APPENDIX F

Dredged Material Characterization Report for Cap Sante Marina

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Dredge Material Characterizatio
Cap Sante Marina
Anacortes, Washington

HARTCROWSER
Delivering smarter solutions

Prepared for
Cap Sante Marina

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CONTENTS

CONTENTS (Continued)

Page

TABLES

FIGURES

CONTENTS (Continued) Page

DREDGE MATERIAL CHARACTERIZATION
CAP SANTE MARINA
ANACORTES, WASHINGTON

1.0 INTRODUCTION

This report presents the results of the Dredged Material Management Program (DMMP) sediment characterization performed at the Cap Sante Marina (Cap Sante) located in Anacortes, Washington (Figure 1). The purpose of this study is to characterize the sediments proposed to be removed by dredging at the site relative to the DMMP chemical, biological toxicity, and bioaccumulation criteria for deposit at the DMMP-designated Rosario Strait open water disposal site. This characterization of proposed dredge material is necessary to complete the permitting for the dredging project.

To complete the dredge material characterization of Cap Sante, sediment core samples were collected from each of the twelve Dredge Material Management Units (DMMUs) designated in the project Sampling and Analysis Plan (Hart Crowser, 1998; Figure 2). Composite samples representative of each of the twelve DMMUs were analyzed for DMMP-specified chemical, conventional, and grain size parameters. Additionally, as the result of marginal Screening Level (SL) exceedences of select Polycyclic Aromatic Hydrocarbons (PAHs) in a single DMMU (C8), biological toxicity testing was performed on sediment samples from that DMMU. Further, bioaccumulation testing was performed on composite samples representative of the nine DMMUs exceeding the DMMP-Bioaccumulation Trigger (BT) value for tributyltin.

The results of this dredge material characterization show that the proposed Cap Sante dredge materials meet the chemical, biological toxicity, and bioaccumulation suitability criteria for open-water disposal. Biological toxicity testing results indicate that the chemical SL exceedences detected in DMMU C8 do not result in significant toxicity to marine test organisms. Bioaccumulation testing shows that significant biological accumulation effects are not likely to result from exposure to the dredged materials exceeding the tributyltin BT.

This sediment characterization program was performed in accordance with the DMMP-approved Sampling and Analysis Plan (SAP; Hart Crowser, 1998) and Sampling Plan Addendum (Addendum; Hart Crowser, 1999) prepared for this project. Sediment sampling, handling, and analysis were conducted in general accordance with the protocols established by the DMMP (1998), Puget Sound Estuary Program (PSEP, 1989a, 1989b, and 1989c), and US Environmental

Protection Agency (EPA, 1983a, 1983b, 1986, 1991a, 1991b, and 1991c), as specified in the SAP and Addendum.

1.1 Background Information

The Port of Anacortes proposes to perform maintenance and navigational dredging at the Cap Sante Marina (Cap Sante) located on the eastern shoreline of the City of Anacortes (Figure 1). The project design elevation for Cap Sante is -12 feet Mean Lower Low Water (MLLW). Presently, the current mudline of much of the central basin of the marina lies between elevations -8 and -13 feet MLLW; whereas, along the boundaries of the marina, sediments comprising the dredge prism range up to 14 feet in thickness. The proposed dredge project will be conducted in two phases. The initial phase will be maintenance dredging of the southern marina basin. The second phase will be performed in the northern portion of the marina basin and along the marina boundaries. The estimated volume of dredge material is approximately 345,000 cubic yards (cy). The preferred disposal option for this project is the DMMP-designated Rosario Straight unconfined open-water site.

2.0 SEDIMENT SAMPLING AND ANALYSIS

2.1 Sample and Survey Location Control

Sampling locations for this study were selected to provide adequate spatial coverage of the proposed dredge prism material located within each of the twelve DMMUs identified for the project. Samples collected were intended to be representative of the sediment conditions of the dredge prism. In total, 47 locations within the project area were sampled as shown on Figure 2. Proposed sampling location C1-04 was not sampled due to foul weather conditions. Subsequently, sediment representative of C1-04 was not included in the composite analysis of DMMU C1

Sediment sampling was accomplished using the hand coring methodology described in the SAP. Initial sediment sampling was performed on February 17-23, 1999. Re-sampling for the purpose of collecting bioaccumulation test sediments was performed on January 12-14, 2000. A summary of field sampling results is presented in Table 1.

The sampling locations were surveyed using an on-board Differential Global Positioning System (GPS). Latitude and longitude coordinates for the sampling locations are presented in Table 1 Based on poor GPS coverage, several

sampling locations were hand surveyed using known points identified on a scaled map of the site.

2.2 Sediment Sampling, Handling, and Analysis

Upon retrieval of the sediment core samples, the acceptability of each core was assessed relative to the criteria established in the SAP. After acceptance, the core samples were logged and subsampled in the field. The composite samples were processed upon collection of the core sections contributing to each composite.

Processing of the sediment core samples consisted of opening the core sampler longitudinally and removing material representing the desired sample interval. After removal, material from each interval was placed into a designated stainless steel bowl for homogenization. Composite samples were created by homogenizing equal proportions of sediment from the respective core locations included in each composite. The sample compositing scheme used in this dredge material characterization study is presented in Table 2.

Once a given composite sample was retrieved, the sediment was well-homogenized before transfer to a specific sample container. After filling, sample containers were placed in a cooled ice chest for transport to the analytical laboratory under chain of custody procedures described in the SAP. Composite samples were analyzed for the DMMP chemicals of concern, including: metals, pore water tributyltin, semivolatile organics, chlorinated hydrocarbons, phthalates, phenols, volatile organics, pesticides, polychlorinated biphenyls (PCBs), and other miscellaneous extractables. Additionally, the sediment samples were analyzed for sediment conventionals and grain size. Sediment chemical analysis was performed by MultiChem Analytical Services and Columbia Analytical Services. Grain size analysis was performed by Hart Crowser. For the purposes of this investigation, only the composite samples representative of the proposed dredge material were collected and submitted for analysis, consistent with the DMMP-approved SAP.

Subsamples submitted for analysis of volatile and sulfide compounds were collected directly from the sediment sampler prior to homogenization. Volatile and sulfide subsamples are summarized in Table 2.

2.2.1 Biological Toxicity Testing

Based on the results of the chemical analysis, DMMP-specified biological toxicity testing was initiated on the composite sample collected from DMMU C8 during the initial round of sampling. Biological toxicity testing was performed by

Parametrix, Inc. Reference sediments for the biological toxicity testing were collected from Carr Inlet, Washington, by Bio-Marine Services.

2.2.1 Bioaccumulation Testing

As the result of tributyltin BT exceedences in DMMUs C1, C2, C6, C7, C8, C9, C10, C11, and C12, bioaccumulation testing was performed. Additional sediment was collected from Cap Sante in accordance with the project SAP and Addendum following the procedures described above. Sediment core samples were collected from the nine DMMUs containing sediments exceeding the tributyltin BT. Core samples were collected from the sampling locations established by the initial round of field work (Figure 2). Two test composite samples (COMP-1 and COMP-2) were created by mixing equal portions of sediment from DMMUs with pore water tributyltin concentrations less than 0.3 µg/L (C2, C6, C8, C9, C11, and C12) and greater than 0.3 µg/L (C1, C7, and C10) as shown on Figure 3. Composite test samples were submitted to Battelle Marine Sciences Laboratory for the bioaccumulation testing program described in the Addendum. Upon completion of the bioaccumulation test, tissue samples were transferred from Battelle to Columbia Analytical for analysis under the chain of custody procedures described in the SAP.

3.0 SEDIMENT PHYSICAL CHARACTERISTICS

Descriptions of the sediment core samples were recorded in the field. Discrete core sample descriptions are presented in Table 3.

Grain size distribution was determined for each composite sample following PSEP protocols. After analysis, the sample was classified in accordance with the Unified Soil Classification (USC) System. A summary of grain size results is presented in Table 4. Sediments composing the proposed dredge prism range from clayey Silt to slightly clayey, slightly gravelly Silt.

4.0 SEDIMENT CHEMICAL ANALYSIS RESULTS

4.1 Data Validation

Overall, the Data Quality Objectives (DQOs), as set forth in the Project Plan (Hart Crowser, 1998), were met, and the data for this project are acceptable for use as reported. No results were rejected as a result of the QA/QC review; therefore, data for this project are 100 percent complete.

A detailed chemical data quality review and laboratory certificates of analysis are presented in Appendix A. Results of the sediment chemical analysis, compared to DMMP chemical criteria are presented in Table 5.

4.2 Metals

Seven of the nine metals analyzed for were detected in twelve composite sediment samples. However, concentrations did not exceed DMMP Screening Levels (SL). Antimony and silver were not detected in the composite sediment samples.

4.3 Pore Water Tributyltin

Tributyltin was detected in the pore water of the twelve composite sediment samples initially analyzed. Concentrations exceeded DMMP SL and BT values in nine of the twelve samples. The SL and BT were not exceeded in composite samples C3, C4, and C5.

Pore water tributyltin was detected above the SL and BT in the two composite samples collected for bioaccumulation testing (Comp-1 and Comp-2).

4.4 Pesticide/PCBs

Neither pesticides nor PCBs were detected in the composite sediment samples analyzed.

4.5 Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)

Concentrations of LPAH compounds analyzed were detected in at least one of the composite sediment samples analyzed. The concentration of phenanthrene in composite sediment sample C8 exceeded its SL.

4.6 High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)

Concentrations of HPAH compounds analyzed were detected in at least one of the composite sediment samples analyzed. The concentrations of chrysene, fluoranthene, pyrene, and total HPAHs exceeded their respective SL in composite C8.

4.7 Phenols

Five phenol constituents were detected in the composite sediment samples , however, the concentrations were below their respective SL.

4.8 Phthalates

Four of the six phthalate compounds analyzed for were detected in the twelve composite sediment samples analyzed. No phthalates exceeded their respective SL.

4.9 Semivolatile Organic Compounds

Benzoic acid, benzyl alcohol, and dibenzofuran were detected in at least one composite sediment sample. However, concentrations of these detected constituents were below their respective SL.

4.10 Volatiles Organic Compounds

No volatile constituents were detected in the composite sediment samples analyzed.

5.0 SEDIMENT BIOLOGICAL TOXICITY TESTING RESULTS

Sediment biological toxicity testing consisted of bioassays conducted on one test sediment (representative of DMMU 8) and one reference sediment using amphipod, *Ampelisca abdita*; the larvae of a purple sea urchin, *Strongylocentrutus purpuratus*, and the benthic dwelling polychaete worm, *Neanthes arenaceodentata.* These tests were conducted in accordance with the DMMP guidance on sediment characterization.

5.1 Data Validation

With the exception explained below, the overall Data Quality Objectives (DQOs), as set forth in the project SAP, were met. The data for this project are considered acceptable for use as reported. No results were rejected as the outcome of the QA/QC review.

Due to limited test organism availability and time constraints on the collection of appropriate reference sediment samples, the Amphipod and Juvenile Polychaete bioassay testing was initiated two days beyond the DMMO holding time guidance of 56 days. Communications with the DMMO on this issue resulted in the agency approval of the delayed start time. Based on the quality review of data, these data are considered to be of acceptable quality and usable for open-water disposal suitability determination.

A detailed data quality review and the Parametrix biological toxicity testing results report are presented in Appendix B. A summary of biological testing

results compared to DMMP sediment quality guidelines is presented in Tables 5, 6, and 7.

5.2 10-Day Amphipod Acute Mortality Test (Ampelisca abdita)

Amphipod bioassay testing was performed on one Cap Sante composite sediment sample C8, one reference sediment, and one clean, negative control sediment using *Ampelisca abdita*. The results of this bioassay were interpreted relative to the DMMP Tier III Biological Testing Interpretive Criteria for dispersive disposal sites and summarized in Table 6. Results of the 10-day amphipod test show that sediments represented by composite sample C8 meet the DMMP suitability criteria for open-water disposal.

5.3 20-Day Juvenile Infaunal Growth Test (Neanthes arenaceodentata)

Juvenile infaunal growth testing was performed on one Cap Sante composite sediment sample C8, one reference sediment, and one clean, negative control sediment using *Neanthes arenaceodentata*. The results of this bioassay were interpreted relative to the DMMP Tier III Biological Testing Interpretive Criteria for dispersive disposal sites and summarized in Table 7. Results of the 20-day Juvenile infaunal growth test show that sediments represented by composite sample C8 meet the DMMP suitability criteria for open-water disposal.

5.4 Sediment Larval Test (Strongylocentrutus purpuratus)

Sediment larval testing was performed on one Cap Sante composite sediment sample C8, one reference sediment, and one clean, negative control sediment using *Strongylocentrutus purpuratus*. The results of this bioassay were interpreted relative to the DMMP Tier III Biological Testing Interpretive Criteria for dispersive disposal sites and summarized in Table 8. Results of the sediment larval test show that sediments represented by composite sample C8 exceed the numerical criteria for a 2-hit failure; however, the test results are not significantly different from the reference sediment test. In this case, the test sediment is considered to meet the DMMP suitability criteria for open-water disposal.

6.0 SEDIMENT BIOACCUMULATION TESTING RESULTS

Bioaccumulation testing consisted of a long-term exposure to sediments using adult bivalve, *Macoma nasuta*, and an adult polychaete, *Nephtys caecoides*, after which organism tissues were analyzed for tributyltin. Two test composite samples (COMP-1 and COMP-2) were created by mixing equal portions of sediment from DMMUs with pore water tributyltin concentrations less than 0.3 µg/L (C2, C6, C8, C9, C11, and C12) and greater than 0.3 µg/L (C1, C7, and

C10) as shown on Figure 3. The protocol is based on the EPA-approved methodology and guidance from the U.S. Army Corps of Engineers (Corps).

6.1 Data Validation

The overall DQOs, as set forth in the Addendum, were met. The data for this project are considered acceptable for use as reported. No results were rejected as the outcome of the QA/QC review.

A detailed data quality review and the Batelle bioaccumulation testing results report are presented in Appendix C. Analytical results of the bioaccumulation testing tributyltin analysis are presented in Table 9. A summary of bioaccumulation testing results compared to DMMP sediment quality guidelines is presented in Table 10.

6.2 45-Day Adult Bivalve Test (Macoma nasuta)

Adult bivalve bioaccumulation testing was performed on two Cap Sante composite sediment samples Comp-1 and Comp-2 and one reference sediment using *Macoma nasuta*. The results of this bioaccumulation test were interpreted relative to the DMMP Tier III Biological Testing Interpretive Criteria and summarized in Table 10. Results of the 45-day adult bivalve bioaccumulation test show that tributyltin did not accumulate at concentrations greater than the DMMP-specified target tissue concentration guidelines. Additionally, average tissue concentrations were determined to be significantly less than the action level. As a result, sediments represented by composite samples Comp-1 and Comp-2 are determined to meet the DMMP suitability criteria for open-water disposal.

6.3 45-Day Adult Polychaete Test (Nephtys caecoides)

Adult polychaete bioaccumulation testing was performed on two Cap Sante composite sediment samples Comp-1 and Comp-2 and one reference sediment using *Nephtys caecoides*. The results of this bioaccumulation test were interpreted relative to the DMMP Tier III Biological Testing Interpretive Criteria and summarized in Table 10. Results of the 45-day adult polychaete bioaccumulation test show that tributyltin did not accumulate at concentrations greater than the DMMP-specified target tissue concentration guidelines. Additionally, average tissue concentrations were determined to be significantly less than the action level. As a result, sediments represented by composite samples Comp-1 and Comp-2 are determined to meet the DMMP suitability criteria for open-water disposal.

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8.0 LIMITATIONS

Work for this project was performed, and this report prepared, in general accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the Port of Anacortes for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied is made.

Any questions regarding our work and this report, the presentation of the information, and the interpretation of the data are welcome and should be referred to the undersigned.

We trust that this report meets your needs.

Sincerely,

HART CROWSER, INC.

DRAFT

JOHN M. HERZOG PH.D.
Sediment Quality Specialist

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Table 1 - Summary of Field Sampling Results

Sample Location	North Coordinate	West Coordinate	Time	Tide Height in Feet	Mudline Elevation in Feet MLLW	Depth to Sediment in Feet	Core Length in Feet
DMMU C1							
C1-01	48° 30.804'	122°36.534'	12:00	4	-9.7	13.7	3.3
C1-02	48° 30.737'	122° 36.535'	13:40	4.3	-6.7	11.0	4.5
C1-03	48°30.752'	122°36.306'	15:00	5.7	-10.1	15.8	2.9
C1-04	No Data	No Data	NA	NA	NA	NA	NA
C1-05	48° 30.752'	122°36.306'	15:53	6.2	-8.3	14.5	4.7
C1-06	48°30.785'	122°36.269'	17:30	7.2	9.8	17.0	3.2
DMMU C2							
C2-01	48° 30.914'	122° 36.498'	15:20	1.3	-8.2	9.5	3.4
C2-02	48°30.936'	122°36.467'	17:00	1.4	-8.1	9.5	4.9
C2-03	48°30.941'	122°36.389'	17:40	1.9	-5.8	7.7	5.0
C2-04	No Data	No Data	16:30	1.2	1.2	0.0	3.8
DMMU C3							
C3-01	48° 30.933'	122° 36.259'	8:25	3.0	-8.0	3.3	5.0
C3-02	48°30.914'	122°36.253'	9:00	8.3	-0.2	8.5	5.0
C3-03	48°30.894'	122°36.224'	9:40	8.4	0.4	8.0	5.0
C3-04	48° 30.225'	122°36.211'	10:10	8.4	-0.9	7.5	5.0
DMMU C4							
C4-01	48° 30.858'	122° 36.227'	12:15	6.6	-2.7	9.3	5.0
C4-02	48° 30.847	122° 36.203'	11:40	7.4	-1.7	9.1	5.0
C4-03	48° 30.828'	122° 36.227'	12:30	6.3	-2.5	8.8	5.0
C4-04	48° 30.819'	122° 36.204'	12:00	6.9	-2.3	9.2	5.0
DMMU C5							
C4-01	48° 30.792'	122° 36.209'	14:15	2.5	-1.3	3.8	5.0
C4-02	48° 30.763'	122° 36.235'	13:00	3.3	-2.9	6.2	5.0
C4-03	48° 30.752'	122° 36.284'	11:00	4.3	-3.7	8.0	5.0
C4-04	No Data	No Data	10:00	6.9	-6.7	13.6	5.0
DMMU C6							
C6-01	No Data	No Data	15:00	4.0	-9.4	13.4	3.6
C6-02	48° 30.911'	122° 36.430'	15:20	4.3	-10.1	14.4	2.9
C6-03	48° 30.885'	122° 36.393'	15:45	4.8	-9.8	14.6	3.2
C6-04	48° 30.909'	122° 36.365'	16:15	5.3	-9.2	14.5	3.8
DMMU C7							
C7-01	48° 30.909'	122° 36.306'	15:45	1.2	10.5	11.7	2.5
C7-02	48° 30.877'	122° 36.251'	15:00	2.3	10.2	12.5	2.8
C7-03	48° 30.834'	122° 36.304'	16:00	1	11	12	2
C7-04	48° 30.831'	122° 36.267'	15:15	1.7	11.3	13	1.7

Table 1 - Summary of Field Sampling Results

Sample Location	North Coordinate	West Coordinate	Time	Tide Height in Feet	Mudline Elevation in Feet MLLW	Depth to Sediment in Feet	Core Length in Feet
DMMU C8							
C8-01	48° 30.894'	122° 36.505'	12:00	4.8	10.2	15	3
C8-02	48° 30.854'	122° 36.507'	1420	6.3	-9.9	16.2	3.4
C8-03	48° 30.839'	122° 36.436'	14:45	6.5	-10.5	17	2.5
C8-04	48° 30.842'	122° 36.352'	15:17	6.9	-10.1	17	2.9
DMMU C9							
C9-01	48° 30.825'	122° 36.496'	8:50	7.2	-10.5	17.7	2.5
C9-02	48° 30.80'	122° 36.469'	11:15	4.7	-9.9	14.6	3.1
C9-03	No Data	No Data	10:00	5.7	-11	16.7	2
C9-04	48° 30.800'	122° 36.389'	10:30	5.2	-10.1	15.3	2.9
DMMU C10							
C10-01	No Data	No Data	11:15	6.6	-9.3	15.8	3.7
C10-02	No Data	No Data	11:15	6.6	-8.2	14.8	4.8
C10-03	No Data	No Data	11:15	6.6	-9.6	16.2	3.4
C10-04	No Data	No Data	11:15	6.6	-9.9	16.5	3.1
DMMU C11							
C11-01	48° 30.753'	122° 36.502'	9:00	7.8	-9.2	17	3.8
C11-02	48° 30.753'	122° 36.470'	9:30	6.7	-8.6	15.3	4.4
C11-03	48° 30.755'	122° 36.421'	10:15	5.7	-9.1	14.8	3.9
C11-04	48° 30.755'	122° 36.391'	10:40	5.1	-9	14.1	4
DMMU C12							
C12-01	48° 30.745'	122° 36.497'	12:00	3.4	-10.3	13.7	2.7
C12-02	48° 30.723'	122° 36.444'	12:40	3.2	-9.5	12.7	3.5
C12-03	No Data	No Data	13:45	3.3	-9	12.3	4
C12-04	48° 30.723'	122° 36.395'	13:15	3.2	-8.8	12	4.2

NA- Not Applicable

No Data- Data were not collected due to GPS outages. Samples were located using hand survey techniques.

Table 2 - Sample Compositing Plan

Composite Sample Number	Core Sections
C1	C1-01A, C1-02A, C1-03A, C1-05A, C1-06A
C2	C2-01A, C2-02A, C2-03A, C2-04A
C3	C3-01A, C3-02A, C3-03A, C3-04A
C4	C4-01A, C4-02A, C4-03A, C4-04A
C5	C5-01A, C5-02A, C5-03A, C5-04A
C6	C6-01A, C6-02A, C6-03A, C6-04A
C7	C7-01A, C7-02A, C7-03A, C7-04A
C8	C8-01A, C8-02A, C8-03A, C8-04A
C9	C9-01A, C9-02A, C9-03A, C9-04A
C10	C10-01A, C10-02A, C10-03A, C10-04A
C11	C11-01A, C11-02A, C11-03A, C11-04A
C12	C12-01A, C12-02A, C12-03A, C12-04A
Comp-1	C1-01A, C1-02A, C1-03A, C1-05A, C1-06A, C10-01A, C10-02A, C10-03A, C10-04A, C7-01A, C7-02A, C7-03A, C7-04A
Comp-2	C2-01A, C2-02A, C2-03A, C2-04A, C6-01A, C6-02A, C6-03A, C6-04A, C8-01A, C8-02A, C8-03A, C8-04A, C9-01A, C9-02A, C9-03A, C9-04A, C11-01A, C11-02A, C11-03A, C11-04A, C12-01A, C12-02A, C12-03A, C12-04A

Smple Identification	Sample Depth Interval in Feet	Visual Sediment Description
C1-01	0.0 to 1.5	Soft, wet, brown organic SILT; trace shell fragments and worms.
	1.5 to 3.3	Medium stiff, wet, brown, organic SILT; wood fragments at 3.2 feet.
C1-02	0.0 to 0.6	Soft, wet, black SILT; trace shell fragments.
	0.6 to 2.6	Medium stiff, wet, brown, organic SILT; wood fragments at 3.2 feet; sand lens at 2.0 feet.
	2.6 to 3.2	Dense, wet, gray, silty, gravelly SAND; shell fragments.
C1-03	0.0 to 1.2	Medium stiff, wet, black, slightly gravelly, sandy SILT; metal scale; wood/shell fragments; slight sheen.
	1.2 to 2.7	Hard, green, silty CLAY.
C1-04	NA	NA
C1-05	0.0 to 1.1	Very soft, wet, brown, organic SILT.
	1.1 to 2.8	Soft, wet, brown, organic SILT;trace shell fragments/wood at 1.1 and 1.6 feet.
	2.8 to 3.2	Medium stiff, gray SILT.
C1-06	0.0 to 1.1	Soft, wet, brown, organic SILT; worms and shell fragments.
	1.1 to 1.2	Loose, wet, brown SAND.
	1.2 to 2.3	Soft, wet, brown approximately 50% wood chip/sawdust in SILT matrix.
C2-01	0.0 to 1.3	Very soft, wet, brown SILT; trace shells.
	1.3 to 2.6	Hard, wet, gray SILT.
C2-02	0.0 to 1.1	Soft, wet, brown, organic SILT.
	1.1 to 2.2	Medium dense, wet, gray, silty, fine SAND; abundant shell fragments.
	2.2 to 2.4	Hard, wet, gray SILT.
C2-03	0.0 to 1.0	Soft, wet, dark gray SILT; scattered shells.
	1.0 to 2.1	Dense, wet, gray, very sandy GRAVEL; mix of round and angular.
	2.1 to 3.55	Very stiff, wet, gray, clayey SILT.
C2-04	0.0 to 1.6	Soft, wet, brown, slightly sandy, slightly gravelly SILT; trace wood.
	1.6 to 2.7	Medium dense, wet, gray, silty, fine SAND; abundant shell fragments.
C3-01	0.0 to 0.25	Very soft, wet, brown SILT.
	0.25 to 0.8	Medium dense, wet, gray, silty SAND.
	0.8 to 1.63	Dense, wet, gray, slightly silty, very gravelly SAND.
	1.63 to 1.83	Stiff, wet, gray SILT.
	1.83 to 2.8	Dense, wet, gray, slightly silty, gravelly SAND.
C3-02	0.0 to 1.1	Soft, wet, brown, organic SILT; trace shell/wood fragments.
	1.1 to 3.0	Medium dense, wet, gray, silty, fine SAND; abundant shell fragments.
	3.0 to 3.8	Dense, wet, gray, gravelly SAND.
C3-03	0.0 to 2.8	Soft, wet, brown to gray, slightly sandy SILT; shell fragments; areas of organics; occasional gravel; rusted iron.
	2.8 to 3.0	Soft, wet, gray SILT; shell fragments.
	3.0 to 3.7	Dense, wet, gray, silty, gravelly SAND.
C3-04	0.0 to 2.8	Soft, wet, dark gray, slightly sandy SILT; abundant shell fragments; live worm; trace wood.
	2.8 to 3.5	Dense, wet, gray, silty, gravelly SAND.
C4-01	0.0 to 0.4	Very soft, wet, brown SILT.
	0.4 to 1.3	Soft, wet, gray, slightly sandy SILT; scattered shell fragments.
	1.3 to 3.4	Stiff, wet, gray SILT; abundant shell fragments; trace wood.
	3.4 to 3.8	Fibrous PEAT, w/gray SILT interbeds.
C4-02	0.0 to 0.9	Very soft, wet, dark gray, slightly sandy SILT; scattered shell fragments.
	0.9 to 3.0	Medium stiff, wet, gray SILT; abundant shell fragments.
	3.0 to 4.1	Fibrous PEAT, w/ 1-inch SILT interbeds; scattered twigs and wood.

4974/CapTables.xls - Table 3

Smple Identification	Sample Depth Interval in Feet	Visual Sediment Description
C4-03	0.0 to 1.0	Very soft, wet, dark gray, slightly sandy SILT.
	1.0 to 3.9	Medium stiff, wet, gray SILT; abundant shell fragments.
C4-04	0.0 to 1.2	Soft, wet, dark gray, slightly sandy SILT; wood and trace shells.
	1.2 to 2.8	Medium stiff, wet, gray SILT; abundant shell fragments.
	2.8 to 3.6	PEAT, w/silt interbeds (up to 2inches).
C5-01	0.0 to 0.8	Very soft, wet, brown SILT; live clams; trace eel grass.
	0.8 to 2.2	Soft, wet, gray, slightly sandy SILT; abundant shell fragments.
	2.2 to 3.2	Soft, wet, brown, organic SILT; twigs and wood.
	3.2 to 3.6	Soft, wet, brown, clayey SILT.
	3.6 to 4.4	Soft, wet, brown, organic SILT; wood fragments.
C5-02	0.0 to 0.2	Very soft, wet, brown SILT; eelgrass.
	0.2 to 1.9	Medium dense, wet, gray, silty SAND; abundant shell fragments.
	1.9 to 3.8	Medium dense, wet, gray, very silty, fine SAND; abundant shell fragments.
	3.9 to 4.0	White, chalky volcanic ASH layer (1-inch).
	4.0 to 4.6	Soft, wet, brown, fibrous PEAT.
C5-03	0.0 to 1.0	Soft, wet, organic SILT; trace shells.
	1.0 to 2.0	Medium dense, wet, gray, slightly silty, gravelly SAND; abundant shells.
	2.0 to 2.55	Stiff, wet, gray, slightly sandy SILT; shells.
	2.55 to 3.0	Medium dense, wet, gray, slightly sandy SILT; scattered GRAVEL/shells.
	3.0 to 3.4	Stiff, wet, gray, sandy SILT; shells.
	3.4 to 4.3	Dense, wet, gray, fine SAND; shell fragments.
C5-04	0.0 to 0.25	Soft, wet, brown SILT.
	0.25 to 1.2	Medium dense, wet, gray, slightly silty, gravelly SAND; trace shell fragments.
	1.2 to 3.2	Soft, wet, brown to gray, organic SILT; abundant wood; trace shells; fibrous peat at 2.5 to 3.0 feet.
	3.2 to 4.3	Soft, wet, yellow ASH with abundant shells; SILT laminae interbedded.
C6-01	0.0 to 1.2	Very soft, wet, brown, organic SILT.
	1.2 to 2.0	Soft, wet, brown, organic SILT.
	2.0 to 3.0	Very stiff, wet, gray, clayey SILT; trace SAND.
C6-02	0.0 to 1.0	Very soft, wet, brown, organic SILT; trace shell fragments.
	1.0 to 2.2	Soft, wet, brown, organic SILT; approximately 20% sawdust and wood; SILT lenses (1.8 and 2.0 feet).
C6-03	0.0 to 1.6	Soft, wet, black to brown SILT; trace shell fragments; H_2S odor.
	1.6 to 2.3	Soft, wet, brown SILT; approximately 50% sawdust and wood chips.
C6-04	0.0 to 1.8	Soft, wet, brown, organic SILT; approximately 50% wood chips (1.0 to 1.2 feet).
	1.8 to 3.1	Dense, wet, gray, medium to fine SAND; brown, silty SAND laminae.
C7-01	0.0 to 0.6	Very soft, wet, dark gray SILT.
	0.6 to 2.6	Medium stiff, wet, gray SILT; abundant shell fragments.
C7-02	0.0 to 1.4	Very soft, wet, brown, organic SILT; wood and trace shells.
	1.4 to 2.0	Medium stiff, wet, gray SILT; abundant shells.
	2.0 to 2.3	Dense, wet, gray, gravelly SAND; shells.
C7-03	0.0 to 0.5	Soft, wet, gray SILT.
	0.5 to 1.8	Medium stiff, wet, gray SILT; abundant shell fragments.
C7-04	0.0 to 0.6	Very soft, wet, brown, organic SILT.
	0.6 to 2.2	Fibrous PEAT.
C8-01	0.0 to 0.8	Soft, wet, black SILT; trace shells.
	0.8 to 1.2	Medium dense, wet, gray, silty SAND.
	1.2 to 2.4	Hard, moist to wet, gray SILT; fine stratification/laminae.

4974/CapTables.xls - Table 3

Smple Identification	Sample Depth Interval in Feet	Visual Sediment Description
C8-02	0.0 to 2.9	Soft, wet, black, organic SILT; shell fragments at surface and 2.0 feet.
C8-03	0.0 to 1.4	Soft, wet, brown, organic SILT.
	1.4 to 2.0	Medium stiff, wet, brown, organic SILT.
C8-04	0.0 to 2.2	Soft, wet, brown, organic SILT; wood at 0.4 and 1.8 feet.
C9-01	0.0 to 1.5	(Light green SILT dusting over) soft, wet, brown, organic SILT; trace shell fragments.
	1.5 to 2.7	Medium stiff, wet, brown, organic SILT.
C9-02	0.0 to 1.6	Soft, wet, brown, organic SILT; trace shells; strong H_2S odor.
	1.6 to 2.3	Soft, wet, brown, organic SILT; approximaely 25% sawdust/wood fiber.
C9-03	0.0 to 1.4	Soft, wet, brown, organic SILT; trace shell fragments; H_2S odor; metal scale at approximately 1.0 foot.
	1.4 to 2.2	Medium stiff, wet, brown, organic SILT; wood.
C9-04	0.0 to 1.5	Soft, wet, brown, organic SILT; trace shell fragments; H_2S odor.
	1.5 to 2.0	Soft-med. stiff, wet, brown, organic SILT; trace wood.
C10-01	0.0 to 0.8	Very soft, wet, brown, organic SILT; trace shell fragments/wood.
	0.8 to 2.1	Soft, wet, brown, organic SILT; occasional shell fragments.
	2.1 to 2.5	Medium stiff, wet, gray SILT; occasional shell fragments.
	2.5 to 2.9	Dense, wet, gray, slightly gravelly, silty SAND.
C10-02	0.0 to 0.7	Very soft, wet, brown, organic SILT; trace shell fragments.
	0.7 to 3.1	Soft, wet, brown, organic SILT; trace wood/ grasses.
	3.1 to 3.9	Medium stiff, wet, brown, organic SILT; abundant shell fragments; trace wood.
C10-03	0.0 to 0.8	Very soft, wet, dark gray SILT.
	0.8 to 1.6	Soft, wet, brown, organic SILT.
	1.6 to 2.3	Medium stiff, wet, light brown, clayey SILT.
C10-04	0.0 to 1.0	Very soft, wet, dark gray SILT.
	1.0 to 2.2	Soft, wet, brown, organic SILT.
C11-01	0.0 to 0.6	Very soft, wet, green-brown SILT.
	0.6 to 2.4	Soft, wet, brown, organic SILT; scattered shell fragments; trace wood.
	2.4 to 2.8	Medium stiff to stiff, wet, brown SILT; abundant shell fragments; trace wood.
	2.8 to 3.2	Dense, wet, gray, slightly silty, gravelly SAND; abundant shell fragments.
C11-02	0.0 to 1.3	Very soft, wet, green-brown, organic SILT; trace shell fragments; slight sheen.
	1.3 to 3.1	Soft, wet, brown, organic SILT; scattered shell fragments; 2- by 3-inch aluminum sheeting at 2.4 feet.
C11-03	0.0 to 2.0	Soft, wet, brown, organic SILT; shell fragments; wood/bark at 2.0 feet.
	2.0 to 2.8	Soft to medium stiff, wet, brown, organic SILT; wood/bark at 2.1 feet.
C11-04	0.0 to 1.1	Very soft, wet, brown, organic SILT.
	1.1 to 1.8	Soft, wet, brown, organic SILT.
	1.8 to 2.6	Medium stiff, wet, brown, organic SILT; trace shell fragments.
C12-01	0.0 to 0.63	Soft, wet, brown, organic SILT; trace shell fragments.
	0.63 to 0.96	Wood and sawdust.
	0.96 to 1.00	SAND lens.
	1.0 to 2.2	Stiff, wet, gray, slightly sandy SILT; abundant shell fragments.
C12-02	0.0 to 1.15	Soft, wet, brown, organic SILT; trace sea grasses/shell fragments.
	1.15 to 1.25	Sawdust and wood chips; trace SAND layer at 1.25 feet.
	1.25 to 2.4	Stiff, gray, slightly sandy SILT; abundant shell fragments.

Smple Identification	Sample Depth Interval in Feet	Visual Sediment Description
C12-03	0.0 to 1.8	Very soft, wet, gray-black, organic SILT; piece of nylon rope at 0.6 foot.
	1.8 to 2.4	Sawdust and wood chips; trace SAND at 2.4 feet.
	2.4 to 3.0	Medium stiff, wet, gray SILT; abundant shell fragments.
C12-04	0.0 to 0.8	Very soft, wet, brown, organic SILT; trace shell fragments; H_2S odor.
	0.8 to 1.3	Sawdust and wood chips.
	1.3 to 1.34	Small SAND lens; scattered shells.
	1.34 to 3.1	Medium stiff, wet, gray, slightly sandy SILT; abundant shell fragments.

Table 4 - Summary of Grain Size Characterization Results

Sample Identification	Gravel in Percent	Sand in Percent	Silt in Percent	Clay in Percent	Sediment Description
C1	0	26	54	20	Clayey, sandy SILT
C2	3	27	50	20	Clayey, sandy SILT
C3	12	47	35	6	Slightly clayey, slightly gravelly silty SAND
C4	1	21	57	21	Clayey, sandy SILT
C5	15	47	28	10	Slightly clayey, slightly gravelly silty SAND
C6	0	44	41	15	Clayey, very sandy SILT
C7	0	13	65	22	Sandy, clayey SILT
C8	0	15	71	14	Clayey, sandy SILT
C9	0	5	73	22	Clayey SILT
C10	0	7	68	25	Slightly sandy, clayey SILT
C10 Dup	0	7	68	25	Slightly sandy, clayey SILT
C10 Trip	0	9	69	22	Slightly sandy, clayey SILT
C11	0	4	70	26	Clayey SILT
C12	0	16	59	25	Sandy, clayey SILT

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID	PSDDA	902026-8	902036-8	902036-11	902036-14	902036-2
Sample ID	SL	C1	C2	C3	C4	C5
Conventionals in %						
Ammonia As Nitrogen		66	22	5.3	12	24
Moisture			50	34	40	56
Total Organic Carbon		3.6	3.5	1.4	1.8	4.5
Total Solids		53	53.4	68.6	60.7	59.2
Total Sulfide		270	200	310	100	200
Total Volatile Solids		9.39	6.94	3.36	4.35	8.29
Metals in mg/kg						
Antimony	150	5.8 U	5.5 U	3.9 U	4.6 U	4.7 U
Arsenic	57	6.4	5.2	5.1	4.8	5.5
Cadmium	5.1	0.58 U	0.55 U	0.39 U	0.46 U	0.47 U
Copper	390	55	43	21	20	22
Lead	450	26	12	7.6	7.2	8.6
Mercury	0.41	0.21 U	0.2 U	0.16 U	0.17 U	0.18 U
Nickel	140	26	28	15	19	18
Silver	6.1	1.2 U	1.1 U	0.78 U	0.92 U	0.95 U
Zinc	410	95 J	77 J	49 J	46	44 J
Pore Water TBT in µg/L						
Tributyltin	0.15 *	0.47	0.20	0.015	0.02	0.03
Tetra-n-butyltin						
Di-n-butyltin						
n-Butyltin						
LPAHs in mg/kg						
2-Methylnaphthalene	0.67	0.036	0.011 J	0.007 J	0.032 U	0.014 J
Acenaphthene	0.5	0.05	0.008 J	0.017 U	0.019 U	0.024
Acenaphthylene	0.56	0.023	0.033	0.012 J	0.021 U	0.005 J
Anthracene	0.96	0.11	0.072	0.034 J	0.01 J	0.034 J
Fluorene	0.54	0.045	0.027	0.021	0.016 J	0.028
Naphthalene	2.1	0.11	0.094	0.058	0.06	0.085
Phenanthrene	1.5	0.22	0.23	0.16	0.061	0.16
Total LPAHs	5.2	0.558	0.464	0.285	0.147	0.336
HPAHs in mg/kg						
Benzo(a)anthracene	1.3	0.2	0.26	0.093	0.025 J	0.082
Benzo(a)pyrene	1.6	0.13	0.29	0.099	0.026	0.067
Benzo(b)fluoranthene		0.33 T	0.61 T	0.15 T	0.052 TJ	0.17 T
Benzo(g,h,i)perylene	0.67	0.067	0.18	0.059	0.016 J	0.036
Benzo(k)fluoranthene		0.33 T	0.61 T	0.15 T	0.052 TJ	0.17 T
Chrysene	1.4	0.29	0.46	0.11	0.043	0.18
Dibenz(a,h)anthracene	0.23	0.035	0.027	0.012 J	0.021 U	0.019 U
Fluoranthene	1.7	1.1	0.47	0.39	0.089	0.34
Indeno(1,2,3-cd)pyrene	0.6	0.065	0.16	0.051	0.022 U	0.032
Pyrene	2.6	0.44	0.59	0.22	0.1	0.35
Total Benzofluoranthenes	3.2	0.33	0.61	0.15	0.052 J	0.17
Total HPAHs	12	2.987	3.657	1.334	0.403	1.427
Semivolatiles in mg/kg						
1,2,4-Trichlorobenzene	0.031	0.023 U	0.031 U	0.028 U	0.031 U	0.028 U
Dibenzofuran	0.54	0.047	0.009 J	0.02 U	0.022 U	0.024
N-Nitrosodiphenylamine	0.028	0.017 U	0.023 U	0.021 U	0.023 U	0.021 U
Semivolatiles in µg/kg						
Benzoic Acid	650	49 J	50 J	14 J	14 J	19 J

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID Sample ID	PSDDA SL	902026-8 C1	902036-8 C2	902036-11 C3	902036-14 C4	902036-2 C5
Benzyl Alcohol	57	3.2 J	0.77 J	33 U	36 U	0.74 J
Phenols in µg/kg						
2,4-Dimethylphenol	29	3.4 J	1.3 J	0.65 J	15 U	0.96 J
2-Methylphenol	63	3.5 J	33 U	30 U	33 U	29 U
4-Methylphenol	670	190	74	51	67	63
Pentachlorophenol	400	6.5 J	2.7 J	48 U	53 U	1 J
Phenol	420	39 J	15 J	18 J	18 J	10 U
Phthalates in mg/kg						
Bis(2-ethylhexyl)phthalate	8.3	0.15	0.18	0.023 UJ	0.046 UJ	0.055 UJ
Butylbenzylphthalate	0.97	0.02 J	0.11 U	0.049 U	0.053 U	0.048 U
Di-n-butylphthalate	5.1	0.021 UJ	0.036 U	0.033 U	0.036 U	0.032 U
Di-n-octylphthalate	6.2	0.038 U	0.13	0.047 U	0.052 U	0.047 U
Diethylphthalate	1.2	0.028 U	0.038 U	0.035 U	0.038 U	0.034 U
Dimethylphthalate	1.4	0.025	0.014 J	0.031 U	0.034 U	0.03 U
Pesticide/PCBs in mg/kg						
Aroclor 1016		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1221		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1232		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1242		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1248		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1254		0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aroclor 1260		0.077 U	0.067 U	0.051 U	0.056 U	0.06 U
Total PCBs	0.13	0.071 U	0.067 U	0.051 U	0.056 U	0.06 U
Aldrin	0.01	0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Alpha-Chlordane		0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Dieldrin	0.01	0.007 U	0.007 U	0.005 U	0.006 U	0.006 U
Gamma-BHC (Lindane)		0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Heptachlor	0.01	0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Hexachlorobenzene	0.022	0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Hexachlorobutadiene	0.029	0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Hexachloroethane	1.4	0.029 U	0.04 UJ	0.037 UJ	0.04 UJ	0.036 UJ
P,P'-DDD		0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
P,P'-DDE		0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
P,P'-DDT		0.004 U	0.003 U	0.003 U	0.003 U	0.003 U
Volatiles in mg/kg						
1,2-Dichlorobenzene	0.035	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
1,3-Dichlorobenzene	0.17	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
1,4-Dichlorobenzene	0.11	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
Ethylbenzene	0.01	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
Tetrachloroethene	0.057	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
Total Xylenes	0.04	0.004 U	0.004 U	0.003 U	0.003 U	0.005 U
Trichloroethene		0.004 U	0.004 U	0.003 U	0.003 U	0.005 U

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID	PSDDA	902028-8	902036-17	902026-2	902026-5	902036-5
Sample ID	SL	C6	C7	C8	C9	C10
Conventionals in %						
Ammonia As Nitrogen		20	40	58	80	67
Moisture		43	54			57
Total Organic Carbon		1.9 J	3	3.2	3.9	3.7
Total Solids			45.3	40	59	47.3
Total Sulfide		380	220	870	930	130
Total Volatile Solids		4.34	9.22	7.51	9.3	16.4
Metals in mg/kg						
Antimony	150	4.8 U	5.8 U	5.5 U	6.5 U	6.2 U
Arsenic	57	4.2	5.9	5.5	6.4	5.3
Cadmium	5.1	0.48 U	0.58 U	0.55 U	0.65	0.62 U
Copper	390	33	48	51	59	64
Lead	450	7.7	10	19	26	25
Mercury	0.41	0.18 U	0.21 U	0.2 U	0.24 U	0.27
Nickel	140	21	24	30	32	27
Silver	6.1	0.97 U	1.2 U	1.1 U	1.3 U	1.2 U
Zinc	410	58	120 J	90 J	110 J	92 J
Pore Water TBT in µg/L						
Tributyltin	0.15	0.18	0.34	0.29	0.24	0.32
Tetra-n-butyltin						
Di-n-butyltin						
n-Butyltin						
LPAHs in mg/kg						
2-Methylnaphthalene	0.67	0.022 U	0.017 J	0.003 J	0.004 J	0.005 J
Acenaphthene	0.5	0.011 J	0.02	0.03 J	0.024	0.019 U
Acenaphthylene	0.56	0.017	0.059	0.031 J	0.02	0.004 J
Anthracene	0.96	0.023 J	0.15	0.11	0.033	0.027 J
Fluorene	0.54	0.022	0.056	0.1	0.03	0.019 J
Naphthalene	2.1	0.016 J	0.063	0.014 J	0.027	0.028 J
Phenanthrene	1.5	0.071	0.34	1.8	0.13	0.13
Total LPAHs	5.2	0.16	0.688	2.085	0.264	0.208
HPAHs in mg/kg						
Benzo(a)anthracene	1.3	0.063	0.33	0.47	0.091	0.083
Benzo(a)pyrene	1.6	0.064	0.29	0.25	0.087	0.074
Benzo(b)fluoranthene		0.19 T	0.47 T	1.9 T	0.16 T	0.17 T
Benzo(g,h,i)perylene	0.67	0.035	0.21	0.13	0.058	0.042
Benzo(k)fluoranthene		0.19 T	0.47 T	1.9 T	0.16 T	0.17 T
Chrysene	1.4	0.12	0.41	1.5	0.14	0.19
Dibenz(a,h)anthracene	0.23	0.014 J	0.071	0.062 J	0.027	0.021 U
Fluoranthene	1.7	0.19	0.78	5.2	0.25	0.27
Indeno(1,2,3-cd)pyrene	0.6	0.034	0.18	0.14	0.054	0.037
Pyrene	2.6	0.22	0.7	3	0.25	0.26
Total Benzofluoranthenes	3.2	0.19	0.47	1.9	0.16	0.17
Total HPAHs	12	1.12	3.911	14.55	1.277	1.296
Semivolatiles in mg/kg						
1,2,4-Trichlorobenzene	0.031	0.021 U	0.029 U	0.022 U	0.022 U	0.031 U
Dibenzofuran	0.54	0.009 J	0.028	0.055 J	0.019	0.022 U
N-Nitrosodiphenylamine	0.028	0.016 U	0.022 U	0.016 U	0.016 U	0.023 U
Semivolatiles in µg/kg						
Benzoic Acid	650	18 J	26 J	43 J	43 J	53 J

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID	PSDDA	902028-8	902036-17	902026-2	902026-5	902036-5
Sample ID	SL	C6	C7	C8	C9	C10
Benzyl Alcohol	57	49 U	0.83 J	1.9 J	1.9 J	5 J
Phenols in µg/kg						
2,4-Dimethylphenol	29	21 U	1.4 J	1.3 J	1.4 J	1.3 J
2-Methylphenol	63	45 U	30 U	1.4 J	2.4 J	33 U
4-Methylphenol	670	26 J	56	55	130	140
Pentachlorophenol	400	2.1 J	2.2 J	11 J	8 J	4.5 J
Phenol	420	8 U	16 J	30 J	36 J	31
Phthalates in mg/kg						
Bis(2-ethylhexyl)phthalate	8.3	0.089	0.14	0.11	0.12	0.13
Butylbenzylphthalate	0.97	0.036 U	0.05 U	0.037 U	0.038 U	0.053 U
Di-n-butylphthalate	5.1	0.025 U	0.034 U	0.025 U	0.02 UJ	0.036 U
Di-n-octylphthalate	6.2	0.036 U	0.049 U	0.036 U	0.037 U	0.052 U
Diethylphthalate	1.2	0.026 U	0.035 U	0.026 U	0.027 U	0.038 U
Dimethylphthalate	1.4	0.009 J	0.008 J	0.014 J	0.017 J	0.034 U
Pesticide/PCBs in mg/kg						
Aroclor 1016		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1221		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1232		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1242		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1248		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1254		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aroclor 1260		0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Total PCBs	0.13	0.061 U	0.072 U	0.068 U	0.079 U	0.078 U
Aldrin	0.01	0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Alpha-Chlordane		0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Dieldrin	0.01	0.006 U	0.007 U	0.007 U	0.008 U	0.008 U
Gamma-BHC (Lindane)		0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Heptachlor	0.01	0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Hexachlorobenzene	0.022	0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Hexachlorobutadiene	0.029	0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Hexachloroethane	1.4	0.028 UJ	0.038 UJ	0.028 U	0.029 U	0.04 UJ
P,P'-DDD		0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
P,P'-DDE		0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
P,P'-DDT		0.003 U	0.004 U	0.003 U	0.004 U	0.004 U
Volatiles in mg/kg						
1,2-Dichlorobenzene	0.035	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
1,3-Dichlorobenzene	0.17	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
1,4-Dichlorobenzene	0.11	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
Ethylbenzene	0.01	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
Tetrachloroethene	0.057	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
Total Xylenes	0.04	0.004 U	0.004 U	0.003 U	0.005 U	0.004 U
Trichloroethene		0.004 U	0.004 U	0.003 U	0.005 U	0.004 U

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID	PSDDA	902028-2	902028-5	902026-10	K2000363-002	K2000363-001
Sample ID	SL	C11	C12	TRIP BLANK	COMP-2	COMP-1
Conventionals in %						
Ammonia As Nitrogen		76	35			
Moisture		57	41			
Total Organic Carbon		4.1 J	3.9 J			
Total Solids						
Total Sulfide		640	70			
Total Volatile Solids		9.08	8.48			
Metals in mg/kg						
Antimony	150	6.2 U	5.6 U			
Arsenic	57	6.8	6.3			
Cadmium	5.1	0.78	0.6			
Copper	390	67	280			
Lead	450	33	23			
Mercury	0.41	0.23	0.22 U			
Nickel	140	33	27			
Silver	6.1	2.5 U	1.1 U			
Zinc	410	120	100			
Pore Water TBT in µg/L						
Tributyltin	0.15	0.27	0.20		0.30	0.29
Tetra-n-butyltin					0.05 U	0.05 U
Di-n-butyltin					0.05 U	0.05 U
n-Butyltin					0.05 U	0.05 U
LPAHs in mg/kg						
2-Methylnaphthalene	0.67	0.021 J	0.004 J			
Acenaphthene	0.5	0.022	0.017			
Acenaphthylene	0.56	0.03	0.021			
Anthracene	0.96	0.088	0.051			
Fluorene	0.54	0.036	0.029			
Naphthalene	2.1	0.053	0.04			
Phenanthrene	1.5	0.2	0.21			
Total LPAHs	5.2	0.429	0.368			
HPAHs in mg/kg						
Benzo(a)anthracene	1.3	0.22	0.14			
Benzo(a)pyrene	1.6	0.18	0.16			
Benzo(b)fluoranthene		0.46 T	0.48 T			
Benzo(g,h,i)perylene	0.67	0.14	0.093			
Benzo(k)fluoranthene		0.46 T	0.48 T			
Chrysene	1.4	0.33	0.26			
Dibenz(a,h)anthracene	0.23	0.057	0.045			
Fluoranthene	1.7	0.58	0.5			
Indeno(1,2,3-cd)pyrene	0.6	0.12	0.091			
Pyrene	2.6	0.56	0.39			
Total Benzofluoranthenes	3.2	0.46	0.48			
Total HPAHs	12	3.107	2.639			
Semivolatiles in mg/kg						
1,2,4-Trichlorobenzene	0.031	0.023 U	0.023 U			
Dibenzofuran	0.54	0.016 U	0.016			
N-Nitrosodiphenylamine	0.028	0.017 U	0.017 U			
Semivolatiles in µg/kg						
Benzoic Acid	650	46 J	32 J			

Table 5 - Chemical Analysis Results for Sediment Samples

Lab ID	PSDDA	902028-2	902028-5	902026-10	K2000363-002	K2000363-001
Sample ID	SL	C11	C12	TRIP BLANK	COMP-2	COMP-1
Benzyl Alcohol	57	2.1 J	1.6 J			
Phenols in µg/kg						
2,4-Dimethylphenol	29	2.9 J	1.9 J			
2-Methylphenol	63	2.7 J	2.4 J			
4-Methylphenol	670	140	190			
Pentachlorophenol	400	26 J	24 J			
Phenol	420	30 J	20 J			
Phthalates in mg/kg						
Bis(2-ethylhexyl)phthalate	8.3	0.16	0.2			
Butylbenzylphthalate	0.97	0.039 U	0.04 U			
Di-n-butylphthalate	5.1	0.026 U	0.021 J			
Di-n-octylphthalate	6.2	0.076 U	0.039 U			
Diethylphthalate	1.2	0.028 U	0.028 U			
Dimethylphthalate	1.4	0.015 J	0.017 J			
Pesticide/PCBs in mg/kg						
Aroclor 1016		0.078 U	0.072 U			
Aroclor 1221		0.078 U	0.072 U			
Aroclor 1232		0.078 U	0.072 U			
Aroclor 1242		0.078 U	0.072 U			
Aroclor 1248		0.078 U	0.072 U			
Aroclor 1254		0.078 U	0.072 U			
Aroclor 1260		0.078 U	0.072 U			
Total PCBs	0.13	0.078 U	0.072 U			
Aldrin	0.01	0.004 U	0.004 U			
Alpha-Chlordane		0.004 U	0.004 U			
Dieldrin	0.01	0.008 U	0.007 U			
Gamma-BHC (Lindane)		0.004 U	0.004 U			
Heptachlor	0.01	0.004 U	0.004 U			
Hexachlorobenzene	0.022	0.004 U	0.004 U			
Hexachlorobutadiene	0.029	0.004 U	0.004 U			
Hexachloroethane	1.4	0.029 UJ	0.03 UJ			
P,P'-DDD		0.004 U	0.004 U			
P,P'-DDE		0.004 U	0.004 U			
P,P'-DDT		0.004 U	0.004 U			
Volatiles in mg/kg						
1,2-Dichlorobenzene	0.035	0.005 U	0.003 U	0.002 U		
1,3-Dichlorobenzene	0.17	0.005 U	0.003 U	0.002 U		
1,4-Dichlorobenzene	0.11	0.005 U	0.003 U	0.002 U		
Ethylbenzene	0.01	0.005 U	0.003 U	0.001 U		
Tetrachloroethene	0.057	0.005 U	0.003 U	0.001 U		
Total Xylenes	0.04	0.005 U	0.003 U	0.001 U		
Trichloroethene		0.005 U	0.003 U	0.001 U		

* Bioaccumulation trigger.
U = Not detected at indicated detection limit.
J = Estimated value.
T = Value represents the total of benzo(b) and benzo(k)fluoranthene.
[ ] = Concentration exceeds screening level.

Table 6- Results of Amphipod Sediment Bioassay (Percent Mortality Endpoint)

			Replicate Percent Mortality						Dispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID	1	2	3	4	5	Mean	1-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05) and M_T-M_R > 10%	2-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05)
Amphipod Mortality	*Ampelisca abdita*	Control	5	0	15	0	0	4		
		Reference (CR-02)	5	5	10	25	35	16		
		C8	10	20	20	30	15	19		Pass

SD: Statistically different

M: Percent mortality

Subscripts: R = reference sediment, C = negative control, T = test sediment

X: Bioassay exceeds the criteria

Table 7- Results of Sediment Larval Bioassay (Normality Endpoint)

Test	Test Species	Sample ID	Replicate Raw Counts of Normal Larvae 1	2	3	4	5	Mean	Dispersive Disposal Site Interpretation Guidelines: 1-hit rule N_T/N_C < 0.80 and N_T/N_C vs N_R/N_C SD (p=.10) and N_R/N_C-N_T/N_C > 0.15	2-hit rule N_T/N_C < 0.80 and N_T/N_C vs N_R/N_C SD (p=.10)
Sediment Larval (unscreened)	*Strongylocentrotus purpuratus*	Control	233	221	183	187	157	196.20		
(Initial Count - 245 embryos)		Reference (CR-02)	163	163	181	110	157	154.80		
		C8	171	124	148	100	144	137.40		NSD

SD: Statistically different

NSD: Not statistically different

N: Counts of normal larvae

Subscripts: R = reference sediment, C = negative control, T = test sediment

X: Bioassay exceeds the criteria

Table 8- Results of Juvenile Polychaete Sediment Bioassay (Mean Individual Growth Rate Endpoint)

			Replicate Mean Individual Growth Rate in mg/ind/d						Dispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID	1	2	3	4	5	Mean	1-hit rule MIG_T/MIG_C < 0.80 and MIG_T vs MIG_R SD (p=.05) and MIG_T/MIG_R < 0.70	2-hit rule MIG_T/MIG_C < 0.80 and MIG_T vs MIG_R SD (p=.05)
Juvenile Polychaete	Neanthes	Control	0.83	0.89	0.96	0.94	0.97	0.92		
		Reference (CR-02)	1.01	0.95	0.95	1.00	1.03	0.98		
		C8	0.84	0.92	0.84	0.54	0.78	0.78		Pass

* Reference sediment failed to meet performance criteria.

SD: Statistically different

NSD: Not statistically different

MIG: Mean individual growth rate (mg/individual/day)

Subscripts: R = reference sediment, C = negative control, T = test sediment

Table 9 - Analytical Results for Bioaccumulation Testing

	Concentration in mg/kg wet weight				
	Tetra-n-butyltin	Tri-n-butyltin	Di-n-butyltin	n-Butyltin	Lipids
DMMP Tissue Guideline	0.6	0.6	0.6	0.6	in %
Comp-1					
MAC-2	0.001 U	0.011	0.0028	0.0003 J	1.05
MAC-3	0.001 U	0.01	0.0025	0.001 U	1.07
MAC-8	0.001 U	0.011	0.0027	0.001 U	0.97
MAC-12	0.001 U	0.015	0.0036	0.001 U	1.23
MAC-17	0.001 U	0.013	0.0025	0.001 U	1.16
Average	0.001 U	0.012	0.0028	0.0009 J	1.10
Variance	0	3E-06	2E-07	8E-08	0.0081
T-Test	NA	-5E+05	-9E+06	-2E+07	NA
NEP-2	0.001 U	0.0013	0.0011	0.001 U	1.11
NEP-3	0.001 U	0.0012	0.001 J	0.0002 J	1.20
NEP-8	0.001 U	0.0011	0.0008 J	0.001 U	1.20
NEP-12	0.001 U	0.001	0.0013	0.0003 J	1.25
NEP-17	0.001 U	0.0013	0.0005 J	0.0002 J	1.16
Average	0.001 U	0.0012	0.0009	0.0005 J	1.18
Variance	0	1E-08	7E-08	1E-07	0.0022
T-Test	NA	-1E+08	-2E+07	-1E+07	NA
Comp-2					
MAC-1	0.001 U	0.015	0.0035	0.0013	1.39
MAC-7	0.001 U	0.018	0.0043	0.0005 J	1.08
MAC-10	0.001 U	0.018	0.0029	0.001 U	1.07
MAC-11	0.001 U	0.017	0.0032	0.001 U	1.32
MAC-20	0.001 U	0.021	0.0048	0.0005 J	1.16
Average	0.001 U	0.0178	0.0037	0.0009	1.20
Variance	0	4E-06	5E-07	1E-07	0.0167
T-Test	NA	-4E+05	-3E+06	-1E+07	NA
NEP-1	0.001 U	0.0017	0.0013	0.001 U	1.66
NEP-7	0.001 U	0.0018	0.0016	0.0003 J	1.15
NEP-10	0.001 U	0.0021	0.0007 J	0.0005 J	1.24
NEP-11	0.001 U	0.002	0.0012	0.0003 J	1.21
NEP-20	0.001 U	0.0017	0.0013	0.001 U	1.20
Average	0.001 U	0.0019	0.0012	0.0006 J	1.29
Variance	0	3E-08	9E-08	1E-07	0.0347
T-Test	NA	-6E+07	-2E+07	-1E+07	NA

Table 9 - Analytical Results for Bioaccumulation Testing

	Concentration in mg/kg wet weight				
	Tetra-n-butyltin	Tri-n-butyltin	Di-n-butyltin	n-Butyltin	Lipids
DMMP Tissue Guideline	0.6	0.6	0.6	0.6	in %
Reference					
MAC-5	0.001 U	0.0012	0.0024	0.001 U	1.01
MAC-6	0.001 U	0.0016	0.0018	0.001 U	1.25
MAC-9	0.001 U	0.0014	0.0016	0.001 U	1.04
MAC-15	0.001 U	0.0019	0.0034	0.001 U	1.06
MAC-19	0.001 U	0.0016	0.0014	0.001 U	1.06
Average	0.001 U	0.0015	0.0021	0.001 U	1.08
Variance	0	5E-08	5E-07	0	0.0072
T-Test	NA	-3E+07	-3E+06	NA	NA
NEP-5	0.001 U	0.001 U	0.0008 J	0.001 U	1.35
NEP-6	0.001 U	0.001 U	0.0006 J	0.001 U	1.24
NEP-9	0.001 U	0.001 U	0.0004 J	0.001 U	1.15
NEP-15	0.001 U	0.001 U	0.0014	0.0002 J	1.07
NEP-19	0.001 U	0.001 U	0.001 U	0.001 U	1.20
Average	0.001 U	0.001 U	0.0008	0.0008	1.20
Variance	0	0	1E-07	1E-07	0.0087
T-Test	NA	NA	-1E+07	-1E+07	NA
Background					
MAC-21	0.001 U	0.0067	0.0028	0.0009 J	1.26
MAC-22	0.001 U	0.0023	0.0021	0.001 U	1.27
MAC-23	0.001 U	0.0032	0.0027	0.001 U	1.29
Average	0.001 U	0.0041	0.0025	0.001 U	1.27
Variance	0	4E-06	1E-07	2E-09	0.0002
T-Test	NA	-3E+05	-1E+07	-5E+08	NA
NEP-24	0.001 U	0.001 U	0.001 U	0.001 U	1.19
NEP-25	0.001 U	0.001 U	0.001 U	0.001 U	1.48
NEP-26	0.001 U	0.001 U	0.001 U	0.001 U	1.41
Average	0.001 U	0.001 U	0.001 U	0.001 U	1.36
Variance	0	0	0	0	0.0153
T-Test	NA	NA	NA	NA	NA

U = Not detected at indicated detection limit.
J = Estimated value.

Table 10- Summary of Bioaccumulation Testing Analytical Results

	Concentration in mg/kg (wet weight)					
	Tetra-n-butyltin	Tri-n-butyltin		Di-n-butyltin	n-Butyltin	Lipids
DMMP Tissue Guideline	None	0.6		None	None	in %
Comp-1						
Initial testing (TBT porewater)		max value 0.47 ug/l				
Retest of composite (TBT porewater)		0.29 ug/l	Adjusted tissue			
ratio I/R		1.62	chemistry values			
MAC-2	0.001 U	0.011	0.0178	0.0028	0.0003 J	1.05
MAC-3	0.001 U	0.01	0.0162	0.0025	0.001 U	1.07
MAC-8	0.001 U	0.011	0.0178	0.0027	0.001 U	0.97
MAC-12	0.001 U	0.015	0.0243	0.0036	0.001 U	1.23
MAC-17	0.001 U	0.013	0.0211	0.0025	0.001 U	1.16
Average	0.001 U	0.012	0.0194	0.00282	0.00086 J	1.096
Variance	0	0.0000040	0.0000105	0.000000207	0.000000098	0.0102
t statistic (test vs guidelines)	NA	-657.4039854	-400.4940475 SD	NA	NA	NA
NEP-2	0.001 U	0.0013	0.0021	0.0011	0.001 U	1.11
NEP-3	0.001 U	0.0012	0.0019	0.001 J	0.0002 J	1.20
NEP-8	0.001 U	0.0011	0.0018	0.0008 J	0.001 U	1.20
NEP-12	0.001 U	0.001	0.0016	0.0013	0.0003 J	1.25
NEP-17	0.001 U	0.0013	0.0021	0.0005 J	0.0002 J	1.16
Average	0.001 U	0.00118	0.0019	0.00094	0.00054 J	1.18
Variance	0	0.00000002	0.00000004	0.0000001	0.0000001	0.0022
t statistic (test vs guidelines)	NA	-10269.67828	-6328.859723 SD	NA	NA	NA
Comp-2						
Initial testing (TBT porewater)		max value 0.29 ug/l				
Retest of composite (TBT porewater)		0.30 ug/l				
ratio I/R		0.966666667				
MAC-1	0.001 U	0.015		0.0035	0.0013	1.39
MAC-7	0.001 U	0.018		0.0043	0.0005 J	1.08
MAC-10	0.001 U	0.018		0.0029	0.001 U	1.07
MAC-11	0.001 U	0.017		0.0032	0.001 U	1.32
MAC-20	0.001 U	0.021		0.0048	0.0005 J	1.16
Average	0.001 U	0.0178		0.00374	0.00086	1.20
Variance	0	0.0000047		0.0000006	0.0000001	0.0167
t statistic (test vs guidelines)	NA	-600.4934496		NA	NA	NA
NEP-1	0.001 U	0.0017		0.0013	0.001 U	1.66
NEP-7	0.001 U	0.0018		0.0016	0.0003 J	1.15
NEP-10	0.001 U	0.0021		0.0007 J	0.0005 J	1.24
NEP-11	0.001 U	0.002		0.0012	0.0003 J	1.21
NEP-20	0.001 U	0.0017		0.0013	0.001 U	1.20
Average	0.001 U	0.00186		0.00122	0.00062 J	1.29
Variance	0	0.00000003		0.0000001	0.0000001	0.0347
t statistic (test vs guidelines)	NA	-7362.594441		NA	NA	NA
Reference						
MAC-5	0.001 U	0.0012		0.0024	0.001 U	1.01
MAC-6	0.001 U	0.0016		0.0018	0.001 U	1.25
MAC-9	0.001 U	0.0014		0.0016	0.001 U	1.04
MAC-15	0.001 U	0.0019		0.0034	0.001 U	1.06
MAC-19	0.001 U	0.0016		0.0014	0.001 U	1.06
Average	0.001 U	0.00154		0.00212	0.001 U	1.08
Variance	0	0.0000001		0.0000007	0.0000000	0.009
NEP-5	0.001 U	0.001 U		0.0008 J	0.001 U	1.35
NEP-6	0.001 U	0.001 U		0.0006 J	0.001 U	1.24
NEP-9	0.001 U	0.001 U		0.0004 J	0.001 U	1.15
NEP-15	0.001 U	0.001 U		0.0014	0.0002 J	1.07
NEP-19	0.001 U	0.001 U		0.001 U	0.001 U	1.20
Average	0.001 U	0.001 U		0.00084	0.00084	1.20
Variance	0	0		0.000000148	0.000000128	0.0109
Background						
MAC-21	0.001 U	0.0067		0.0028	0.0009 J	1.26
MAC-22	0.001 U	0.0023		0.0021	0.001 U	1.27
MAC-23	0.001 U	0.0032		0.0027	0.001 U	1.29
Average	0.001 U	0.004066667		0.002533333	0.000966667 U	1.27
Variance	0	0.0000054		0.0000001	0.000000003	0.0002
NEP-24	0.001 U	0.001 U		0.001 U	0.001 U	1.19
NEP-25	0.001 U	0.001 U		0.001 U	0.001 U	1.48
NEP-26	0.001 U	0.001 U		0.001 U	0.001 U	1.41
Average	0.001 U	0.001 U		0.001 U	0.001 U	1.36
Variance	0	0		0	0	0.0229

Notes:

SD- Result is significantly different than the tributyltin tissue guideline (0.6 mg/kg wet weight/ 3 mg/kg dry weight)

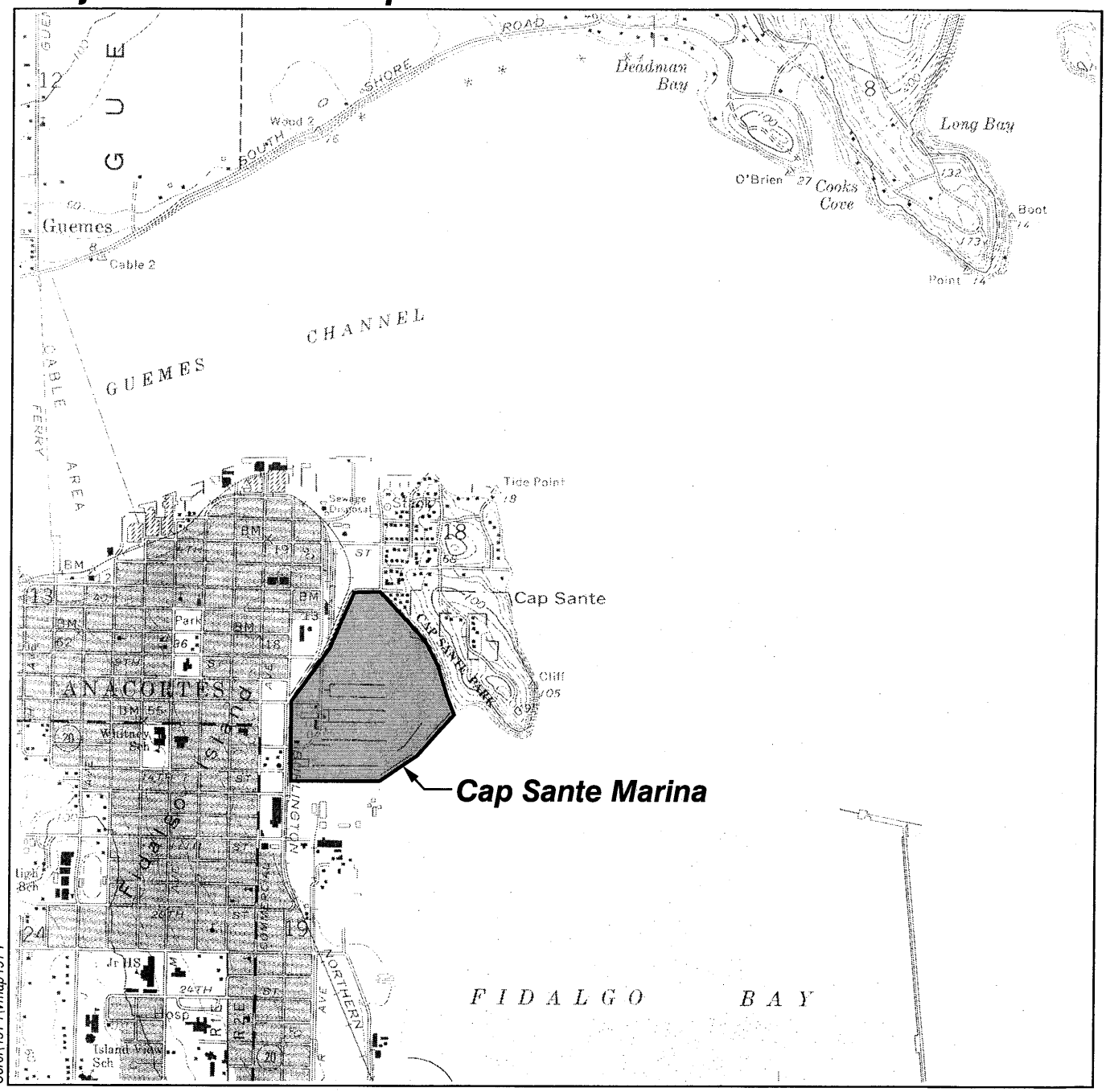
U = Not detected at indicated detection limit.

J = Estimated value.

NA = Not applicable.

4974/CapTables.xls - Table 10

Project Location Map



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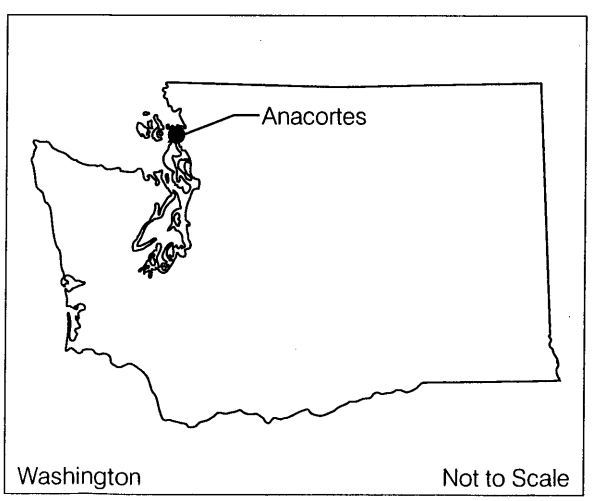

0 2000 4000

Scale in Feet

Note: Base map prepared from USGS 7.5 minute quadrangle map of Anacortes, Washington, dated 1973.

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Figure 1

Confirmed Sampling Location Plan

Cap Sante Marina

(1) SURFACE DMMU DESIGNATION

C2-01 CONFIRMED SAMPLE LOCATION AND NUMBER

C1-04 PROPOSED LOCATION NOT SAMPLED

· FOUND C.O.E. BRASS CAP MONUMENTS.

/ FOUND PREVIOUS SURVEY CONTROL POINTS

0 SET 2" AL CAP ON #5 REBAR

* SET PN&D NAIL WITH SHINER

- WOOD PILE

— - - WOOD PILE WAVE BARRIER

=====(CULVERT LOCATION

Note: Base map prepared from drawing provided by Pertorvich, Nottingham & Drage, Inc. entitled "Plan View", dated September 7, 1998.

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Figure 2

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TBT Bioaccumulation Testing
Sampling Location Plan
Cap Sante Marina

DMMUs INCLUDED IN BIOACCUMULATION TEST SAMPLE COMP 1

DMMUs INCLUDED IN BIOACCUMULATION TEST SAMPLE COMP 2

(1) SURFACE DMMU DESIGNATION

C2-01 CONFIRMED SAMPLE LOCATION AND NUMBER

C1-04 PROPOSED LOCATION NOT SAMPLED

· FOUND C.O.E. BRASS CAP MONUMENTS.

/ FOUND PREVIOUS SURVEY CONTROL POINTS

0 SET 2" AL CAP ON #5 REBAR

* SET PN&D NAIL WITH SHINER

- WOOD PILE

— - - WOOD PILE WAVE BARRIER

=====(CULVERT LOCATION

Note: Base map prepared from drawing provided by Pertorvich, Nottingham & Drage, Inc. entitled "Plan View", dated September 7, 1998.

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Figure 3

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APPENDIX A
CHEMICAL DATA QUALITY REVIEW AND CERTIFICATES OF ANALYSIS

APPENDIX A
CHEMICAL DATA QUALITY REVIEW AND CERTIFICATES OF ANALYSIS

A.1 Sediment Chemical Analysis

Twelve sediment samples and twelve subsamples for volatile organics and sulfide, were collected between February 17 and 23, 1999. The samples were submitted to MultiChem Analytical Services (MultiChem) of Seattle, WA for analysis of the following:

- Total Metals (EPA Method 6000/7000);
- Semivolatile Organics (EPA Method 8270, and 8270 SIM);
- Volatile Organics (EPA Method 8260);
- Pesticides/PCBs (EPA Method 8081/8082);
- Total Organic Carbon (EPA Method 9060 mod);
- Total Sulfide (PSEP);
- Ammonia (PSEP);
- Total Volatile Solids (PSEP); and
- Total Solids (PSEP).

The samples were also submitted to Columbia Analytical Services (CAS) of Kelso, WA for analysis of the following:

- Pore water Tributyltin (TBT, Krone et al., 1989);

The following criteria were evaluated in the standard data quality review process for the results:

- Holding times;
- Method blanks;
- Reporting limits;
- Surrogate recoveries;
- Blank spike/blank spike duplicate (BS/BSD) recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries; and
- Laboratory duplicates relative percent differences (RPDs).

Two batches of samples (SDG 909028 and 909026) were received by MultiChem at temperatures below the recommended 4± 2 °C. Results were not qualified based on sample temperature receipt.

Total Metals. All required holding times were met. Reporting limits were below DMMP SLs. Zinc was detected in the digestion blank; however, associated

sample results were greater than five times the blank contamination so no results were qualified. BS and MS recoveries were within control limits. Serial dilution RPDs for zinc in several samples were greater than 10 percent. Associated sample results were qualified as estimated (J). Laboratory duplicate RPDs were acceptable with the exception of copper associated with C6, C11, and C12. Associated sample results were qualified as estimated (J).

Semivolatile Organics. All required holding times were met. Reporting limits were below DMMP SLs. Result for the individual isomers of benzofluoranthene could not be reported due to poor chromatographic resolution; results qualified with T indicate the result reported is the sum of the benzo(b) and benzo(k) isomers. Method blank contamination was present for phenol, benzoic acid, bis(2-ethylhexyl)phthalate, and di-n-butylphthalate. Associated sample results less than five times the phenol and benzoic acid contamination and ten times the phthalate contamination were qualified as not detected (U). Surrogate recoveries were within control limits with the following exceptions. 2,4,6-tribromophenol was below control limits in two method blanks. 2-fluorobiphenyl was below control limits in several samples. 2-fluorophenol and nitrobenzene was below control limits in C11. Qualifiers were not assigned since the other surrogate recoveries were acceptable.

BS/BSD recoveries were within control limits with the following exceptions. Hexachloroethane, 2,4-dimethylphenol, pentachlorophenol, and 1,2,4-trichlorobenzene recoveries were below control limits in the BS/BSD. BS/BSD and MS/MSD RPDs for these compounds were also out of control limits. MS/MSD recoveries of fluoranthene, benzo (a) pyrene, phenanthrene, 2,4-dimethylphenol, pentachlorophenol, and hexachloroethane were below control limits. 2,4-dimethylphenol and pentachlorophenol results from associated samples were already qualified as estimated by the laboratory. Hexachloroethane and results associated with low BS and MS recoveries were qualified as estimated (UJ/J).

BS/BSD RPDs of several compounds were out of control limits. No results were qualified since the associated BS recoveries and MS/MSD RPDs were acceptable. MS/MSD RPDs of several compounds were out of control limits. MS recoveries of several PAHs in sample C8 were not calculable due to sample inhomogeneity. Results were not qualified based on MS/MSD recoveries alone.

Volatile Organics. All required holding times were met. Reporting limits were below DMMP SLs. No method blank contamination was detected. Surrogate MS/MSD and BS recoveries were within laboratory control limits. MS/MSD RPDs were within control limits.

Pesticides/PCBs. All required holding times were met. Reporting limits were below DMMP SLs. No method blank contamination was detected. Surrogate and BS/BSD recoveries were within laboratory control limits with the following exceptions. Aldrin and heptachlor BS recoveries were below control limits. Results were not qualified since MS/MSD recoveries were acceptable. Recovery of TCMX in C4 was below control limits. No results were qualified since the remaining surrogate recovery was acceptable. Recoveries of several pesticides in the MS/MSD were below control limits because the MSD extract went dry during the concentrating step. The associated MS/MSD RPDs were also out of control limits. No results were qualified based on MS/MSD recoveries alone. Laboratory duplicate RPDs were within control limits.

Total Organic Carbon. All required holding times were met. No method blank contamination was detected. BS and MS recoveries were acceptable. Laboratory triplicates were not performed. The laboratory duplicate RPD associated with samples C11, C12, and C6 was out of control limits. Associated results were qualified as estimated (J).

Total Sulfide. All required holding times were met. No method blank contamination was present. MS recoveries were acceptable. Laboratory duplicate RPDs were within control limits.

Ammonia. All required holding times were met. No method blank contamination was present. BS and MS recoveries were acceptable. Laboratory duplicate RPDs were within control limits.

Total Volatile Solids/Total Solids. All required holding times were met. No method blank contamination was present. Laboratory duplicate RPDs were within control limits.

Pore Water Tributyltin. All required holding times were met. Pore water was extracted within seven days. Reporting limits were below DMMP SLs. No method blank contamination was present. Surrogate recoveries were within control limits. LCS and MS/MSD recoveries were acceptable.

A.2 Tissue Chemical Analysis

Thirty-six tissue samples from bioaccumulation test on Comp-1 and Comp-2 were collected on April 1, 2000. The samples were submitted to Columbia Analytical Services of Kelso, WA for analysis of Butyltins (TBT) and Lipids (Gravimetric).

The following criteria were evaluated in the standard data quality review process for the results:

- Holding times;
- Method blanks;
- Surrogate recoveries;
- Laboratory control sample recoveries; and
- Matrix spike/matrix spike duplicate (ms/msd) recoveries and relative percent differences (RPD).

All required holding times were met. No method blank contamination was present. Surrogate recoveries were within laboratory control limits. LCS and MS/MSD recoveries and RPDs were within control limits.

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CERTIFICATES OF ANALYSIS
COLUMBIA ANALYTICAL SERVICES

APPENDIX B
SEDIMENT BIOLOGICAL TOXICITY DATA QUALITY REVIEW AND BIOLOGICAL TOXICITY TESTING REPORT

APPENDIX B
SEDIMENT BIOLOGICAL TOXICITY DATA QUALITY REVIEW AND BIOLOGICAL TOXICITY TESTING REPORT

B.1 Introduction

Parametrix, Inc., of Kirkland, Washington, was contracted to conduct bioassays of sediments collected as part of a Dredged Material Management Program (DMMP) sediment characterization study for Peratrovich, Nottingham & Drage, Inc., and Hart Crowser, Inc.

Bioassays were conducted by Parametrix's Environmental Toxicology Laboratory, a State of Washington-accredited laboratory (Lab accreditation number C033: Expiration September 30, 2000). Parametrix's Environmental Toxicology Laboratory is certified to perform the sediment bioassays under the Puget Sound Estuary Program (PSEP, 1995) and DMMP protocols.

B.2 Sediment Bioassay Data Quality Review

Three test sediments were collected by Hart Crowser personnel on February 17, 1999 (Sample ID C8) and February 18, 1999 (C9 and C1), and provided to Parametrix on February 22, 1999. A reference sediment sample was collected by Bio-Marine Services, of Seattle, Washington, from Carr Inlet and delivered to Parametrix on April 13, 1999.

A suite of three bioassays was conducted on one of the test sediments (C8) and the reference sediment:

- 10-day amphipod mortality test using *Ampelisca abdita*
- 20-day juvenile polychaete growth test using *Neanthes arenaceodentata*
- 96-hour sediment larval test using *Strongylocentrotus purpuratus*

The following criteria were evaluated as part of this data quality review:

- Chain of custody procedures and sample holding procedures;
- Evaluation of data completeness and transcription accuracy;
- Bioassay test conditions (water quality assurance parameters);
- Bioassay performance in negative control and reference sediments; and
- Bioassay performance in positive control tests.

Laboratory performances in the sediment bioassays were evaluated against the PSEP (1995) protocols, the Sediment Management Standards: Marine Bioassays Recommended Quality Assurance and Quality Control Deliverables (Ecology,

1996), and the Dredged Material Evaluation and Disposal Procedures Manual (Corps, 2000).

B.2.1 Chain of Custody Procedures and Sample Holding

Samples were transferred to the bioassay testing laboratory using established chain of custody procedures. Test and reference sediments were purged with nitrogen on receipt at the testing laboratory and held in the dark at 4°C until tested. Sediment larval bioassay testing was initiated on April 13, 1999, 55 days after sample collection. Amphipod and juvenile polychaete bioassays were initiated on April 16, 1999, 58 days after sample collection.

B.2.2 Data Evaluation

Copies of the raw data forms were reviewed for completeness. Summary tables were reviewed for fidelity of transcription of the raw data. No errors or omissions were noted.

B.2.3 Bioassay Test Conditions

Water quality parameters were compared to the PSEP (1995) and the PSDDA (1994) specifications. The water quality assurance parameters are summarized in Table 1 by test species and type.

Table 1 PSEP (1995) and PSDDA (1994) water quality assurance parameters for sediment bioassays.

Parameter	Amphipod *(Ampelisca abdita)*	Juvenile Polychaete *(Neanthes arenaceodentata)*	Echinoderm Larval *(Strongylocentrotus purpuratus)*
Temperature in °C	19 to 21	19 to 21	14 to 16
Salinity in ppt	27 to 29	28 to 35	27 to 29
Dissolved oxygen in mg/L	4 to 10	4 to 10	4 to 10
pH	7 to 9	7 to 9	7 to 9
Ammonia in mg/L unionized	0 to 1.0*	0 to 0.7	0 to 0.04
Sulfide in mg/L total	0 to 0.5	0 to 1.0	0 to 0.5

* total ammonia for amphipods

B.2.4 Amphipod Bioassay

There were no deviations of the water quality parameters for temperature, dissolved oxygen, or pH. Salinity had a minor water quality deviation in one of

the reference toxicant series. Salinity was outside the protocol-specified range by +1 ppt on one day during the test. It is doubtful that this water quality deviation had significant effects on the results.

Total ammonia values for the reference and control sediments were within the water quality parameters. The test sediment (C8) exceeded the PSDDA warning limit of 1.0-mg/L total ammonia in the overlying water on Day 1 and Day 10. Total ammonia concentrations increased from 3.27 mg/L at the test initiation to 5.19 mg/L at test termination. The test sediment should be flagged for possible ammonia toxicity.

All sulfide concentrations were below the critical limit of 0.5 mg/L specified by PSDDA.

B.2.5 Juvenile Polychaete Bioassay

There were no deviations of the water quality parameters for temperature, salinity, dissolved oxygen, or pH. Unionized ammonia concentrations for the test, reference, and control sediments were below the critical value of 0.7 mg/L unionized ammonia specified by PSDDA. All sulfide concentrations were below the critical limit of 0.5 mg/L specified by PSDDA.

B.2.6 Sediment Larval Bioassay

There were no deviations of the water quality parameters for temperature, salinity, dissolved oxygen, or pH. Unionized ammonia concentrations for the test, reference, and control sediments were below the critical value of 0.04 mg/L unionized ammonia specified by PSDDA. All sulfide concentrations were below the critical limit of 0.5 mg/L specified by PSDDA.

B.3 Bioassay Performance–Positive Control

B.3.1 Amphipod Bioassay

The reference toxicant 50 percent Lethal Concentration (LC50) for this test was 0.50 mg/L cadmium, within the PSEP range of 0.07 to 0.91 mg/L cadmium and within Parametrix's control chart limits.

B.3.2 Juvenile Polychaete Bioassay

The reference toxicant LC50 for this test was 6.82 mg/L cadmium, within the PSDDA range of 6.0 to 19 mg/L cadmium but slightly below the PSEP-specified range of 7.1 to 17.9 mg/L cadmium. The LC50 value is within Parametrix's control chart warning limits of 3.72 and 12.53 mg/L cadmium.

B.3.3 Sediment Larval Bioassay

The reference toxicant LC50 for this test was 0.96 mg/L cadmium and within Parametrix's control chart limits.

B.4 Bioassay Performance–Negative Controls and Reference Sediments

B.4.1 Amphipod Bioassay

Negative control mean mortality was <10 percent and was considered acceptable by the current PSDDA and SMS criteria. The mean mortality response of the reference sediment was 16 percent, within the PSDDA limit of ≤20 percent over negative control and the SMS limit of ≤25 percent over the negative control.

B.4.2 Juvenile Polychaete Bioassay

Negative control and reference sample mortality was 0 percent and thus acceptable under the current PSDDA and SMS criteria. Mean individual growth rate in the control was ≥0.38 mg/individual/day and reference growth rate/ control growth rate was ≥0.80. Both were considered acceptable by the current PSDDA criteria.

B.4.3 Sediment Larval Bioassay

The negative seawater control combined mortality/abnormality (19.8 percent) was <30 percent and was considered acceptable by the current PSDDA and SMS criteria. The mean combined mortality/abnormality for the reference sediment was 21.1 percent, normalized to the seawater control, well below the PSDDA limit of ≤35 percent.

B.5 Final QA Determination

B.5.1 Amphipod Bioassay

Testing for the amphipod bioassay using *Ampelisca abdita* began 58 days after sediment collection, which is slightly greater than the PSDDA holding time limitation and considerably longer than the 14 days recommended by PSEP (1995). In addition, the test sediment showed total ammonia levels at test initiation and test termination above the PSDDA warning level. Elevated ammonia levels may be the result of the extended holding times. The elevated ammonia levels do not appear to have resulted in significantly increased mortalities but should be flagged for possible ammonia toxicity effects. The

significant protocol deviation resulting from the exceedence of the holding time limitations does not appear to have compromised data quality. Toxicity has been documented to remain the same or to increase with holding times in excess of 8 weeks (Becker and Ginn, 1990, as reported in Kendall and Fox, 1991). Test results should be more ecologically conservative with extended holding times. The slight salinity elevation observed in the positive control test is judged to be a minor deviation and should not have significantly affected the result. The positive control, reference, and negative control tests met the applicable performance criteria. The data are judged to be of acceptable quality and usable for any application.

B.5.2 Juvenile Polychaete Bioassay

Testing for the juvenile polychaete bioassay using *Neanthes arenaceodentata* began 58 days after sediment collection, which is slightly longer than the PSDDA holding time limitation of 8 weeks and considerably longer than the 14 days recommended by PSEP (1995). The positive control, reference, and negative control tests met the applicable performance criteria. The significant protocol deviation resulting from the exceedence of the holding time limitation indicates that the results of this test should be used with caution. Reduced growth rates may be the result of increased toxicity associated with extended holding times. The bioassay results should be judged to be ecologically conservative. Data are judged to be of acceptable quality. The protocol deviations do not appear to have compromised the quality of the results.

B.5.3 Sediment Larval Bioassay

Testing for the sediment larval bioassay using *Strongylocentrotus purpuratus* began 55 days after sediment collection, within the 8-week PSDDA holding time limitation, but considerably longer than the 14 days recommended by PSEP (1995). The positive control, reference, and negative control tests met the applicable performance criteria. All data collected appear to be of good quality and usable for any application.

B.6 References

Corps (US Army Corps of Engineers), 2000. Dredged material evaluation and disposal procedures: a users manual for the Puget Sound Dredged Disposal Analysis (PSDDA) Program. Prepared by the US Army Corps of Engineers, Seattle District, Seattle, Washington, US Environmental Protection Agency, Region X, Washington Department of Natural Resources, and Washington Department of Ecology.

Ecology (Washington State Department of Ecology), 1996. Sediment management standards: marine bioassays, Task II, recommended quality assurance and quality control deliverables. Ecology, Publication No 96-314, Olympia.

Kendall, D., and D. Fox, 1991. Modifications to holding time for biological testing [online report]. Dredged Material Management Program Issue Paper presented at the 3rd SMARM meeting. Dredged Material Management Office website [November 9, 1998].
URL:<http://www.nws.usace.army.mil/dmmo/3rd_arm/biotim91.htm>

PSDDA (Puget Sound Dredged Disposal Analysis), 1994. Dredged analysis information system (DAIS), version 4.4. Electronic database from the US Army Corps of Engineers, Seattle District, Seattle, Washington.

PSEP (Puget Sound Estuary Program), 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Final report by PTI Environmental Services for US Environmental Protection Agency, Region X, Office of Puget Sound, Seattle, Washington.

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SEDIMENT BIOLOGICAL TOXICITY TESTING REPORT
PARAMETRIX, INC.

APPENDIX C
SEDIMENT BIOACCUMULATION DATA QUALITY REVIEW AND BIOACCUMULATION TESTING REPORT

APPENDIX C
SEDIMENT BIOACCUMULATION DATA QUALITY REVIEW AND BIOACCUMULATION TESTING REPORT

C.1 Introduction

Battelle Marine Sciences Laboratory (Battelle), of Sequim, Washington, was contracted to conduct the exposure portion of a 45-day, dual species bioaccumulation test on sediments collected from Anacortes, Washington, as part of a Dredged Material Management Program (DMMP) sediment characterization study for Hart Crowser, Inc., Seattle, Washington. Bioaccumulation testing was conducted by Battelle's Sequim Bay Marine Sciences Laboratory, a State of Washington-accredited laboratory (Lab accreditation number C043: Expiration November 23, 2000).

C.2 Sediment Bioassay Data Quality Review

Two test sediments were collected by Hart Crowser personnel and delivered to Battelle on January 21, 2000. Reference sediment was collected by Battelle personnel from Sequim Bay, sieved through a 1-mm mesh sieve, and stored in a cold room until needed.

Bioaccumulation testing was conducted using two species: *Macoma nasuta* and *Nephtys caecoides*. Test protocols included the co-testing of the two species in the same aquaria. Test duration was 45 days. *M. nasuta* were collected from Discovery Bay, Washington. The animals were supplied by Johnson and Gunstone of Port Townsend, Washington, and arrived on February 8, 2000. Sequim Bay reference sediments were used for the *M. nasuta* control sediments. *N. caecoides* and control sediments from Tomales Bay, California, were supplied by Brezina and Associates of Dillon Beach, California, and arrived on February 10, 2000.

The following criteria were evaluated as part of this data quality review:

- Bioaccumulation test conditions (water quality parameters);
- Bioaccumulation test performance in positive control tests; and
- The bioaccumulation testing procedures were based on the US Environmental Protection Agency methods (Lee et al., 1989) and the Puget Sound Dredge Disposal Analysis (PSDDA) guidelines (Corps, 1998a) for dredged material.

Additional protocols developed by Battelle for the recent East Duwamish Waterway project were also used.

C.2.1 Bioaccumulation Test Conditions

Battelle's acceptable water quality parameters (Table 1) are within the range of values PSEP (1995) and PSDDA (1994) used in evaluating water quality for bioassay testing.

Table 1 Battelle's acceptable water quality parameters for bioaccumulation tests.

Parameter	Acceptable Ranges
Temperature in °C	14 to 18
Salinity in ppt	28 to 32
Dissolved oxygen in mg/L	4 to 10
pH	7.3 to 8.3

There were no deviations from Battelle's water quality parameters for dissolved oxygen, or pH. Salinity was slightly elevated (>32.0 ppt) on 5 of the 45 days of the test as a result of elevated ambient seawater salinity. The highest measured salinity was 32.3 ppt, barely above the acceptable range on two days during the test. It is doubtful that these water quality deviations will have any significant effects on the results.

Temperature was below the minimal acceptable value of 14.0°C on day 42 of the test due to a power failure. Temperature dropped to 12.0°C. The other parameters were within the acceptable ranges. There did not appear to be any observed adverse effects from the single day of low temperatures.

C.2.2 Bioassay Performance–Positive Control

A concurrent reference toxicant test using copper was conducted on each species using a geometrically increasing concentration series. The concentration range had at least one concentration with mortality of greater than 50 percent and one with mortality of less than 50 percent. The calculated median lethal concentration (LC50) for *M. nasuta* was 1.23 mg/L copper. This value was within Battelle's control chart warning limits. The LC50 for *N. caecoides* was 0.13 mg/L copper, also within Battelle's control chart warning limits. Battelle's control charts were based on nine data points which is more than the five data points needed to develop an initial set of warning limits (Corps, 1998b). The health and sensitivity of the test animals to the reference toxicant is similar to the response of other groups of test organisms used in previous studies.

C.2.3 Bioaccumulation Test Performance–Survivorship

Mean survivorship of *M. nasuta* in the two test sediments was 90 and 95 percent. The *M. nasuta* survivorship was 96 percent in the reference/*M. nasuta* control sediment and 94 percent in the *N. caecoides* control sediment. Mean survivorship of *N. caecoides* in the two test sediments was 91 and 93 percent. The *N. caecoides* survivorship was 89 percent in the reference/*M. nasuta* control sediment and 98 percent in the *N. caecoides* control sediment. Survivorship values were above Battelle's survivorship target value of 80 percent.

C.3 Final QA Determination

Bioaccumulation testing protocols are still being revised and updated by the agencies. There are few agency standards for the 45-day bioaccumulation testing using two species. The results of this study were compared to Battelle's internal standards developed during other bioaccumulation studies. Battelle's water quality parameters are within the range of values found in the animals' natural habitats and are similar to test conditions required in other bioassays with similar animals. Survivorship in the 45-day test was above 89 percent in all treatments. Minor protocol deviations in regards to salinity and temperature are unlikely to affect the results of the test or the quality of the data. Based on the data available regarding the test conditions, including the water quality measurements, reference toxicant test performance, and survivorship, the bioaccumulation test performance is acceptable and the data are usable for PSDDA dredge disposal determinations.

C.4 References

Corps (US Army Corps of Engineers), 1998a. Dredged material evaluation and disposal procedures: a user's manual for the Puget Sound Dredged Disposal Analysis (PSDDA) program. US Army Corps of Engineers, Seattle, Washington.

Corps, 1998b. Evaluation of dredged material proposed for discharge in waters of the US–inland testing manual [online report]. Prepared by the US Army Corps of Engineers and US Environmental Protection Agency. US EPA website [May 6, 1998]. URL: <http://www.epa.gov/OST/pubs/ITM/>.

Lee, H., B.L. Boese, J. Pelletier, M. Winsor, D.T. Specht, and R.C. Randall, 1989. Guidance manual: bedded sediment bioaccumulation tests. US Environmental Protection Agency ERL-N, Pacific Branch Bioaccumulation Team, EPA/600/X-89/302, ERLN-N111, Newport, Oregon.

PSDDA (Puget Sound Dredged Disposal Analysis), 1994. Dredged analysis information system (DAIS), version 4.4. Electronic database from the US Army Corps of Engineers, Seattle District, Seattle, Washington.

PSEP (Puget Sound Estuary Program), 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Final report by PTI Environmental Services for US Environmental Protection Agency, Region X, Office of Puget Sound, Seattle, Washington.

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SEDIMENT BIOACCUMULATION TESTING REPORT
BATTELLE MARINE SCIENCES LABORATORY