> 100
	50	94	
	100	94	
B7	10	100	> 100
	50	100	
	100	98	

* Statistically significant difference from the Site Water Control

Reference Toxicants					
Copper Sulfate Survival			Ammonia Survival		
Conc. (%)	Mean % Survival	LC50 (µg/L)	Conc. (%)	Mean % Survival	EC50(µg/L)
Control	100	199.437	Control	96.7	26.229
25	96.7		2.96	100	
50	100		6.75	93.3	
100	96.7		14.1	83.3	
200	50		27.9	46.7	
400	0		57.1	0	

Laboratory Mean E/LC50 (µg/L):
Standard Deviation:
Sensitivity:

197.188
87.637
Normal

32.386
18.029
Normal

TABLE 19
Test Sediment Data Summary – *R. abronius*

Sample I.D.	% Survival (Mean ± SD)	% Reduction from Reference*	% Survival per Replicate				
			1	2	3	4	5
Control	95	-	85	100	100	95	95
LA-2	86	-	95	85	60	95	95
B1	33*	53	40	25	20	40	40
B2	26*	60	25	25	15	35	30
B3	35*	51	20	45	30	35	45
B4	26*	60	30	25	15	30	30
B5	37*	49	50	35	20	30	50
B6	40*	46	50	25	45	40	40
B7	38*	48	45	60	10	40	35

* Statistically significant difference from the Site Water Control

Reference Toxicant Results					
Cadmium			Ammonia		
Conc. (mg/L)	% Survival	LC50 (mg/L)	mg NH ₃ /L	% Survival	LC50 (mg/L)
Control	97	0.827	Control	97	69.58
0.125	100		16.2	90	
0.25	100		31.2	90	
0.50	80		60	80	
1.0	33		124	0	
2.0	0		220	0	

Laboratory Mean LC₅₀ (mg/L):
Standard Deviation:
Sensitivity:

0.752
0.334
Normal

78.62
17.92
Normal

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3.2.2.2 *Neanthes arenaceodentata* 10-Day Static Test Results

Results for all tests conducted with *N. arenaceodentata* are summarized in Table 20. Relevant water quality parameters were monitored daily for each treatment and were consistently acceptable for the protocol. The mean LA-2 reference site survival rate was 98%. The mean survival rate calculated for the AB Marina composite samples ranged from 98 to 100%, indicating that the dredged material meets the polychaete SP criteria for aquatic disposal suitability.

The positive control reference toxicant used was cadmium chloride, tested at nominal concentrations of 2.5, 5, 10, 20, and 40 mg Cd²⁺/L. The calculated Cd LC50 was 8.8 mg Cd²⁺/L, which was within two standard deviations of the laboratory mean (10.5 ± 2.9 mg Cd²⁺/L), indicating that *N. caecoides* sensitivity fell within the normal range. The ammonia LC50 (127 mg NH₃/L) was also within the normal range of organism sensitivity.

3.3 BIOACCUMULATION POTENTIAL TESTS

3.3.1 Organism Exposures

Water quality parameters in the flow-through bioaccumulation exposures were within the recommended limits prescribed for the test species. At the end of 28 days, the test organisms were removed via a 1-mm screen, counted, and placed in a flow-through chamber without sediment for purging of gut contents for 24 hours. Mean survival for the bivalve clams ranged from 90.4 to 97.6% across the control, reference and all AB Marina sediment treatments. Mean survival for the bivalve clams ranged from 79.3 to 92.7% across the control, reference and all AB Marina sediment treatments. A summary of survival results for bioaccumulation test species is presented in Table 21.

3.3.2 Tissue Chemistry

Based on sediment chemistry results, tissues from BP test organisms exposed to AB Marina sediments were analyzed for DDT and metals residues. As discussed in Section 2.4, the chemistry laboratory staff composited tissues from all five replicates for each sample treatment, prohibiting statistical comparisons for individual sample areas. The results will however be discussed in terms of absolute comparisons to determine whether the limited data set may warrant a reduction in analytical scope for the analyses of test organism tissues as part of the current retest procedures. All tissue chemistry data is presented in Table 22.

3.3.2.1 *Macoma nasuta*

The DDT concentration reported for the LA-2 exposed *Macoma nasuta* tissues was <1.0 µg/kg. The DDT concentrations in *Macoma* tissues reported for the project site treatments ranged from <1.0 to 8.3 µg/kg wet weight, well below any of the following established environmental and human health protection criteria (all wet weight basis):

- National Academy of Sciences recommendation: 50 µg/kg
- National Sediment Quality Inventory Wildlife Criteria: 39.3 µg/kg
- NY/NJ Harbor Estuary Program Wildlife Value: 20 µg/kg
- U.S. EPA screening value for human health: 300 µg/kg

All metals detected in *M. nasuta* tissues exposed to AB Marina sediments with the exception of lead were seemingly consistent with the levels reported for LA-2 exposed *M. nasuta* tissues. The lead concentration reported for the LA-2 tissue composite was 0.270 mg/kg, while the AB Marina tissue composites ranged from 0.431 to 1.120 mg/kg.

TABLE 20
Test Sediment Data Summary – *N. arenaceodentata*

Sample I.D.	% Survival (Mean ± SD)	% Reduction from Reference*	% Survival per Replicate				
			1	2	3	4	5
Control	96	-	100	90	100	90	100
LA-2	98	-	100	100	100	90	100
B1	98	NA	100	90	100	100	100
B2	100	NA	100	100	100	100	100
B3	98	NA	100	100	90	100	100
B4	100	NA	100	100	100	100	100
B5	100	NA	100	100	100	100	100
B6	98	NA	100	100	100	90	100
B7	98	NA	100	90	100	100	100

NA = Not Applicable: Reference survival is lower than or equal to % survival results.

Reference Toxicant Results					
Cadmium			Ammonia		
Conc. (mg/L)	% Survival	LC50 (mg/L)	mg NH ₃ /L	% Survival	LC50 (mg/L)
Control	100	8.817	Control	80	126.95
3.75	100		17.6	93	
7.5	73		35.1	100	
15	0		63.6	100	
30	0		136	40	
60	0		250	0	

Laboratory Mean LC ₅₀ (mg/L):	10.531	105.50
Standard Deviation:	2.973	29.59
Sensitivity:	Normal	Normal

TABLE 21
Summary of Bioaccumulation Sediment Exposure Survival Results.

Sample ID	<i>Macoma nasuta</i> (% Survival)	<i>Nephtys caecoides</i> (% Survival)
Control	90.4	92.7
LA-2	96.0	87.7
B1	97.6	79.3
B2	96.8	83.3
B3	93.6	87.3
B4	92.8	86.0
B5	96.0	81.7
B6	95.2	81.0
B7	95.2	82.0

* Percent survival estimate based on initiation of test with 35 animals in replicate 1.

TABLE 22
Summary of Tissue Analysis for Bioaccumulation Tests with *M. nasuta* and *N. caecoides*

SAMPLE	SUBSTRATE	DDT (µg/Kg)	METALS (mg/kg)									
			Hg	Cd	Cr	Cu	Pb	Ni	Se	Ag	Zn	As
Background	Mn Tissue	<1.00	0.012	<0.100	<0.100	2.71	0.141	0.375	0.114	<0.100	12.0	2.30
	Nc Tissue	<1.00	0.024	0.190	0.641	6.83	0.138	0.919	0.886	<0.100	31.6	3.58
LA-2 Reference	Sediment	4.16	0.04	0.220	28.7	9.60	6.96	13.1	0.33	<0.15	50.8	3.59
	Mn Tissue	<1.00	0.011	<0.100	0.303	3.11	0.270	0.746	0.166	<0.100	16.0	3.20
	Nc Tissue	7.36	0.014	0.320	<0.100	3.66	0.206	0.616	0.691	<0.100	48.6	4.09
B1	Sediment	13.5	0.83	0.664	47.8	60.1	71.0	22.5	0.41	0.33	148	8.98
	Mn Tissue	7.58	0.018	<0.100	0.347	3.09	0.798	0.738	0.229	<0.100	16.4	2.61
	Nc Tissue	14.0	0.013	0.286	0.247	3.60	0.206	0.616	0.691	<0.100	48.6	4.09
B2	Sediment	11.7	0.36	0.747	41.5	49.2	72.1	18.9	0.37	0.34	135	6.05
	Mn Tissue	7.34	0.019	<0.100	0.307	3.68	0.802	0.725	0.258	<0.100	17.8	2.98
	Nc Tissue	9.62	<0.005	0.293	<0.100	3.47	0.255	0.689	0.648	<0.100	40.8	3.73
B3	Sediment	13.5	0.36	0.601	34.7	44.3	54.8	17.6	0.31	0.23	102	5.50
	Mn Tissue	8.27	0.018	<0.100	0.464	4.17	1.12	0.772	0.255	<0.100	20.9	2.90
	Nc Tissue	<1.00	<0.005	0.300	<0.100	3.33	0.269	0.577	0.606	<0.100	43.6	3.64
B4	Sediment	13.8	0.29	0.855	41.5	52.3	85.0	20.2	0.33	0.35	204	6.22
	Mn Tissue	7.80	<0.005	<0.100	0.344	2.99	0.829	0.719	0.179	<0.100	17.5	2.30
	Nc Tissue	11.6	0.008	0.269	<0.100	3.58	0.374	0.619	0.767	<0.100	42.6	3.77
B5	Sediment	12.5	0.31	0.901	50.8	56.0	97.9	22.7	0.47	0.46	155	7.33
	Mn Tissue	7.29	0.007	<0.100	0.330	3.28	0.817	0.615	0.132	<0.100	16.5	2.62
	Nc Tissue	12.1	0.005	0.294	0.111	4.48	0.399	0.705	0.816	<0.100	47.5	3.92
B6	Sediment	6.77	0.18	1.13	49.9	76.2	70.9	22.4	0.42	0.58	213	6.65
	Mn Tissue	<1.00	0.010	<0.100	0.187	3.09	0.431	0.908	0.358	<0.100	15.2	2.89
	Nc Tissue	23.2	0.005	0.325	0.110	4.98	0.284	0.679	0.462	<0.100	48.9	3.60
B7	Sediment	7.26	0.28	0.558	39.1	54.6	58.8	18.6	0.35	0.50	136	7.10
	Mn Tissue	6.89	0.015	<0.100	0.461	3.43	0.600	0.660	0.278	<0.100	16.5	2.74
	Nc Tissue	11.4	0.005	0.282	<0.100	4.24	0.278	0.684	0.746	<0.100	42.6	3.86

< Indicates concentrations are less than the corresponding method detection limit (MDL)

3.3.2.2 *Nephtys caecoides*

The DDT concentration reported for the LA-2 exposed *N. caecoides* tissues was 7.36 $\mu\text{g}/\text{kg}$. The DDT concentrations in *Macoma* tissues reported for the project site treatments ranged from <1.0 to 23.2 $\mu\text{g}/\text{kg}$ wet weight. Other than the 23.2 $\mu\text{g}/\text{kg}$ detected in the composite made from tissues exposed to Basin 6 sediments, none of the *Nephtys* tissue composites exhibited DDT concentrations above 14.0 $\mu\text{g}/\text{kg}$.

All metals detected in *N. caecoides* tissues exposed to AB Marina sediments, including lead, appear to be consistent with the levels reported for *N. caecoides* tissues exposed to the LA-2 reference sample.

4 DISCUSSION

4.1 CHEMICAL AND PHYSICAL ANALYSIS OF TEST SEDIMENTS

- The metals copper, mercury and lead were detected at levels above ER-L values in most AB Marina samples. Mercury measured in sample B6 was the one exception.
- Zinc was detected at levels above the ER-L value in samples B4, B5 and B6; and arsenic was detected above the ER-L in sample B1.
- With the exception of mercury detected in the Basin 1 sample (0.83 mg/kg), none of the measured metals exceeded more than 29% of the span between the ER-L and ER-M values.
- Mercury in the Basin 1 sample does not appear to exhibit bioaccumulative potential as the concentrations observed in the B1 composite tissue samples for both BP species were consistent with both the background (time = 0) and reference sediment tissues. If additional analyses are necessary to resolve the extent to which Basin 1 sediments exhibit higher mercury concentrations, results will be provided in an addendum to this report.
- With the exception of DDT and negligible concentrations of PAH constituents, organic contaminants were not detected in AB Marina sediments.
- DDT concentrations was detected in the LA-2 reference sample at 4.16 $\mu\text{g}/\text{kg}$, and ranged from 6.77 to 13.8 $\mu\text{g}/\text{kg}$ in AB Marina composite samples. Normalized to organic carbon content, the highest DDT concentration was 1.2 ppm OC. These values are higher than the ER-L, but below levels of significant concern as established by U.S. EPA Region IX, which determined that 7.5 ppm OC should be considered a site specific threshold for bioaccumulative concern for another coastal California harbor (USEPA 1998).

4.2 BIOASSAYS

- Significant toxicity was not observed with the polychaete SP or any of the three SPP tests
- The amphipod SP test using *Rhepoxinius abronius* exhibited significant toxicity among all AB Marina samples relative to the LA-2 reference treatments. This amphipod was selected based on previous performance in grain size profiles similar to those exhibited by the AB Marina sediments.
- Because the toxicity results do not vary significantly among the seven project samples ($\bar{x} = 34 \pm 5.6\%$), there is no significant correlation between contaminant concentrations or grain size constituents.
- The observed *R. abronius* survival rates contrast significantly with the high survival rates observed with each of the six other species tested under this study (see Table 24). Due to the absence of any significantly elevated contaminant concentrations, additional test procedures may be necessary to ascertain the relevance of the reduced *R. abronius* survival rates. Results of any additional testing will be provided in an addendum to this report.

4.3 BIOACCUMULATION STUDIES

- Due to the inadvertent compositing of the treatment tissue replicates, statistical analysis is not possible with the data currently available. Retesting has been initiated and tissue chemistry results will be provided as an addendum to this report.

TABLE 23
Mean Survival Rate Summary for SP and BP Tests

Species	Sample Identification						
	B-1	B-2	B-3	B-4	B-5	B-6	B-7
<i>R. abronius</i> (%)	33	26	35	26	37	40	38
<i>N. arenaceodentata</i> (%)	98	100	98	100	100	98	98
<i>M. nasuta</i> (%)	98	97	94	94	97	95	94
<i>N. caecoides</i> (%)	79	83	87	85	81	83	81
<i>M. edulis</i> (LC50)	>100	>100	>100	>100	>100	>100	>100
<i>M. bahia</i> (LC50)	>100	>100	>100	>100	>100	>100	>100
<i>M. beryllina</i> (LC50)	>100	>100	>100	>100	>100	>100	>100

- DDT and heavy metals were measured in tissues exposed to project and reference sediments. However, since sediment contaminant levels were generally low, tissue concentrations following 28-day exposures were not expected to be elevated.
- Although the absence of sample replication prohibited statistical comparisons between contaminant concentrations detected project samples and those detected in the LA-2 reference sample, a review of the tissue composite data shows that the only contaminant detected at a level substantially higher than the LA-2 tissues was lead measured in *M. nasuta* tissues.
- However, the *M. nasuta* lead concentrations (up to 1.12 mg/kg) is still below the tissue level of concern (2.8 mg/kg) as established by the Environmental Residue-Effects Database (ERED) generated by the U.S. Army Corps of Engineers (USACE 2005).

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**TIER III SEDIMENT CHARACTERIZATION REPORT APPENDICES
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