Appendix A

Pre-Remedial Design Evaluation Report (2003)

WHATCOM WATERWAY PRE-REMEDIAL DESIGN EVALUATION DATA REPORT

Prepared for

Georgia-Pacific Corporation

Washington Department of Natural Resources

Port of Bellingham

City of Bellingham

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1 INTRODUCTION

Anchor Environmental L.L.C. (Anchor) and Landau Associates, Inc. (Landau) were retained by a group of the Bellingham Bay Potentially Liable Parties (PLPs), including Georgia-Pacific Corporation (G-P), Washington Department of Natural Resources (DNR), Port of Bellingham (Port), and City of Bellingham (City) to conduct a pre-remedial design evaluation (PRDE) of key sediment quality and geotechnical characteristics of surface and subsurface materials in Bellingham Bay, Washington (Figure 1). The purpose and scope of the PRDE study was to support the design of cleanup actions for the Whatcom Waterway Site and associated sediment cleanup sites in Bellingham Bay, more specifically described in Agreed Order No. 02TCPNR-2002 between G-P and the Washington Department of Ecology (Ecology), and in the PRDE Work Plan/Sampling and Analysis Plan (SAP) approved by Ecology under the Agreed Order (Anchor 2002).

This PRDE study is intended to inform remedial design of potential remedies previously evaluated in the Whatcom Waterway Site Remedial Investigation/Feasibility Study (RI/FS) and Whatcom Waterway Supplemental FS, as well as in the Bellingham Bay Comprehensive Strategy Environmental Impact Statement (EIS) and Supplemental EIS, as they pertain to the Whatcom Waterway Site. The PRDE consisted of the following elements:

a. Refinement of the areal boundaries of sediments exceeding Sediment Quality Standards (SQS) defined in Chapter 173-204 WAC, as the basis for subsequent remedial design
b. Determination of whether certain sediments located in the outer Whatcom Waterway channel area (Units 1A and 1B described in the EIS), may be suitable for beneficial reuse as part of the overall cleanup remedy
c. Performance of a series of contaminant mobility and geotechnical tests of prospective dredge materials, to be used as a basis for subsequent remedial design of cleanup remedies, including placement of sediments in a local confined disposal facility (e.g., G-P Aerated Stabilization Basin; ASB)

Field sampling for this study occurred in early June 2002. Final data from the contaminant mobility tests were received on January 7, 2003.

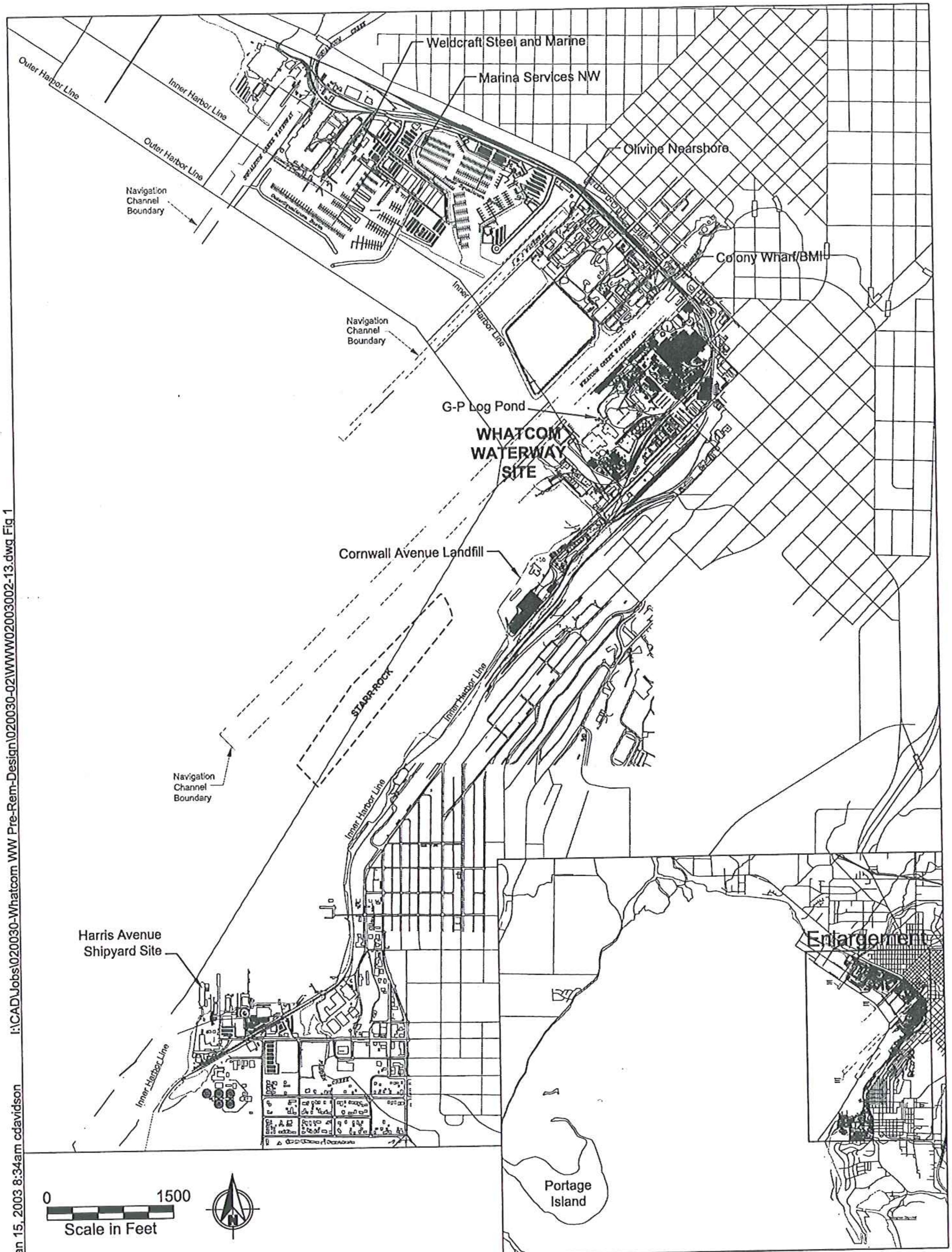

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Figure 1
Whatcom Waterway Site Area Map

ANCHOR ENVIRONMENTAL, L.L.C.

2 OVERVIEW OF PRIMARY INVESTIGATION COMPONENTS

Four broad sediment sampling and characterization efforts were conducted in Bellingham Bay during the PRDE study. This section outlines the primary investigation elements. Sampling and analysis procedures for all investigation elements were performed in accordance with the Work Plan/SAP (Anchor 2002).

2.1 Confirmatory Surface Sediment Sampling

A total of 19 surface sediment samples were collected from the Whatcom Waterway Site during the PRDE sampling (Figure 2). Sixteen of these surface sediment samples were collected where exceedances of biological SQS criteria were observed during the previous sediment sampling in 1996, and reported in the Whatcom Waterway RI/FS (Anchor and Hart Crowser 2000). Natural recovery modeling also presented in the RI/FS predicted that analytes exceeding SQS criteria were likely to recover to levels below these criteria by 2002. To verify this condition, individual surface sediment samples were submitted for analysis of all identified chemicals of potential concern (COPCs) as well as acute and chronic confirmatory biological (bioassay) tests, as defined in the Work Plan/SAP (Anchor 2002).

In addition, three surface stations that previously did not exhibit toxicity (below SQS criteria in bioassays[1]), but nevertheless exceeded the mercury bioaccumulation screening level (BSL; 1.2 milligrams per kilogram [mg/kg]) were sampled and analyzed for the COPCs defined in the Work Plan/SAP (Anchor 2002). Again, natural recovery modeling presented in the RI/FS predicted that mercury concentrations were likely to recover to below BSL levels by 2002; this condition was evaluated directly through the PRDE sampling.

2.2 Units 1A/1B PSDDA Screening-Level Characterization

Located in the outer Whatcom Waterway, sediment site Units 1A and 1B contain relatively low levels of COPCs (below SQS criteria in surface sediments), and may be suitable for beneficial reuse, potentially as ASB capping material. Following general screening-level Puget Sound Dredge Disposal Analysis (PSDDA) characterization procedures, 16 sediment cores, each approximately 4 feet long, were collected from sediment site Units 1A/1B (Figure 2) and were combined to form four 4-point composite samples for chemical analysis. The

[1] Bioassays conducted on samples collected in October 1998. (Anchor and Hart Crowser 2000)

number of cores and composites supplemented existing data to support both partial characterization requirements for a project-specific PSDDA down-ranking of surface sediments within this area (from high to low/moderate), and to support a potential PSDDA suitability determination (if needed) for the down-ranked material.

A similar approach to screening-level PSDDA suitability determination was previously employed in 1997 for the I&J Waterway and the head of the Whatcom Waterway (Addendum No. 2 to the Whatcom Waterway Project Plans [Hart Crowser 1997]). This element of the PRDE therefore supplements existing beneficial reuse evaluations previously incorporated into the Whatcom Waterway RI/FS (Anchor and Hart Crowser 2000).

2.3 Dredge Water Quality, Settling and Consolidation Testing

A total of eight subsurface sediment cores representative of Whatcom Waterway channel sediments currently targeted for disposal in the ASB were collected for a range of physical and chemical tests (Figure 2). Tests were performed on a single sample composited from all eight cores. Specific tests and their corresponding objectives were as follows:

- Dredge elutriate test (DRET) – to support remedial design evaluations of potential water quality impacts at the point of dredging. The leachant used in this test was collected from Whatcom Waterway.
- Modified elutriate test (MET) – to support remedial design evaluations of water quality discharged from the ASB during filling, simulating geochemical changes occurring in the ASB during active disposal operations. The leachant used in this test was collected from the Whatcom Waterway.
- Column settling test (CST) – to support remedial design evaluations of solids retention within the ASB during filling, and to provide information concerning the volumes occupied by newly placed layers of dredged material. The test slurry was prepared using Whatcom Waterway water at a solids concentration of 150 grams per liter (g/L), in accordance with U.S. Army Corps of Engineers (Corps)-recommended procedures and within the range of conditions anticipated with hydraulic cutterhead dredging operations, as discussed in the Whatcom Waterway Supplemental FS.
- Consolidation test – to provide additional information on the short-and long-term capacity of the ASB.

- Geotechnical parameters – including standard physical analyses to support remedial design evaluations, including water content, grain size distribution, Atterberg limits, specific gravity, consolidation, hydraulic conductivity, and effective porosity.

2.4 Thin-layer Column Leach Test

A thin-layer column leach testing (TCLT) was conducted during this PRDE study to evaluate chemical mobility associated with sediment porewater/leachate following placement of targeted materials in a confined disposal facility such as the ASB. The results of the TCLT will support subsequent remedial design evaluations of long-term water quality protection provided by the prospective confined disposal facility.

A total of 20 subsurface sediment cores representative of the range of Bellingham Bay sediments currently targeted for disposal in the ASB were collected by Anchor for the TCLT evaluation (Figures 2 through 6). Cores were collected from the following sediment cleanup areas in the bay: 1) Whatcom Waterway Site; 2) Marine Services Northwest Site; 3) Olivine Site; 4) Weldcraft Steel & Marine Site (Gate 2 Boatyard); and 5) Harris Avenue Shipyard Site. In addition, nearshore sediment from a sixth area – the Colony Wharf/BMI Site – was collected by GeoEngineers from three representative borings, and submitted for inclusion in this TCLT evaluation (Figure 7).

Material from the cores was used to form respective site composite samples, and material from each of the site composites was then used to form a master composite sample that was submitted for TCLT evaluation. The proportions of sediment from each site reflected the estimated volume that each would contribute to the total amount of material currently targeted to be disposed in the ASB. Details of the testing and compositing procedures are described in the Work Plan/SAP (Anchor 2002).

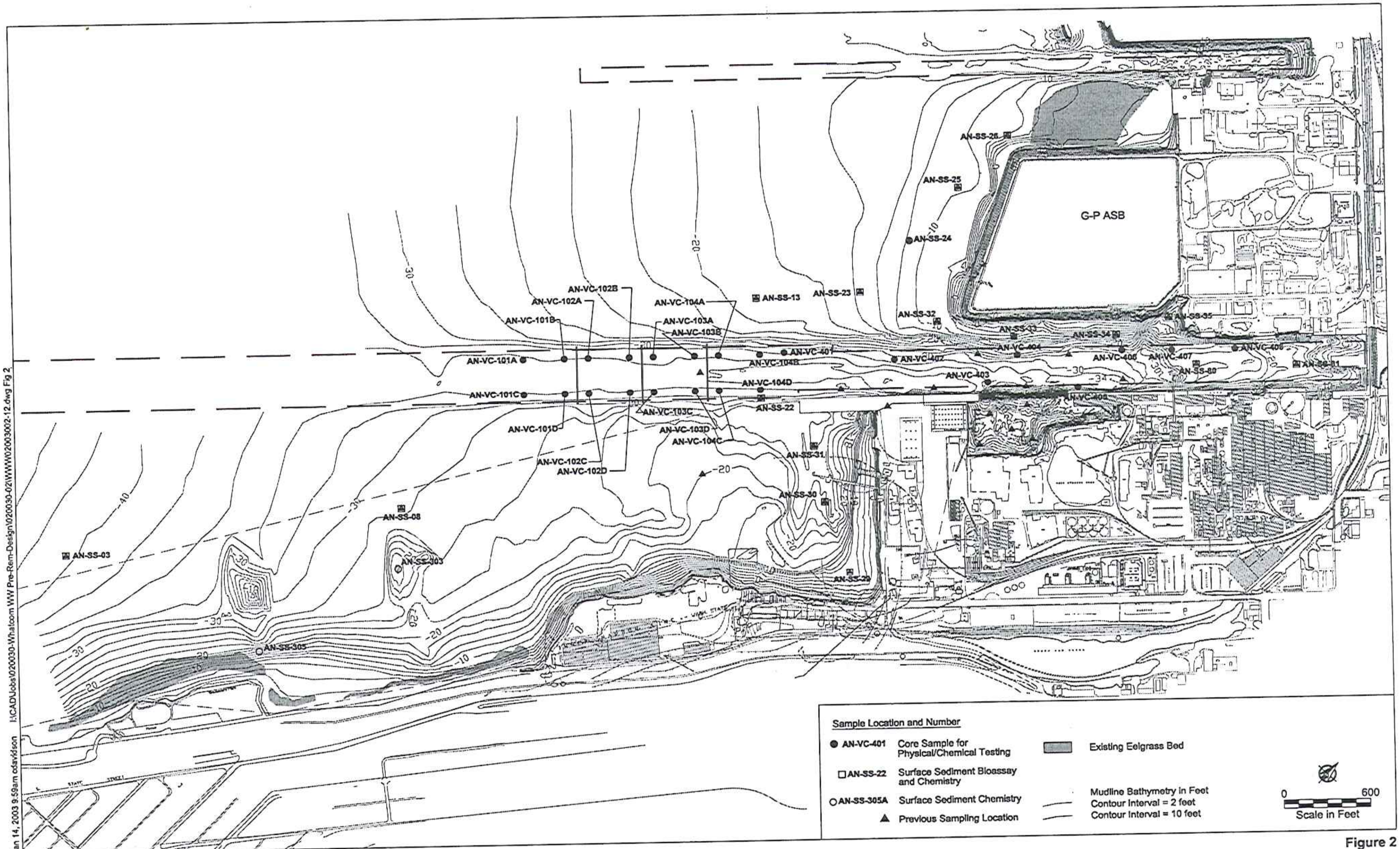

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Figure 2
Sampling Locations
Whatcom Waterway Pre-Remedial Design Evaluation

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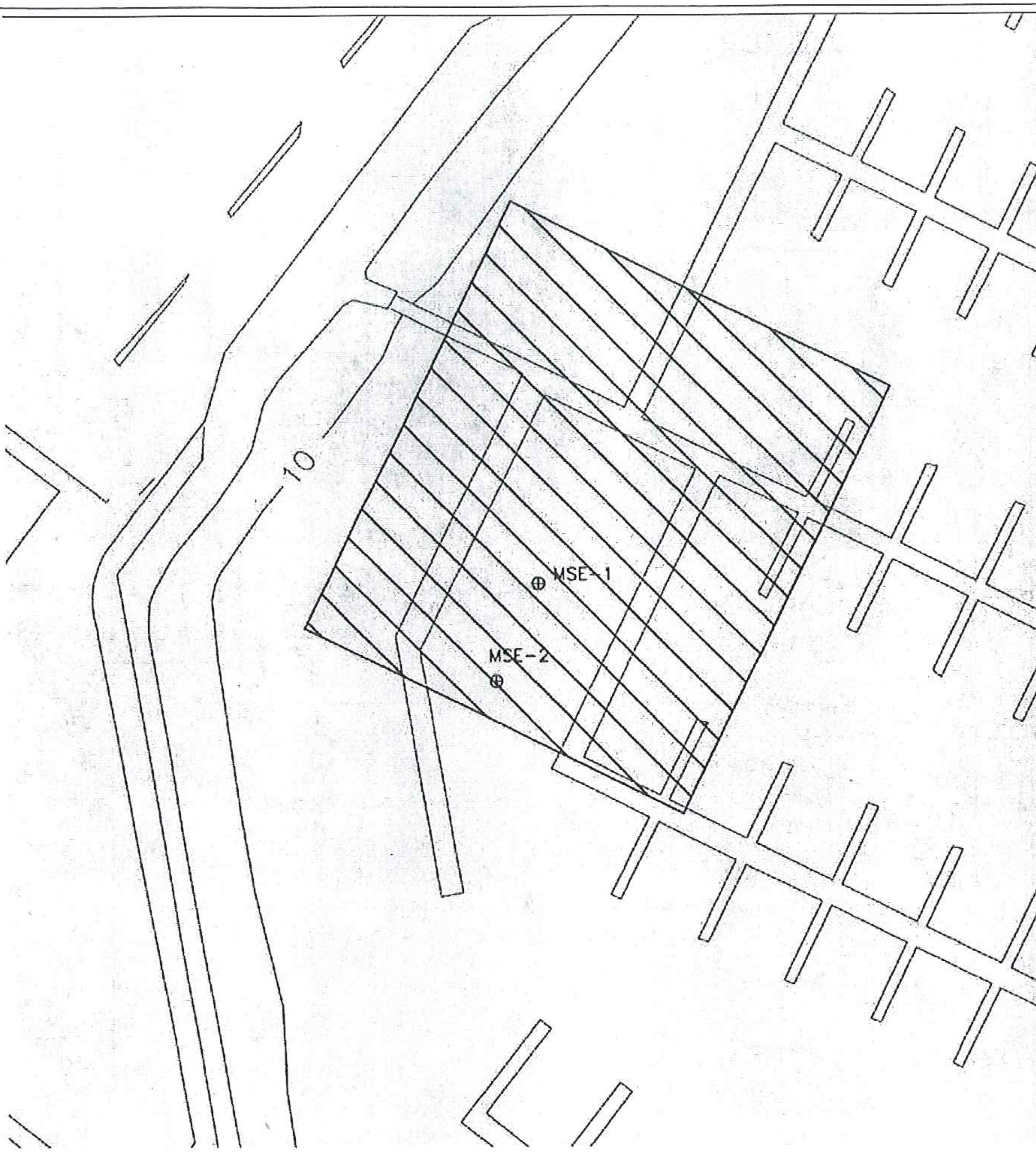

MSE-1 Core Sample Location (Collected 0-3 ft below Mudline)

Anticipated Maximum Extent of Site Remediation Area

0 50
Scale in Feet

Note: Figure prepared from drawing provided by RETEC entitled "Proposed Composite Sample Locations", dated April 29, 2002.

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Figure 3
Actual Core Sample Locations
Marine Services Northwest
Whatcom Waterway Pre-Remedial Design

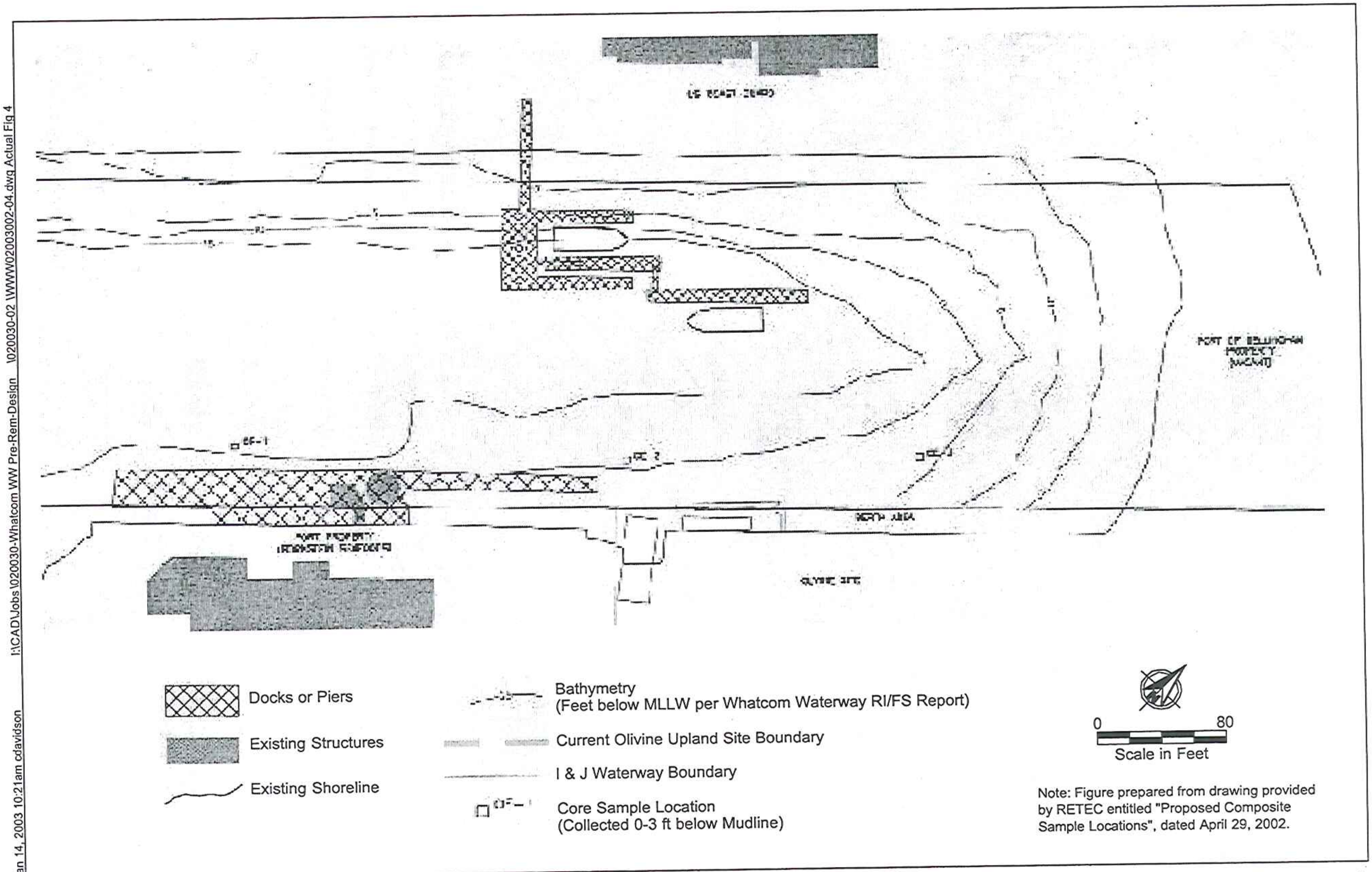

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Figure 4
Actual Core Sample Locations
at the Olivine Site
Whatcom Waterway Pre-Remedial Design

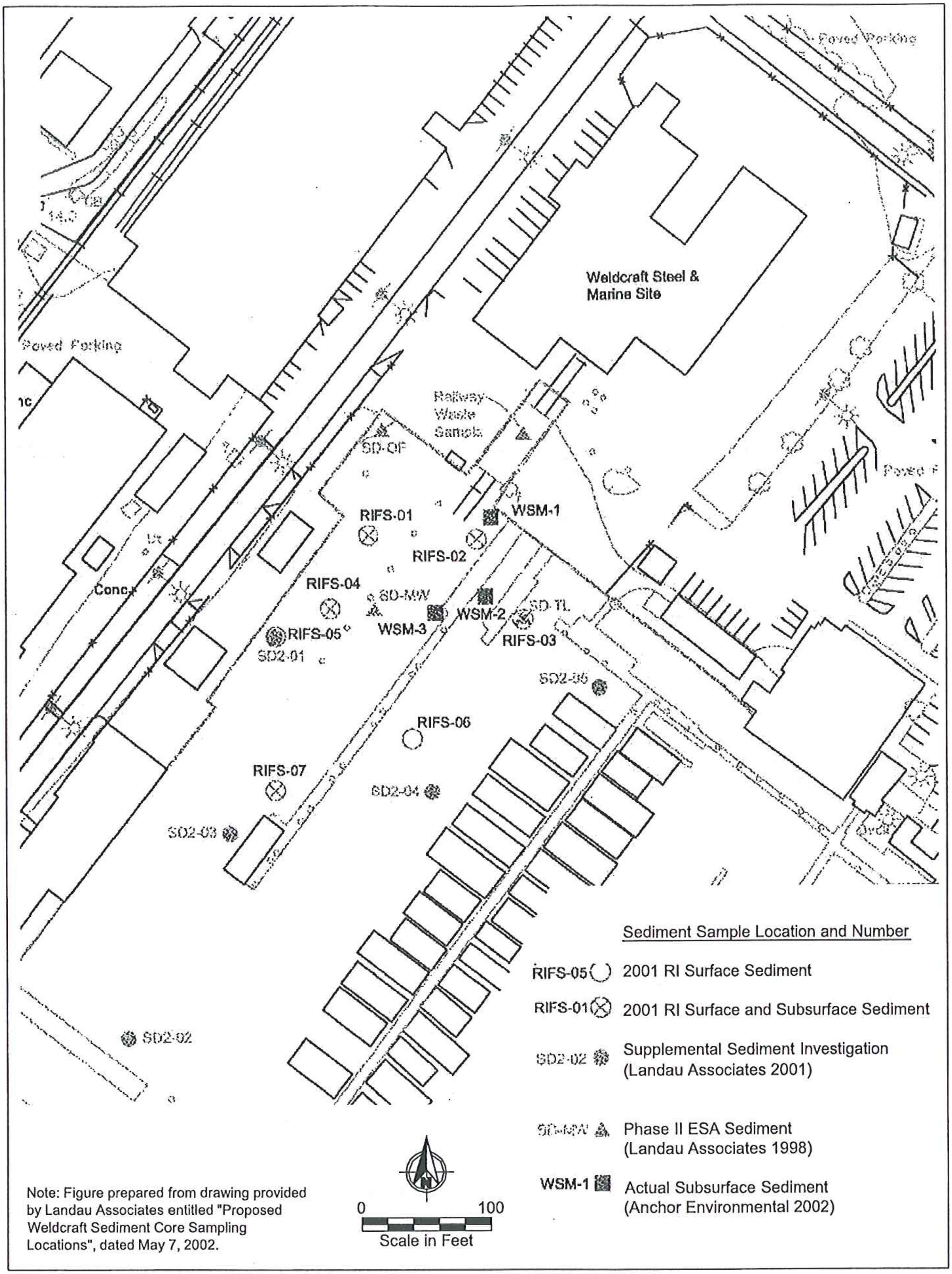

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Figure 5
Actual Core Sample Locations
Weldcraft Steel & Marine
Whatcom Waterway Pre-Remedial Design

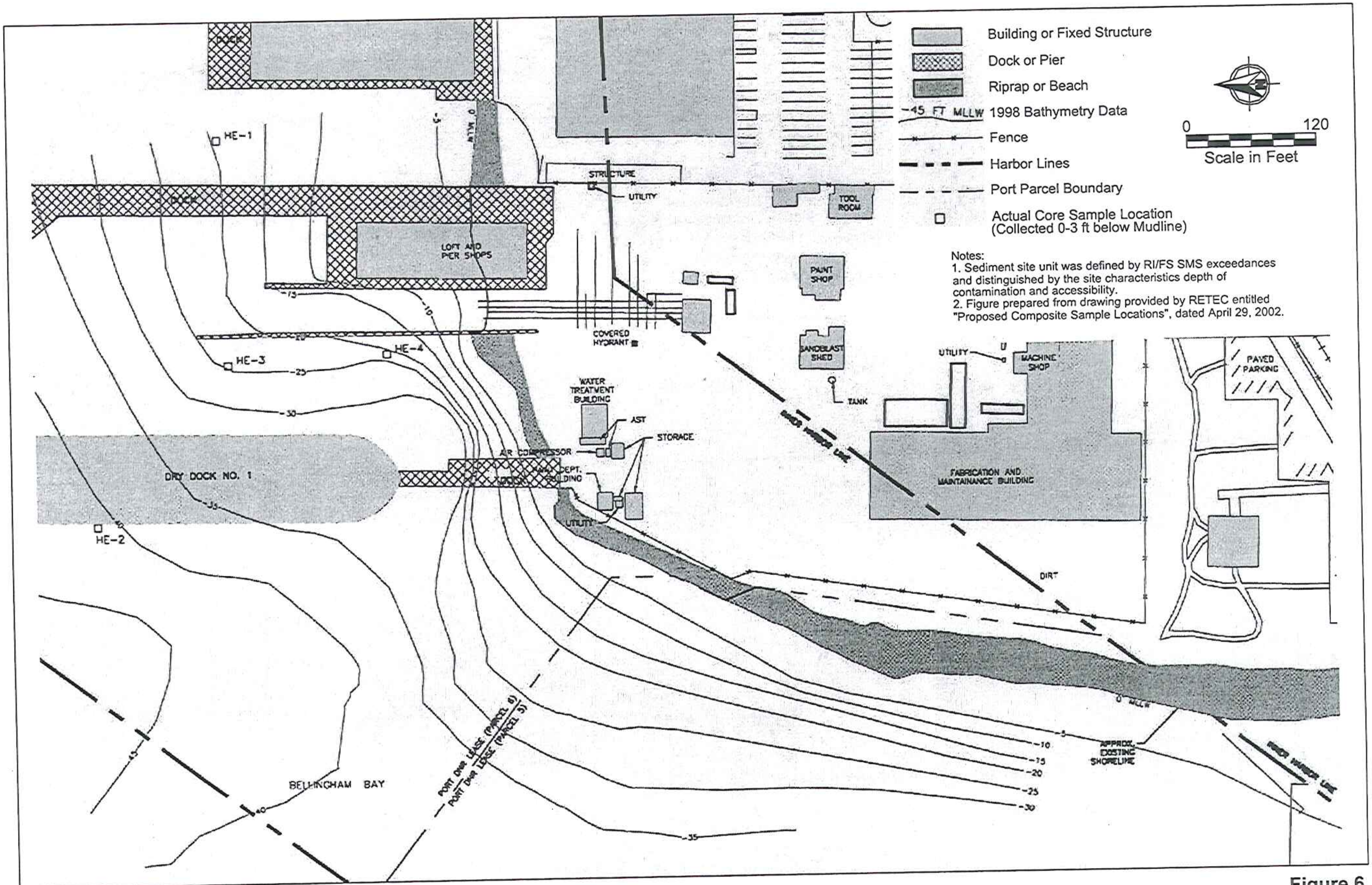

Figure 6
Actual Core Sample Locations
Harris Avenue Shipyard
Whatcom Waterway Pre-Remedial Design

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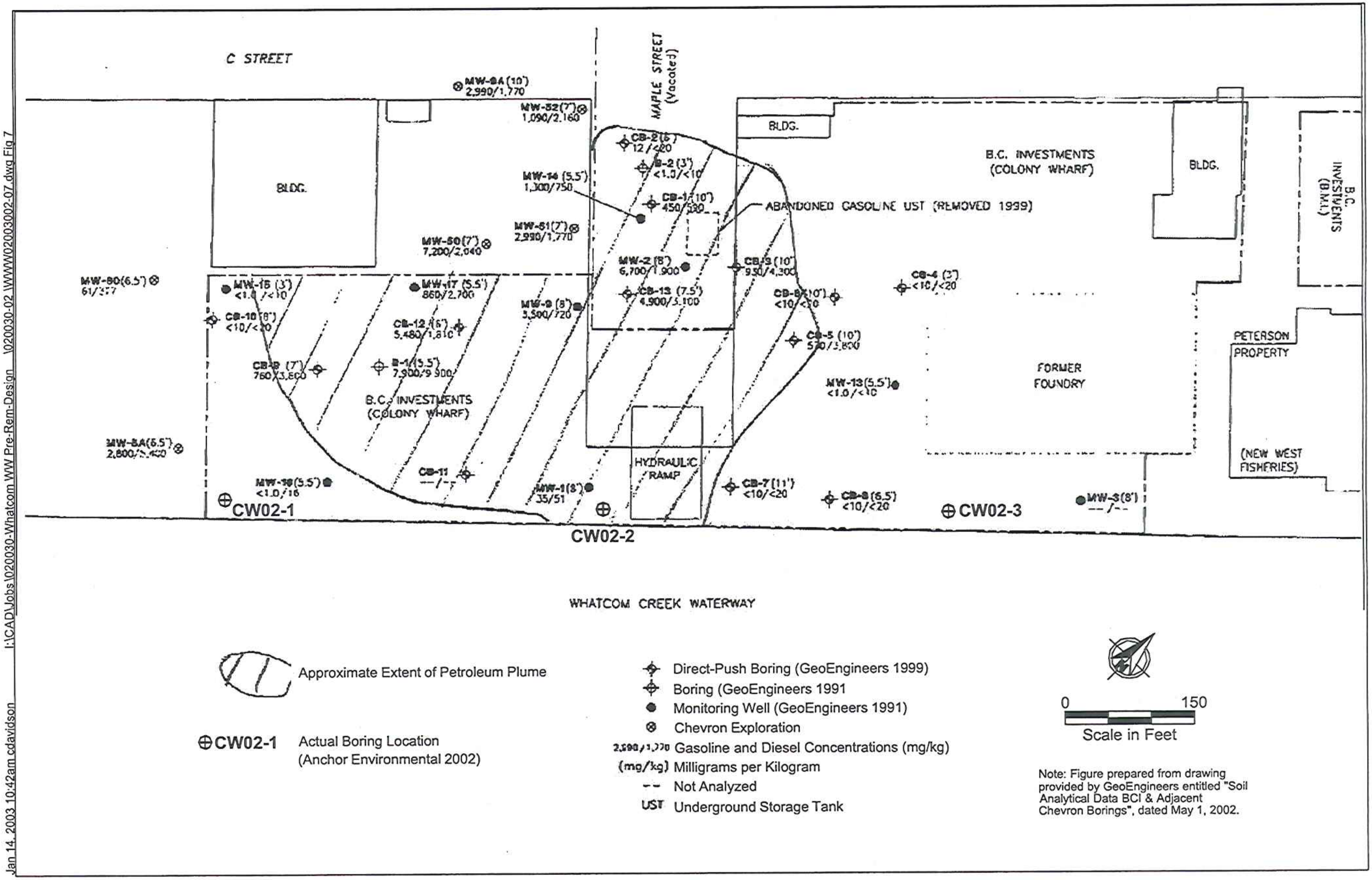

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Figure 7
Actual Soil Boring Locations
at Colony Wharf/BMI
Whatcom Waterway Pre-Remedial Design

3 FIELD ACTIVITIES

3.1 Sample Collection

Field sampling and handling were conducted in accordance with the Work Plan/SAP (Anchor 2002). Field activities were performed during the period of June 3 to 7, 2002 , under the direction of Mr. Dan Hennessy of Anchor and Mr. Bill Jaworski of Marine Sampling Systems (MSS). MSS provided the sampling vessel R/V Nancy Anne, all sample collection equipment, and on-board positioning system, with sampling support provided by Anchor and Landau staff. Mr. Charles Eaton of Bio-Marine Enterprises provided the sampling vessel R/V Kitiwake, the sampling equipment, and navigation equipment for collection of reference and grain size control stations from Carr Inlet, Washington, conducted in May 2002.

A total of 19 surface sediment grab samples, 16 PSDDA cores approximately 4 feet in length, and 20 contaminant mobility/geotechnical cores of varying lengths were collected during the field sampling effort. For the surface grabs, sediment samples were collected from the 0 to12 cm interval, which encompasses the biologically active zone in Bellingham Bay (Anchor and Hart Crowser 2000).

Sample location positions were determined with a differential global positioning system and are accurate to within 3 meters. Table 1 lists station identifiers, coordinates for all sample locations, mudline elevations, and core lengths, where applicable. Figure 2 depicts the locations of surface grabs and cores collected at the Whatcom Waterway Site. Figures 3 through 6, respectively, show the sampling locations at Marine Services Northwest, Olivine, Weldcraft Steel & Marine (Gate 2 Boatyard), and the Harris Avenue Shipyard Site. Figure 7 shows the location of nearshore boring locations at the Colony Wharf/BMI Site.

Table 1
Station Identification and Geographic Coordinates (NAD 83)

Sample ID	Date Sampled	Sample Location (NAD 83)		Sampling Depth (ft)	Mudline Elevation (ft MLLW)	Bottom of Core Elevation (ft MLLW)
		Latitude	Longitude			
AN-SS-03	6/7/02	48 43.9454236	122 30.4581209	0 to -0.6	-40.8	(0 to 12 cm interval)
AN-SS-08	6/7/02	48 44.2498906	122 30.1029401	0 to -0.6	-28.6	(0 to 12 cm interval)
AN-SS-13	6/6/02	48 44.7048603	122 29.9202930	0 to -0.6	-23.4	(0 to 12 cm interval)
AN-SS-22	6/6/02	48 44.6261979	122 29.7927005	0 to -0.6	-36.3	(0 to 12 cm interval)
AN-SS-23	6/6/02	48 44.7924423	122 29.7995959	0 to -0.6	-19.2	(0 to 12 cm interval)
AN-SS-24	6/6/02	48 44.8739015	122 29.8009371	0 to -0.6	-16.8	(0 to 12 cm interval)
AN-SS-25	6/6/02	48 44.9567385	122 29.8052347	0 to -0.6	-14.8	(0 to 12 cm interval)
AN-SS-26	6/6/02	48 45.0390345	122 29.8069918	0 to -0.6	-12.8	(0 to 12 cm interval)
AN-SS-29	6/7/02	48 44.5533695	122 29.4728966	0 to -0.6	-8.8	(0 to 12 cm interval)
AN-SS-30	6/7/02	48 44.5913353	122 29.5890271	0 to -0.6	-25.6	(0 to 12 cm interval)
AN-SS-303	6/7/02	48 44.1976802	122 30.0336478	0 to -0.6	-18.7	(0 to 12 cm interval)
AN-SS-305	6/7/02	48 44.0203555	122 30.1055173	0 to -0.6	-17.6	(0 to 12 cm interval)
AN-SS-31	6/7/02	48 44.6284031	122 29.6702439	0 to -0.6	-29.4	(0 to 12 cm interval)
AN-SS-32	6/6/02	48 44.8293576	122 29.6688401	0 to -0.6	-14.5	(0 to 12 cm interval)
AN-SS-33	6/7/02	48 44.8784540	122 29.5553671	0 to -0.6	-11.2	(0 to 12 cm interval)
AN-SS-34	6/7/02	48 44.9612952	122 29.4312714	0 to -0.6	-13.3	(0 to 12 cm interval)
AN-SS-35	6/7/02	48 45.0176129	122 29.3882879	0 to -0.6	-11.0	(0 to 12 cm interval)
AN-SS-80	6/7/02	48 45.0003879	122 29.2970559	0 to -0.6	-28.3	(0 to 12 cm interval)
AN-SS-81	6/7/02	48 45.0801198	122 29.1736873	0 to -0.6	-21.8	(0 to 12 cm interval)
AN-PC-101A	6/5/05	48 44.4686512	122 30.1316986	0 to -4	-33.0	-37.0
AN-PC-101B	6/5/05	48 44.5020614	122 30.0821461	0 to -4	-32.9	-36.9
AN-PC-101C	6/5/05	48 44.4405745	122 30.0884215	0 to -4	-33.4	-37.4
AN-PC-101D	6/5/05	48 44.4739850	122 30.0388696	0 to -4	-32.6	-36.6
AN-PC-102A	6/5/05	48 44.5214821	122 30.0533425	0 to -4	-33.1	-37.1
AN-PC-102B	6/5/05	48 44.5548925	122 30.0037891	0 to -4	-33.1	-37.1
AN-PC-102C	6/5/05	48 44.4934055	122 30.0100661	0 to -4	-33.1	-37.1
AN-PC-102D	6/5/05	48 44.5268156	122 29.9605127	0 to -4	-32.6	-36.6
AN-PC-103A	6/5/05	48 44.5743128	122 29.9749846	0 to -4	-32.9	-36.9

Table 1
Station Identification and Geographic Coordinates (NAD 83)

Sample ID	Date Sampled	Sample Location (NAD 83)		Sampling Depth (ft)	Mudline Elevation (ft MLLW)	Bottom of Core Elevation (ft MLLW)
		Latitude	Longitude			
AN-PC-103B	6/5/05	48 44.6077227	122 29.9254295	0 to -4	-33.0	-37.0
AN-PC-103C	6/5/05	48 44.5462358	122 29.9317082	0 to -4	-33.7	-37.7
AN-PC-103D	6/5/05	48 44.5796453	122 29.8821531	0 to -4	-32.6	-36.6
AN-PC-104A	6/5/05	48 44.6271427	122 29.8966240	0 to -4	-32.7	-36.7
AN-PC-104B	6/5/05	48 44.6605520	122 29.8470672	0 to -4	-30.6	-34.6
AN-PC-104C	6/5/05	48 44.5990652	122 29.8533476	0 to -4	-32.8	-36.8
AN-PC-104D	6/5/05	48 44.6324742	122 29.8037908	0 to -4	-33.6	-37.6
AN-VC-401	6/4/02	48 44.6816461	122 29.8195019	0 to -6	-31.1	-37.1
AN-VC-402	6/4/02	48 44.7639440	122 29.6752042	0 to -6	-30.9	-36.9
AN-VC-403	6/4/02	48 44.8200163	122 29.5321462	0 to -6	-31.7	-37.7
AN-VC-404	6/4/02	48 44.8656758	122 29.5284813	0 to -6	-24.8	-30.8
AN-VC-405	6/4/02	48 44.8876655	122 29.4147742	0 to -6	-29.8	-35.8
AN-VC-406	6/4/02	48 44.9528630	122 29.4052061	0 to -6	-23.8	-29.8
AN-VC-407	6/4/02	48 44.9714470	122 29.3419641	0 to -6	-28.4	-34.4
AN-VC-408	6/4/02	48 45.0439583	122 29.2683510	0 to -6	-21.6	-27.6
AN-HE-01	6/4/02	48 43.3175141	122 30.8522967	0 to -3	-22.8	-25.8
AN-HE-02	6/4/02	48 43.2987037	122 33.4271909	0 to -3	-40.3	-43.3
AN-HE-03	6/4/02	48 43.3154928	122 30.9045145	0 to -3	-25.4	-28.4
AN-HE-04	6/4/02	48 43.2914202	122 30.9015814	0 to -3	-10.8	-13.8
AN-OE-01	6/3/02	48 45.2640098	122 29.6185852	0 to -3	-17.9	-20.9
AN-OE-02	6/3/02	48 45.2918837	122 29.5742165	0 to -3	-14.2	-17.2
AN-OE-03	6/3/02	48 45.3137378	122 29.5424630	0 to -3	-7.3	-10.3
AN-WSM-01	6/3/02	48 45.4788027	122 30.3643456	0 to -3	-1.7	-4.7
AN-WSM-02	6/3/02	48 45.4688710	122 30.3652138	0 to -3	-8.0	-11.0
AN-WSM-03	6/3/02	48 45.4667108	122 30.3747463	0 to -3	-8.6	-11.6
AN-MSE-01	6/3/02	48 45.4899023	122 30.1101179	0 to -3	-11.1	-14.1
AN-MSE-02	6/3/02	48 45.4844413	122 30.1135466	0 to -3	-10.9	-13.9

3.2 Sample Processing

Surface grab samples were homogenized aboard the sampling vessel and transferred to certified, pre-labeled, pre-cleaned sample containers. Containers were packed in coolers with ice and couriered to analytical laboratories for chemical, physical, and biological analysis.

Core tubes collected for the Unit 1A/1B PSDDA screening-level characterization were capped and stored aboard the sampling vessel on ice. As each group of four cores for a single composite sample were collected, they were transferred to personnel on shore who extruded the material from each core, homogenized the sediments, transferred the material to sample containers, and packed the containers in coolers for subsequent delivery to the analytical laboratory. Table 2 shows the compositing scheme for these cores.

Table 2
Compositing Scheme for PSDDA Screening-Level Characterization, Units 1A/1B

Individual Sample ID	Composite Sample ID	Analysis
AN-PC-401	AN-PC-CMP1	PSDDA Chemicals
AN-PC-402		
AN-PC-403		
AN-PC-404		
AN-PC-405	AN-PC-CMP2	
AN-PC-406		
AN-PC-407		
AN-PC-408		
AN-PC-409	AN-PC-CMP3	
AN-PC-410		
AN-PC-411		
AN-PC-412		
AN-PC-413	AN-PC-CMP4	
AN-PC-414		
AN-PC-415		
AN-PC-416		

Core tubes for use in the TCLT were capped and stored aboard the sampling vessel on ice each day. At the end of the day, cores were transported to the processing laboratory for extrusion and processing of the sediment. Core tube processing at the laboratory was conducted under anaerobic conditions in accordance with the Work Plan/SAP (Anchor

2002). Table 3 shows the compositing scheme for the TCLT evaluation cores and summarizes proportions that each sampling area contributed to the master TCLT composite sample.

Table 3
Compositing Scheme, Composite Sample IDs, and Analysis for TCLT Evaluation

Sampling Site and Individual Sample ID	Area Composite Sample ID	Percent Contribution to Master Composite	Master Composite Sample ID	Analysis
Whatcom Waterway			AN-TC-MCMP	Metals and SVOCs in all six area composites and the master composite
AN-VC-401	AN-TC-CMP1	92.3%		
AN-VC-402				
AN-VC-403				
AN-VC-404				
AN-VC-405				
AN-VC-406				
AN-VC-407				
AN-VC-408				
Harris Avenue Shipyard				
AN-HE-01	AN-TC-CMP2	3.1%		
AN-HE-02				
AN-HE-03				
AN-HE-04				
Olivine				
AN-OE-01	AN-TC-CMP3	2.5%		
AN-OE-02				
AN-OE-03				
Weldcraft Steel & Marine (Gate 2 Boatyard)				
AN-WSM-01	AN-TC-CMP4	0.9%		
AN-WSM-02				
AN-WSM-03				
Colony Wharf/BMI				
GE-CW02-01	AN-TC-CMP5	0.6%		
GE-CW02-02				
GE-CW02-03				
Marine Services NW				
AN-MSE-01	AN-TC-CMP6	0.5%		
AN-MSE-02				

3.3 Deviations from the Work Plan/SAP

The sampling location for AN-VC-407, one of eight cores collected within the Whatcom Waterway, was moved approximately 140 feet north and 130 feet east of the proposed location. Two coring attempts at and near the originally proposed location encountered pea gravel and yielded insufficient sediment recovery. Coring was successful at the third location. Because similar sediment chemical concentrations are expected within the general area of AN-VC-407, encompassing both the proposed and final sample locations, this minor deviation did not adversely affect data quality or usability.

There were no other deviations from the approved Work Plan/SAP (Anchor 2002) either during sample collection or processing.

4 CHEMICAL AND PHYSICAL TESTING

Analytical Resources Inc. (ARI), an Ecology-certified laboratory located in Tukwila, Washington, conducted the chemical testing. Rosa Environmental and Geotechnical Laboratory, Seattle, Washington set up and maintained the TCLT, and also conducted all physical testing for the dredge water quality/settling/testing component. Chemical, physical, and toxicity testing adhered to the most recent Puget Sound Estuary Protocols (PSEP) quality assurance/quality control (QA/QC) procedures (PSEP 1997b) and PSEP analysis protocols. Metals and organic compounds were analyzed according to the guidelines provided in PSEP (1997c) and PSEP (1997d), respectively. Method 9060 (USEPA 1986) was used for the analysis of TOC because the analytical method for TOC in PSEP (1986) is now out of date (PTI 1995). Atterberg limits, specific gravity, consolidation, effective porosity, hydraulic conductivity, and shear strength were analyzed according to American Society for Testing and Materials (ASTM) methods. Sediment toxicity testing was conducted in accordance with Washington Sediment Management Standards (SMS) and PSEP guidelines (1995). All analyses conformed to procedures described in the approved Work Plan/SAP (Anchor 2002), and in the referenced Quality Assurance Project Plans.

4.1 Quality Control/Quality Assurance

The overall data QA/QC program for the PRDE evaluation followed procedures previously developed for the Whatcom Waterway RI/FS, and presented in detail in Anchor (1998a, b). Measures taken to ensure data quality employed current EPA and Ecology protocols. Specific actions are described below:

4.1.1 Field QA/QC

Field QA/QC samples were used to evaluate the efficiency of field decontamination procedures. Filter wipes and blanks were collected for each type of sampling (i.e., surface and subsurface sediments) and were analyzed for the parameters specific to the type of sampling being conducted.

4.1.2 Laboratory QA/QC

For sediment tests, one of the samples submitted for chemical analysis was analyzed as a laboratory matrix spike/matrix spike duplicate (MS/MSD). Additional quality control included method blanks, method blank spikes, surrogate compound analysis, and standard reference material analysis.

For bioassay tests, standard QA/QC procedures were in place to ensure validity of test results and were evaluated based on SMS and PSEP (1997a) performance criteria as described previously in Anchor (1998a, b). Standard QA/QC procedures included the use of negative controls, reference sediment samples, replication, measurement of water quality during testing, and reference toxicant tests.

4.1.3 Chain of Custody

Chain-of-custody forms and seals were used to track sample custody and document the proper handling and integrity of the samples. All containerized sediment samples were shipped to the analytical laboratory after preparation.

4.1.4 Data Validation

Data validation reports are provided in Appendix A, and verified the accuracy and precision of chemical determinations performed during this investigation. All PRDE data were determined to be useable, as qualified in this Data Report, for the purposes of forthcoming remedial design. However, data validation resulted in two primary qualifications. First, bulk sediment antimony determinations did not meet project data quality objectives, and thus were rejected for design purposes. Nevertheless, because antimony is not an identified COPC within the Whatcom Waterway Site (Anchor and Hart Crowser 2000), rejection of the antimony data did not adversely affect the overall usability of the PRDE data set.

Second, leachate samples collected between the 17th and 19th pore volumes of the TCLT contained a significant amount of visible precipitate, which affected the quality of samples collected from the column during this period. A glass fiber filter is normally specified in TCLT procedures (Myers et al. 1996). However, because tributyltin (TBT) is a chemical of potential concern in Bellingham Bay, and because filtering of TBT samples is no longer considered appropriate (PSEP 1997a-d, Hoffman 1998), the filter was not installed in this application. Nevertheless, following observations of discolored and turbid leachate, samples were submitted for both total and dissolved mercury analyses.

Between the 17th and 19th pore volumes of the TCLT, more than a 20-fold variation was observed between dissolved and total mercury concentrations. Because of the high variability observed, this limited set of mercury data were rejected. Since leachate sample data collected before and after this short-term precipitate condition were apparently unaffected, this qualification did not adversely affect the overall usability of the PRDE data set.

4.2 Confirmatory Surface Sediment Chemistry Results

Sampling locations for the 19 surface sediment samples collected from the Whatcom Waterway are shown in Figure 2. All 19 samples were tested for conventionals (total organic carbon, total solids, and grain size), total mercury, and selected phenolic COPCs (2,4-dimethyphenol, 2-methylphenol, 4-methylphenol, pentachlorophenol, and phenol). Validated chemical determinations performed on these samples are summarized in Table 4.

In addition to conventional parameters, the COPCs total mercury, phenol, 2,4-dimethylphenol, 2-methylphenol, and 4-methylphenol were detected in one or more of the 19 samples (Table 4). Concentrations of COPCs were generally lower during the 2002 PRDE sampling, compared to previous 1996-1998 RI/FS samples, consistent with natural recovery modeling predictions (Anchor and Hart Crowser 2000). Mercury exceeded the SQS chemical criterion (0.41 mg/kg) in 12 of the 19 PRDE samples, and also exceeded the minimum cleanup level chemical criterion (MCUL; 0.59 mg/kg) in eight of the samples. Similarly, 2,4-dimethylphenol was detected at concentrations exceeding both the SQS and MCUL chemical criteria (29 μg/kg) in seven of the 19 PRDE samples. The maximum mercury and 2,4-dimethylphenol concentrations detected in the PRDE surface sediment samples were 2.55 mg/kg (station AN-SS-32) and 87 μg/kg (station AN-SS-34), respectively; both of these sample locations were located adjacent to portions of the G-P ASB shoreline (Figure 2). Mercury concentrations detected at station AN-SS-32 also exceeded the site-specific bioaccumulation screening level (BSL) of 1.2 mg/kg (Anchor and Hart Crowser 2000). As discussed in Section 5.0 below, confirmatory biological testing of selected PRDE stations was performed to further evaluate compliance with SQS criteria. Figure 9 provides a summary of sediment analytical chemistry and bioassay testing results, including data from this study and earlier investigations (Anchor and Hart Crowser 2000).

Table 4
Analytical Results for Whatcom Waterway PRDE Surface Sediment Chemistry Samples

Sample ID Sample Date	SQS Criteria	AN-SS-03 6/7/2002	AN-SS-08 6/7/2002	AN-SS- 3 6/6/2002	AN-SS-22 6/6/2002	AN-SS-23 6/6/2002	AN-SS-24 6/6/2002	AN-SS-25 6/6/2002	AN-SS-26 6/6/2002	AN-SS-29 6/7/2002	AN-SS-30 6/7/2002
Conventionals (%)											
Total Organic Carbon	...	2.8	2.4	2.4	2.3	2.7	2.9	2.5	3.1	2.4	3.0
Total solids	...	32.4	41.6	42.8	34.2	43.3	44.4	40.5	63	45.3	39.6
Grain Size (%)											
Gravel	...	0	1.9	0.4	0	1.2	3.8	1.5	1.6	1.5	7.7
Sand	...	7.0	6.1	5.3	3.1	14.9	27.4	18.7	75.1	38	5.4
Silt	...	60.6	55.5	62.4	60.1	54.6	46.9	55.3	13.6	47.8	51.3
Clay	...	32.3	36.6	31.9	36.8	29.3	21.8	24.4	9.9	12.7	35.6
Metals (mg/kg)											
Mercury	0.41	0.20	0.42	0.99	0.30	1.09	1.1	0.8	0.26	0.50	0.40
SVOCs (µg/kg)											
2,4-Dimethylphenol	29	40 U	40 U	46	40 U	53	40 U	75	39 U	40 U	50
2-Methylphenol	63	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
4-Methylphenol	670	290	70	45	69	36	38	55	22	110	93
Pentachlorophenol	400	60 U	60 U	60 U	60 U	60 U	59 U	60 U	59 U	60 U	59 U
Phenol	420	100 U	99 U	100 U	100 U	100 U	99 U	99 U	98 U	130	99 U

Sample ID Sample Date	SQS Criteria	AN-SS-31 6/7/2002	AN-SS-32 6/6/2002	AN-SS-33 6/7/2002	AN-SS-34 6/7/2002	AN-SS-35 6/7/2002	AN-SS-80 6/7/2002	AN-SS-81 6/7/2002	AN-SS-303 6/7/2002	AN-SS-305 6/7/2002
Conventionals (%)										
Total Organic Carbon	...	2.7	2.8	4.0	3.4	4.2	3.1	3.1	3.6	5.0
Total solids	...	38.1	60.1	36.8	51.5	40.7	38.1	42.3	36.2	32.8
Grain Size (%)										
Gravel	...	0.2	6.5	13.4	24	6.3	2.2	0.6	13.1	2.6
Sand	...	5.4	63.2	31.1	47.7	43.6	13.1	38.6	18.0	50.3
Silt	...	57.2	18.1	33.3	17.7	41.3	52.3	46.8	43.8	26.2
Clay	...	37.3	12.0	22.2	10.6	9.0	32.5	13.9	25.2	21.0
Metals (mg/kg)										
Mercury	0.41	0.40	2.55	1.02	0.56	0.50	0.40	0.27	0.82	1.0
SVOCs (µg/kg)										
2,4-Dimethylphenol	29	40 U	39 U	40 U	87	40 U	40 U	42	39 U	77
2-Methylphenol	63	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20	20 U
4-Methylphenol	670	48	46	83	92	140	130	310	86	77
Pentachlorophenol	400	60 U	59 U	59 U	60 U	59 U	60 U	59 U	59 U	60 U
Phenol	420	100 U	99 U	99 U	100 U	120	100 U	99 U	99 U	100 U

Notes: Yellow and orange shaded values denote exceedance of screening level SQS and MCUL chemical criteria, respectively.

4.3 Screening Level PSDDA Characterization – Units 1A and 1B

Following general screening-level PSDDA characterization procedures, 16 sediment cores, each approximately 4 feet long, were collected from sediment site Units 1A/1B (Figure 2) and were combined to form four 4-point composite samples for chemical analysis. Each of the four composite samples was tested for the standard PSDDA list of conventionals, metals, semivolatile organic chemicals (SVOCs), PCBs, and pesticides, consistent with analyte list used in previous PSDDA screening-level evaluations of the I&J Waterway and the head of the Whatcom Waterway (Anchor and Hart Crowser 2000). Validated chemical determinations performed on the PRDE samples are summarized in Table 5.

Only mercury exceeded the PSDDA open-water disposal screening level (0.41 mg/kg; equivalent to the SQS) in any of the four PSDDA sediment composite samples collected from the outer Whatcom Waterway (Units 1A and 1B). Mercury concentrations in the PSDDA composites ranged from 0.90 to 1.25 mg/kg (Table 5). However, none of the screening samples exceeded the PSDDA maximum level for mercury (2.3 mg/kg).

Surface sediments with similar or higher mercury concentrations as those of the PSDDA composites did not exhibit biological effects during the PRDE sampling (see Table 4 and Section 5.0 below). Based on this comparison, potential suitability of Unit 1A/1B sediments for open-water disposal is likely. However, confirmatory biological testing was not performed during the PRDE study to verify suitability for PSDDA open-water disposal (such testing would be required as an element of a final PSDDA suitability determination, should it be needed). Nevertheless, suitability for beneficial reuse of Unit 1A/1B sediments as ASB upland capping material is indicated by these data, as chemical concentrations in the composite samples were at or below the more restrictive of Model Toxics Control Act (MTCA) Method A or B soil screening levels for unrestricted site uses (WAC 173-340; Table 5).

Table 5
Analytical Results for Whatcom Waterway Unit 1A/1B PSDDA Screening

Sample ID Sample Date	PSDDA Screening Levels	PSDDA Max. Level	MTCA Unrestricted Land Use Soil Screening Criteria - Method A (or B)	AN-PC-CMP1 6/5/2002	AN-PC-CMP2 6/5/2002	AN-PC-CMP3 6/5/2002	AN-PC-CMP4 6/5/2002
Conventionals (%)							
Total Organic Carbon	--	--	--	2.5	2.3	2.0	2.1
Total Solids	--	--	--	44.8	47.7	47.5	47.1
Total Volatile Solids	--	--	--				
Grain Size (%)							
Gravel	--	--	--	0.3	0.9	0.9	10.0
Sand	--	--	--	10.9	27.1	9.7	21.7
Silt	--	--	--	45.7	38.1	48.1	35.8
Clay	--	--	--	43.0	34.1	41.4	32.3
Metals (mg/kg)							
Antimony	150	200	(32)	R	R	R	R
Arsenic	57	700	20	10 U	11	11	12
Cadmium	5.1	14	2	0.6	0.7	0.8	0.6
Copper	390	1,300	(2,960)	49	43	51	52
Lead	450	1,200	250	18	16	19	19
Mercury	0.41	2.30	2	1.01	0.90	1.10	1.25
Nickel	140	370	(1,600)	97	80	91	90
Silver	6.1	8.4	(400)	0.6 U	0.6 U	0.6 U	0.6 U
Zinc	410	3,800	(24,000)	97	87	100	97
Tributyltin (µg/L in porewater)							
Tributyltin ion	0.15	--	--	0.025 U	0.025 U	0.025 U	0.031 J
PCBs (µg/kg)							
Aroclor 1016	--	--		20 U	20 U	20 U	20 U
Aroclor 1221	--	--		40 U	39 U	40 U	39 U
Aroclor 1232	--	--		20 U	20 U	20 U	20 U
Aroclor 1242	--	--		20 U	20 U	20 U	20 U
Aroclor 1248	--	--		20 U	28 U	34 U	29 U
Aroclor 1254	--	--	--	20 U	20 U	25	20
Aroclor 1260	--	--		20 U	20 U	20 U	20 U
Total PCBs	130	3,100	100	40 U	39 U	25	20
Pesticides (µg/kg)							
4,4'-DDD	--	--		2 U	2 U	2 U	1.9 U
4,4'-DDE	--	--		2 U	2 U	2 U	1.9 U
4,4'-DDT	--	--		2 U	2 U	2 U	1.9 U
Total DDT	6.9	69	1,000	2 U	2 U	2 U	2 U
Aldrin	10	--	(59)	1 U	1 U	1 U	1 U
gamma-BHC (Lindane)	10	--	(1,000)	1 U	1 U	1 U	1 U
alpha-Chlordane	10	--	(770)	1 U	1 U	1 U	1 U
Dieldrin	10	--	(62)	2 U	2 U	2 U	2 U
Heptachlor	10	--	(220)	1 U	1 U	1 U	1 U
SVOCs (µg/kg)							
LPAHs							
Naphthalene	2,100	2,400	(3,200,000)	36	29	37	52
Acenaphthylene	560	1,300	--	20 U	20 U	19 U	20 U
Acenaphthene	500	2,000	(4,800,000)	20 U	20 U	19 U	15 J
Fluorene	540	3,600	(3,200,000)	20 U	20 U	19 U	23
Phenanthrene	1,500	21,000	--	59	46	65	94
Anthracene	960	13,000	(24,000,000)	16 J	13 J	19 J	35
2-Methylnaphthalene	670	1,900	--	13 J	20 U	19 U	18 J
Total LPAH	5,200	29,000	--	124	88	121	237
HPAHs							
Fluoranthene	1,700	30,000	(3,200,000)	77	68	81	150
Pyrene	2,600	16,000	(2,400,000)	67	67	92	150
Benzo(a)anthracene	1,300	5,100	100	25	22	26	56
Chrysene	1,400	21,000	100	34	30	39	77
Benzo(b)fluoranthene	3,200	9,900	100	27	28	37	48
Benzo(k)fluoranthene	3,200	9,900	100	27	33	34	53
Benzo(a)pyrene	1,600	3,600	100	18 J	22	26	49
Indeno(1,2,3-cd)pyrene	600	4,400	100	17 J	17 J	18 J	31

Table 5
Analytical Results for Whatcom Waterway Unit 1A/1B PSDDA Screening

Sample ID Sample Date	PSDDA Screening Levels	PSDDA Max. Level	MTCA Unrestricted Land Use Soil Screening Criteria - Method A (or B)	AN-PC-CMP1 6/5/2002	AN-PC-CMP2 6/5/2002	AN-PC-CMP3 6/5/2002	AN-PC-CMP4 6/5/2002
Dibenzo(a,h)anthracene	230	1,900	100	20 U	20 U	19 U	20 U
Benzo(g,h,i)perylene	670	3,200	--	20	20	23	30
Total HPAH	12,000	69,000	--	312	307	376	644
Chlorinated Hydrocarbons							
1,3-Dichlorobenzene	170	--	--	20 U	20 U	19 U	20 U
1,4-Dichlorobenzene	110	120	--	20 U	20 U	19 U	20 U
1,2-Dichlorobenzene	35	110	(7,200,000)	20 U	20 U	19 U	20 U
1,2,4-Trichlorobenzene	31	64	(800,000)	20 U	20 U	19 U	20 U
Hexachlorobenzene	22	230	(620)	1.9	1.7	2.4	1.6
Phthalates							
Dimethylphthalate	1,400	--	(80,000,000)	20 U	20 U	19 U	20 U
Diethylphthalate	1,200	--	(64,000,000)	20 U	20 U	19 U	20 U
Di-n-butylphthalate	5,100	--	(8,000,000)	20 U	20 U	19 U	20 U
Butylbenzylphthalate	970	--	(16,000,000)	20 U	20 U	19 U	20 U
bis(2-Ethylhexyl)phthalate	8,300	--	(71,000)	44	32	56	41
Di-n-octylphthalate	6,200	--	(1,600,000)	20 U	20 U	19 U	20 U
Phenols							
Phenol	420	1,200	(48,000,000)	20 U	20 U	19 U	24
2-Methylphenol	63	77	--	20 U	20 U	19 U	20 U
4-Methylphenol	670	3,600	--	50	31	43	52
2,4-Dimethylphenol	29	210	--	20 U	20 U	19 U	20 U
Pentachlorophenol	400	690	(8,300)	99 U	98 U	97 U	98 U
Misc Extractables							
Benzyl alcohol	57	870	(24,000,000)	20 U	20 U	19 U	20 U
Benzoic acid	650	760	(320,000,000)	200 U	200 U	190 U	200 U
Dibenzofuran	540	1,700	--	15 J	20 U	19 J	23
Hexachloroethane	1,400	14,000	(71,000)	20 U	20 U	19 U	20 U
Hexachlorobutadiene	29	270	(13,000)	1 U	1 U	1 U	1 U
n-Nitrosodiphenylamine	28	1,300	(204,000)	20 U	20 U	19 U	20 U

Notes:

U: Not detected. J: Estimated value. R: Rejected value.

Yellow shaded values denote exceedance of screening level PSDDA chemical criteria.

4.4 Dredge Water Quality, Settling, and Consolidation Test Results

Results of sediment elutriate (DRET and MET), consolidation, column settling, and geotechnical parameter tests are summarized below.

4.4.1 Dredge Elutriate and Modified Elutriate Test Results

A DRET and MET were performed on a representative sample of prospective sediments to be dredged from the Whatcom Waterway, to support forthcoming remedial design evaluations of potential water quality impacts at the point of dredging, and of water quality discharged from the ASB during filling, respectively. Sampling locations were in areas of above-average chemical concentrations, as compared with the overall area targeted for dredging. Filtered and unfiltered elutriate samples from the DRET and MET were analyzed for conventionals, metals, and SVOCs. Validated chemical determinations from these tests are summarized on Table 6.

No SVOCs were detected in any of the DRET or MET samples (Table 6). Moreover, metals concentrations detected in the elutriate samples were below surface water quality acute and chronic toxicity criteria (USEPA 2002), as applicable to the dissolved or total recoverable fraction of specific metals. The DRET and MET data indicate that no short-term water quality impacts are likely at either the point of sediment dredging or disposal. More detailed water quality evaluations will be included as part of the forthcoming remedial design.

Table 6
Analytical Results for DRET and MET Determinations

Location ID Sample ID Sample Date	Water Quality Criteria Saltwater Chronic	Saltwater Acute	Whatcom Waterway Composite Sample AN-TC-CMP1 DRET (F)[1] 6/18/2002	DRET (U)[2] 6/18/2002	AN-TC-CMP1 MET (F)[1] 6/19/2002	MET (U)[2] 6/19/2002
Conventionals (mg/L)						
Total Organic Carbon	--	--	--	3.0	--	9.2
Metals (µg/L)						
Arsenic	36	69	3	4	8	7
Cadmium	8.8 (1)	40 (1)	2 U	2 U	2 U	2 U
Chromium	--	--	5 U	16	5 U	5 U
Copper	3.1 (1)	4.8 (1)	2 U	15	2 U	2 U
Lead	8.1 (1)	210 (1)	5 U	11	5 U	5 U
Mercury	0.94	1.8	0.01 U	0.75	0.05	0.04
Nickel	8.2 (1)	74 (1)	5	18	6	6
Silver	--	1.9 (1)	0.4 U	0.4 U	0.4 U	0.4 U
Zinc	81 (1)	90 (1)	6 U	26	6 U	6 U
SVOCs (µg/L)						
LPAHs						
Naphthalene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Acenaphthylene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Acenaphthene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Fluorene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Phenanthrene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Anthracene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
2-Methylnaphthalene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
HPAHs						
Fluoranthene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Pyrene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(a)anthracene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Chrysene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(b)fluoranthene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(k)fluoranthene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(a)pyrene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Indeno(1,2,3-cd)pyrene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Dibenzo(a,h)anthracene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(g,h,i)perylene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Chlorinated Hydrocarbons						
1,3-Dichlorobenzene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Hexachlorobenzene	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Phthalates						
Dimethylphthalate	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Diethylphthalate	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-butylphthalate	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Butylbenzylphthalate	--	--	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Ethylhexyl)phthalate	--	--	4.0 U	4.0 U	4.0 U	4.0 U
Di-n-octylphthalate	--	--	2.0 U	2.0 U	2.0 U	2.0 U
Phenols						
Phenol	--	--	2.0 U	2.0 U	2.0 U	2.0 U
2-Methylphenol	--	--	1.0 U	1.0 U	1.0 U	1.0 U
4-Methylphenol	--	--	1.0 U	1.0 U	1.0 U	1.0 U
2,4-Dimethylphenol	--	--	3.0 U	3.0 U	3.0 U	3.0 U
Pentachlorophenol	7.9	13	5.0 U	5.0 U	5.0 U	5.0 U
Misc Extractables						
Benzyl alcohol	--	--	5.0 U	5.0 U	5.0 U	5.0 U
Benzoic acid	--	--	50 U	50 U	50 U	50 U
Dibenzofuran	--	--	1.0 U	1.0 U	1.0 U	1.0 U
Hexachloroethane	--	--	2.0 U	2.0 U	2.0 U	2.0 U
Hexachlorobutadiene	--	--	2.0 U	2.0 U	2.0 U	2.0 U
n-Nitrosodiphenylamine	--	--	1.0 U	1.0 U	1.0 U	1.0 U

Notes: All water quality criteria from USEPA (2002)

1) Filtered (dissolved) sample analyses. 2) Unfiltered (total recoverable) sample analyses.

U - undetected at the reported concentration

4.4.2 Column Settling, Consolidation, and Geotechnical Test Results

A CST was performed on the Whatcom Waterway prospective dredge prism composite, to support remedial design evaluations of solids retention within the ASB during hydraulic filling, and to provide information concerning the volumes occupied by newly placed layers of dredged material. A consolidation test was also performed on this sample to provide additional information on the short-and long-term capacity of the ASB. Additional supporting geotechnical parameters were determined on the composite sample and on selected individual grab samples, including water content, grain size distribution, Atterberg limits, specific gravity, consolidation, hydraulic conductivity, and effective porosity.

The results of the CST, consolidation test, and various geotechnical tests are included in Appendix B. More detailed settlement and consolidation analyses will be performed using these data, and included as part of the forthcoming remedial design.

4.5 Thin-Layer Column Leach Test Results

A TCLT was conducted during this PRDE study to evaluate chemical mobility of a sediment composite representative of the range of Bellingham Bay sediments currently targeted for disposal in the ASB. Both bulk sediment and leachate samples were collected and analyzed for this component of the investigation. Results are presented below.

4.5.1 Bulk Sediment Analyses

Bulk sediment analyses were performed on the six individual site composite samples, as well as on the master composite comprised of proportionate contributions from each of the sites. Validated chemical determinations performed on these samples are summarized in Table 7.

COPCs for the TCLT evaluation may be identified for initial comparison purposes based on exceedance of SQS (or PSDDA) screening levels in the master composite (Table 7). This comparison resulted in identification of the following three COPCs:

- **Mercury** – also present above screening levels in the Whatcom Waterway and Weldcraft Steel & Marine (Gate 2 Boatyard) subsamples

- **4-Methylphenol** – relatively elevated concentrations of this analyte (though below screening levels) were also observed in the Whatcom Waterway and Olivine subsamples
- **Tributyltin (TBT)** – present above screening levels in the Harris Avenue Shipyard, Marine Services Northwest, and Weldcraft (Gate 2 Boatyard) subsamples, and only marginally below the PSDDA screening level in the master composite.

Other chemicals that exceeded SQS or PSDDA screening levels in individual site sediment composites/subsamples, but were nevertheless below screening levels in the master composite included: copper (Weldcraft and Marine Services NW), zinc (Marine Services NW), 2-methylphenol (Olivine), 2,4-dimethylphenol (Olivine), and fluoranthene (Olivine). The leachate analyses summarized in the section below provided a direct evaluation of the potential mobility of these chemicals in a confined disposal site setting such as the ASB.

4.5.2 TCLT Leachate Analyses

The TCLT was conducted over the period from June to December 2002, during which a total of 27 leachate samples, constituting approximately 22 pore volumes of 1.1 L each, were collected from the column. Leachate samples were analyzed for metals, tributyltin, SVOCs, and pesticides, as well as conventional water quality parameters. Chemical determinations are summarized in Table 8.

Table 7
Analytical Results for Bellingham Bay TCLT Bulk Sediment Composites

Composite Sample Site Proportion in TCLT		TCLT Master Composite	Whatcom Waterway 92.3%	Harris Ave. Shipyard 3.1%	Olivine 2.5%	Weldcraft (Gate 2) 0.9%	Colony Wharf/BMI 0.6%	Marine Services NW 0.5%
Sample ID Sample Date	**SQS (or PSDDA) Screening Level**	**AN-TC-MCMP 6/13/2002**	**AN-TC-CMP1 6/13/2002**	**AN-TC-CMP2 6/13/2002**	**AN-TC-CMP3 6/12/2002**	**AN-TC-CMP4 6/11/2002**	**AN-TC-CMP5 6/10/2002**	**AN-TC-CMP6 6/11/2002**
Conventionals (%)								
Total Organic Carbon	--	5.1	3.7	2.3	4.3	3.2	1.8	2.3
Total Solids	--	49.6	54.2	77.5	53.6	50.4	85.6	42.4
Total Volatile Solids	--	9.2	9.1	2.0	18.0	9.6	1.9	6.0
Metals (mg/kg dry basis)								
Arsenic	57	30 U	10 U	20 U	20 U	20 U	30 U	10
Cadmium	5.1	1.0	1.3	0.7 U	0.9 U	0.9 U	1 U	0.4 U
Copper	390	71	66	49	57	433	62	643
Lead	450	70	62	27	28	53	90	20
Mercury	0.41	2.40	4.55	0.11	0.41	7.60	0.05	0.40
Nickel	(140)	70	67	32	109	107	19	94
Silver	6.1	2 U	0.6	1 U	1 U	1 U	2 U	0.7 U
Zinc	410	139	120	77	121	306	91	472
Tributyltin (µg/kg dry basis)								
Tributyltin ion	(73)	66	12	260	8	1,800	5 U	2,000
SVOCs (µg/kg dry basis)								
Phenols								
Phenol	420	230	59 U	59 U	96	59 U	19 U	58 U
2-Methylphenol	63	60 U	59 U	59 U	76	59 U	19 U	58 U
4-Methylphenol	670	1,100	400	59 U	670	59 U	19 U	58 U
2,4-Dimethylphenol	29	60 U	59 U	59 U	260	59 U	19 U	58 U
Pentachlorophenol	400	130 J	290 U	290 U	300 U	240 J	97 UJ	290 U
Misc Extractables								
Benzyl alcohol	57	60 U	59 U	59 U	59 U	59 U	19 U	58 U
Benzoic acid	650	600 U	590 U	590 U	590 U	590 U	190 U	580 U
SVOCs (mg/kg organic carbon basis)								
LPAHs								
Naphthalene	99	7	12	3	8	5	32	2.5 U
Acenaphthylene	66	1.2 U	1.6 U	2.6 U	1.4 U	5	1.1 U	2.5 U
Acenaphthene	16	7	13	2.6 U	3	15	2	2.5 U
Fluorene	23	5	7	2.6 U	4	12	4	2.5 U
Phenanthrene	100	15	17	7	11	69	11	9
Anthracene	220	7	4	3	4	24	2	6
2-Methylnaphthalene	38	5	9	2.6 U	7	3	32	2.5 U
Total LPAH	370	46	61	13	37	133	82	15
HPAHs								
Fluoranthene	160	22	14	12	20	166	11	17
Pyrene	1,000	15	11	17	17	150	12	22
Benzo(a)anthracene	110	4	3	4	4	38	21	6
Chrysene	110	5	4	6	7	56	32	8
Benzo(b+k)fluoranthene	230	7	4	11	7	94	89	12
Benzo(a)pyrene	99	3	2	5	3	27	36	4
Indeno(1,2,3-cd)pyrene	34	1	1.6 U	3	2	15	29	3
Dibenzo(a,h)anthracene	12	1.2 U	1.6 U	2.6 U	1.4 U	4	9	2.5 U
Benzo(g,h,i)perylene	31	1.2 U	1.6 U	3	1	8	22	2.5 U
Total HPAH	960	57	36	60	60	557	260	73
Chlorinated Hydrocarbons								
1,3-Dichlorobenzene	--	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
1,4-Dichlorobenzene	3.1	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
1,2-Dichlorobenzene	2.3	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
1,2,4-Trichlorobenzene	0.81	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
Phthalates								
Dimethylphthalate	53	1.2 U	1.6 U	2.6 U	1.4 U	7	1.1 U	4
Diethylphthalate	61	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
Di-n-butylphthalate	220	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
Butylbenzylphthalate	4.9	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
bis(2-Ethylhexyl)phthalate	47	5 B	6 B	2.6 U	5 B	34 B	6 B	16 B
Di-n-octylphthalate	58	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
Misc Extractables								
Dibenzofuran	15	5	8	2.6 U	6	11	3	2.5 U
Hexachloroethane	--	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U
n-Nitrosodiphenylamine	11	1.2 U	1.6 U	2.6 U	1.4 U	1.8 U	1.1 U	2.5 U

Notes:
U: Not detected. J: Estimated value. R: Rejected value.
B: Analyte detected in associated blank.
Yellow shaded values denote exceedance of screening level SQS or PSDDA chemical criteria.

Table 8
Analytical Results for Bellingham Bay TCLT Leachate Samples

Bottle Number	Initial Water	C3-01	C3-02	C3-03	C3-04	C3-05	C3-06
Cumulative Leachate Volume (Liters)	NA	0.89	1.78	2.63	3.53	4.42	5.26
Pore Volume (unitless)		0.81	1.62	2.39	3.21	4.02	4.78
TCLT Leachate							
Water Quality Parameters							
pH		7.53	7.53	7.65	7.69	7.63	7.64
Eh (mv)		-27.3	37.2	170.5	138.2	173.2	148.2
Electrical conductivity (mS)		22	17.9	10.5	8	6.1	3.6
Salinity (ppt)		11	9	5	4	3	1.9
Dissolved oxygen (mg/L)		2.6	1.6	1.1	1.3	1.5	1.9
Ferrous iron (mg/L)		0.1	0.1	0.1	0.1	0.3	0.3
Metals (µg/L)							
Arsenic	--	--	2 U	--	2 U	--	**2**
Cadmium	--	--	2 U	--	2 U	--	2 U
Chromium (total)	--	--	5 U	--	5 U	--	**11**
Copper	--	--	3	--	2 U	--	**7**
Lead	--	--	5 U	--	2 U	--	2 U
Mercury	--	--	**0.0106**	--	**0.029**	--	**0.12**
Nickel	--	--	**18**	--	**12**	--	**13**
Silver	--	--	0.4 U	--	0.2 U	--	0.2 U
Zinc	--	--	6 U	--	6 U	--	6 U
Tributyltin (ion)	--	--	0.019 U	--	0.019 U	--	0.019 U
LPAHs (µg/L)							
Naphthalene	--	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthylene	--	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthene	--	1.0 U	--	1.0 U	--	1.0 U	--
Fluorene	--	1.0 U	--	1.0 U	--	1.0 U	--
Phenanthrene	--	1.0 U	--	1.0 U	--	1.0 U	--
Anthracene	--	1.0 U	--	1.0 U	--	1.0 U	--
2-Methylnaphthalene	--	1.0 U	--	1.0 U	--	1.0 U	--
HPAHs (µg/L)							
Fluoranthene	--	1.0 U	--	1.0 U	--	1.0 U	--
Pyrene	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)anthracene	--	1.0 U	--	1.0 U	--	1.0 U	--
Chrysene	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(b)fluoranthene	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(k)fluoranthene	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)pyrene	--	1.0 U	--	1.0 U	--	1.0 U	--
Indeno(1,2,3-cd)pyrene	--	1.0 U	--	1.0 U	--	1.0 U	--
Dibenzo(a,h)anthracene	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(g,h,i)perylene	--	1.0 U	--	1.0 U	--	1.0 U	--
Phthalates (µg/L)							
Dimethylphthalate	--	1.0 U	--	1.0 U	--	1.0 U	--
Diethylphthalate	--	1.0 U	--	1.0 U	--	1.0 U	--
Di-n-butylphthalate	--	1.0 U	--	1.0 U	--	1.0 U	--
Butylbenzylphthalate	--	1.0 U	--	1.0 U	--	1.0 U	--
Bis(2-ethylhexyl)phthalate	--	4.0 U	--	4.0 U	--	4.0 U	--
Di-n-octylphthalate	--	2.0 U	--	2.0 U	--	2.0 U	--
Chlorinated Organics (µg/L)							
1,2-Dichlorobenzene	--	1.0 U	--	1.0 U	--	1.0 U	--
1,3-Dichlorobenzene	--	1.0 U	--	1.0 U	--	1.0 U	--
1,4-Dichlorobenzene	--	1.0 U	--	1.0 U	--	1.0 U	--
1,2,4-Trichlorobenzene	--	1.0 U	--	1.0 U	--	1.0 U	--
Misc. Extractables (µg/L)							
Phenol	--	2.0 U	--	2.0 U	--	2.0 U	--
2-Methylphenol	--	1.0 U	--	1.0 U	--	1.0 U	--
4-Methylphenol	--	1.0 U	--	1.0 U	--	1.0 U	--
2,4-Dimethylphenol	--	3.0 U	--	3.0 U	--	3.0 U	--
Pentachlorophenol	--	5.0 U	--	5.0 U	--	5.0 U	--
Dibenzofuran	--	1.0 U	--	1.0 U	--	1.0 U	--
N-Nitrosodiphenylamine	--	1.0 U	--	1.0 U	--	1.0 U	--
Benzyl alcohol	--	5.0 U	--	5.0 U	--	5.0 U	--
Benzoic acid	--	50 U	--	50 U	--	50 U	--
Hexachloroethane	--	2.0 U	--	2.0 U	--	2.0 U	--
Hexachlorobenzene	--	1.0 U	--	1.0 U	--	1.0 U	--
Hexachlorobutadiene	--	2.0 U	--	2.0 U	--	2.0 U	--

Notes:

(a) Mercury data were rejected based on the following facts:

i) Leachate output between pore volumes 17 and 19 was discolored and turbid due to a short term precipitation condition.

ii) A filter was not installed in theTCLT based on TBT analysis procedures (PSEP 1997a-d; Hoffman 1998). Therefore samples collected during the precipitation condition were not representative.

iii) Mercury concentrations were highly variable during this period (greater than 20-times difference between total and dissolved measurements).

Table 8
Analytical Results for Bellingham Bay TCLT Leachate Samples

Bottle Number	C3-07	C3-08	C3-09	C3-10	C3-11	C3-12
Cumulative Leachate Volume (Liters)	6.12	7.01	7.92	8.76	9.63	10.48
Pore Volume (unitless)	5.56	6.37	7.20	7.96	8.75	9.53
TCLT Leachate						
Water Quality Parameters						
pH	7.81	7.9	8.15	8.47	8.4	8.72
Eh (mv)	142.4	153.8	124.7	124.2	138.7	145.3
Electrical conductivity (mS)	2.2	1.3	0.9	0.64	0.54	0.41
Salinity (ppt)	1.1	0.7	0.4	0.3	0.3	0.2
Dissolved oxygen (mg/L)	2	1.2	1.1	0.6	0.6	0.9
Ferrous iron (mg/L)	0.1	1.1	2.0	2.1	2.8	3.3
Metals (µg/L)						
Arsenic	--	2.0	--	2.7	--	3.5
Cadmium	--	2 U	--	2 U	--	2 U
Chromium (total)	--	23	--	40	--	51
Copper	--	12	--	22.1	--	31
Lead	--	5	--	13	--	20
Mercury	--	0.39	--	0.862	--	1.02
Nickel	--	12.4	--	23.4	--	31.1
Silver	--	0.2 U	--	0.2 U	--	0.2 U
Zinc	--	17	--	36	--	60
Tributyltin (ion)	--	0.018 J	--	0.035 JB	--	0.023 JB
LPAHs (µg/L)						
Naphthalene	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthylene	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthene	1.0 U	--	1.0 U	--	1.0 U	--
Fluorene	1.0 U	--	1.0 U	--	1.0 U	--
Phenanthrene	1.0 U	--	1.0 U	--	1.0 U	--
Anthracene	1.0 U	--	1.0 U	--	1.0 U	--
2-Methylnaphthalene	1.0 U	--	1.0 U	--	1.0 U	--
HPAHs (µg/L)						
Fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)anthracene	1.0 U	--	1.0 U	--	1.0 U	--
Chrysene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(b)fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(k)fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Indeno(1,2,3-cd)pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Dibenzo(a,h)anthracene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(g,h,i)perylene	1.0 U	--	1.0 U	--	1.0 U	--
Phthalates (µg/L)						
Dimethylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Diethylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Di-n-butylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Butylbenzylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Bis(2-ethylhexyl)phthalate	4.0 U	--	4.0 U	--	4.0 U	--
Di-n-octylphthalate	2.0 U	--	2.0 U	--	2.0 U	--
Chlorinated Organics (µg/L)						
1,2-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,3-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,4-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,2,4-Trichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
Misc. Extractables (µg/L)						
Phenol	2.0 U	--	2.0 U	--	2.0 U	--
2-Methylphenol	1.0 U	--	1.0 U	--	1.0 U	--
4-Methylphenol	1.0 U	--	1.0 U	--	1.0 U	--
2,4-Dimethylphenol	3.0 U	--	3.0 U	--	3.0 U	--
Pentachlorophenol	5.0 U	--	5.0 U	--	5.0 U	--
Dibenzofuran	1.0 U	--	1.0 U	--	1.0 U	--
N-Nitrosodiphenylamine	1.0 U	--	1.0 U	--	1.0 U	--
Benzyl alcohol	5.0 U	--	5.0 U	--	5.0 U	--
Benzoic acid	50 U	--	50 U	--	50 U	--
Hexachloroethane	2.0 U	--	2.0 U	--	2.0 U	--
Hexachlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
Hexachlorobutadiene	2.0 U	--	2.0 U	--	2.0 U	--

Notes:

(a) Mercury data were rejected based on the f

i) Leachate output between pore volumes

ii) A filter was not installed in theTCLT bas

iii) Mercury concentrations were highly va

Table 8
Analytical Results for Bellingham Bay TCLT Leachate Samples

Bottle Number	C3-13	C3-14	C3-15	C3-16	C3-17	C3-18
Cumulative Leachate Volume (Liters)	11.37	12.3	13.08	13.97	14.8	15.64
Pore Volume (unitless)	10.34	11.15	11.89	12.70	13.45	14.22
TCLT Leachate						
Water Quality Parameters						
pH	8.79	9.13	9.03	8.83	8.61	8.62
Eh (mv)	127.6	22.3	-245.4	-49.1	70	-11.6
Electrical conductivity (mS)	0.41	0.3	0.25	0.22	0.24	0.25
Salinity (ppt)	0.2	0.1	0.1	0.1	0.1	0.1
Dissolved oxygen (mg/L)	0.8	0.9	1.0	1.1	1.2	0.5
Ferrous iron (mg/L)	5.0	6.1	6.5	3.3	3.2	3.7
Metals (µg/L)						
Arsenic	--	**3.1**	--	**2.3**	--	**2.6**
Cadmium	--	2.0 U	--	2.0 U	--	2.0 U
Chromium (total)	--	**54**	--	**41**	--	**43**
Copper	--	**44**	--	**33**	--	**34**
Lead	--	**26**	--	**21**	--	**23**
Mercury	--	**1.13**	--	**1.29**	--	**1.05**
Nickel	--	**35.1**	--	**26.9**	--	**28.8**
Silver	--	0.2 U	--	0.2 U	--	0.2 U
Zinc	--	**63**	--	**51**	--	**51**
Tributyltin (ion)	--	**0.034**	--	**0.029**	--	**0.019 J**
LPAHs (µg/L)						
Naphthalene	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthylene	1.0 U	--	1.0 U	--	1.0 U	--
Acenaphthene	**1.0**	--	1.0 U	--	1.0 U	--
Fluorene	1.0 U	--	1.0 U	--	1.0 U	--
Phenanthrene	1.0 U	--	1.0 U	--	1.0 U	--
Anthracene	1.0 U	--	1.0 U	--	1.0 U	--
2-Methylnaphthalene	1.0 U	--	1.0 U	--	1.0 U	--
HPAHs (µg/L)						
Fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)anthracene	1.0 U	--	1.0 U	--	1.0 U	--
Chrysene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(b)fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(k)fluoranthene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(a)pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Indeno(1,2,3-cd)pyrene	1.0 U	--	1.0 U	--	1.0 U	--
Dibenzo(a,h)anthracene	1.0 U	--	1.0 U	--	1.0 U	--
Benzo(g,h,i)perylene	1.0 U	--	1.0 U	--	1.0 U	--
Phthalates (µg/L)						
Dimethylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Diethylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Di-n-butylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Butylbenzylphthalate	1.0 U	--	1.0 U	--	1.0 U	--
Bis(2-ethylhexyl)phthalate	4.0 U	--	1.0 U	--	4.0 U	--
Di-n-octylphthalate	2.0 U	--	1.0 U	--	2.0 U	--
Chlorinated Organics (µg/L)						
1,2-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,3-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,4-Dichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
1,2,4-Trichlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
Misc. Extractables (µg/L)						
Phenol	2.0 U	--	2.0 U	--	2.0 U	--
2-Methylphenol	1.0 U	--	1.0 U	--	1.0 U	--
4-Methylphenol	1.0 U	--	1.0 U	--	1.0 U	--
2,4-Dimethylphenol	3.0 U	--	3.0 U	--	3.0 U	--
Pentachlorophenol	5.0 U	--	5.0 U	--	5.0 U	--
Dibenzofuran	1.0 U	--	1.0 U	--	1.0 U	--
N-Nitrosodiphenylamine	1.0 U	--	1.0 U	--	1.0 U	--
Benzyl alcohol	5.0 U	--	5.0 U	--	5.0 U	--
Benzoic acid	50 U	--	30 U	--	50 U	--
Hexachloroethane	2.0 U	--	2.0 U	--	2.0 U	--
Hexachlorobenzene	1.0 U	--	1.0 U	--	1.0 U	--
Hexachlorobutadiene	2.0 U	--	2.0 U	--	2.0 U	--

Notes:

(a) Mercury data were rejected based on the f

i) Leachate output between pore volumes

ii) A filter was not installed in theTCLT bas

iii) Mercury concentrations were highly va

Table 8
Analytical Results for Bellingham Bay TCLT Leachate Samples

Bottle Number	C3-19	C3-20	C3-21	C3-22	C3-23	
Cumulative Leachate Volume (Liters)	16.54	17.41	18.31	19.2	20.1	
Pore Volume (unitless)	15.04	15.83	16.65	17.45	18.27	
					Total	Dissolved
TCLT Leachate						
Water Quality Parameters						
pH	8.21	8.77	8.72	8.27	8.61	8.61
Eh (mv)	-196.6	-207.4	-211.2	-120.6	8.2	8.2
Electrical conductivity (mS)	0.24	0.23	0.22	0.21	0.21	0.21
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1
Dissolved oxygen (mg/L)	1.0	0.8	0.5	1.2	1.4	1.4
Ferrous iron (mg/L)	6.1	5.6	6.4	7.0	4.0	4.0
Metals (µg/L)						
Arsenic	--	3.0	--	3.1	--	--
Cadmium	--	2.0 U	--	2.0 U	--	--
Chromium (total)	--	49	--	56	--	--
Copper	--	42	--	50	--	--
Lead	--	32	--	39	--	--
Mercury	--	1.16	--	R (a)	R (a)	R (a)
Nickel	--	36.4	--	41.2	--	--
Silver	--	0.2 U	--	0.2	--	--
Zinc	--	66	--	88	--	--
Tributyltin (ion)	--	0.030	--	0.026 J	--	--
LPAHs (µg/L)						
Naphthalene	1.0 U	--	1.0 U	--	--	--
Acenaphthylene	1.0 U	--	1.0 U	--	--	--
Acenaphthene	1.0 U	--	1.0	--	--	--
Fluorene	1.0 U	--	1.0 U	--	--	--
Phenanthrene	1.0 U	--	1.0 U	--	--	--
Anthracene	1.0 U	--	1.0 U	--	--	--
2-Methylnaphthalene	1.0 U	--	1.0 U	--	--	--
HPAHs (µg/L)						
Fluoranthene	1.0 U	--	1.0 U	--	--	--
Pyrene	1.0 U	--	1.0 U	--	--	--
Benzo(a)anthracene	1.0 U	--	1.0 U	--	--	--
Chrysene	1.0 U	--	1.0 U	--	--	--
Benzo(b)fluoranthene	1.0 U	--	1.0 U	--	--	--
Benzo(k)fluoranthene	1.0 U	--	1.0 U	--	--	--
Benzo(a)pyrene	1.0 U	--	1.0 U	--	--	--
Indeno(1,2,3-cd)pyrene	1.0 U	--	1.0 U	--	--	--
Dibenzo(a,h)anthracene	1.0 U	--	1.0 U	--	--	--
Benzo(g,h,i)perylene	1.0 U	--	1.0 U	--	--	--
Phthalates (µg/L)						
Dimethylphthalate	1.0 U	--	1.0 U	--	--	--
Diethylphthalate	1.0 U	--	1.0 U	--	--	--
Di-n-butylphthalate	1.0 U	--	1.0 U	--	--	--
Butylbenzylphthalate	1.0 U	--	1.0 U	--	--	--
Bis(2-ethylhexyl)phthalate	4.0 U	--	4.0 U	--	--	--
Di-n-octylphthalate	2.0 U	--	2.0 U	--	--	--
Chlorinated Organics (µg/L)						
1,2-Dichlorobenzene	1.0 U	--	1.0 U	--	--	--
1,3-Dichlorobenzene	1.0 U	--	1.0 U	--	--	--
1,4-Dichlorobenzene	1.0 U	--	1.0 U	--	--	--
1,2,4-Trichlorobenzene	1.0 U	--	1.0 U	--	--	--
Misc. Extractables (µg/L)						
Phenol	2.0 U	--	2.5	--	--	--
2-Methylphenol	1.0 U	--	1.0 U	--	--	--
4-Methylphenol	1.0 U	--	57	--	--	--
2,4-Dimethylphenol	3.0 U	--	3.0 U	--	--	--
Pentachlorophenol	5.0 U	--	5.0 U	--	--	--
Dibenzofuran	1.0 U	--	1.0 U	--	--	--
N-Nitrosodiphenylamine	1.0 U	--	1.0 U	--	--	--
Benzyl alcohol	5.0 U	--	5.0 U	--	--	--
Benzoic acid	50 U	--	50 U	--	--	--
Hexachloroethane	2.0 U	--	2.0 U	--	--	--
Hexachlorobenzene	1.0 U	--	1.0 U	--	--	--
Hexachlorobutadiene	2.0 U	--	2.0 U	--	--	--

Notes:

(a) Mercury data were rejected based on the fo

i) Leachate output between pore volumes

ii) A filter was not installed in theTCLT bas

iii) Mercury concentrations were highly var

Table 8
Analytical Results for Bellingham Bay TCLT Leachate Samples

Bottle Number / Cumulative Leachate Volume (Liters) / Pore Volume (unitless)	C3-24 20.98 19.07	C3-25a 21.33 19.39	C3-25b 21.99 19.99	C3-26 22.8 20.76
TCLT Leachate				
Water Quality Parameters				
pH	8.22	8.13	8.76	8.28
Eh (mv)	68.8	119.6	-182.1	-4.2
Electrical conductivity (mS)	0.19	0.25	0.20	0.22
Salinity (ppt)	0.1	0.1	0.1	0.1
Dissolved oxygen (mg/L)	1.5	3.6	0.8	1
Ferrous iron (mg/L)	4.2	2.8	6.0	2.9
Metals (µg/L)				
Arsenic		--	2.0	1.7
Cadmium		--	2 U	2 U
Chromium (total)		--	35	41
Copper		--	30	21
Lead		--	21	15
Mercury	R (a)	0.806		1.04
Nickel		--	25.3	16.7
Silver		--	0.2 U	0.2 U
Zinc		--	52	43
Tributyltin (ion)		--		
LPAHs (µg/L)				
Naphthalene	--	--	--	--
Acenaphthylene	--	--	--	--
Acenaphthene	--	--	--	--
Fluorene	--	--	--	--
Phenanthrene	--	--	--	--
Anthracene	--	--	--	--
2-Methylnaphthalene	--	--	--	--
HPAHs (µg/L)				
Fluoranthene	--	--	--	--
Pyrene	--	--	--	--
Benzo(a)anthracene	--	--	--	--
Chrysene	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--
Benzo(a)pyrene	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--
Dibenzo(a,h)anthracene	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--
Phthalates (µg/L)				
Dimethylphthalate	--	--	--	--
Diethylphthalate	--	--	--	--
Di-n-butylphthalate	--	--	--	--
Butylbenzylphthalate	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--
Di-n-octylphthalate	--	--	--	--
Chlorinated Organics (µg/L)				
1,2-Dichlorobenzene	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--
Misc. Extractables (µg/L)				
Phenol	--	--	--	--
2-Methylphenol	--	--	--	--
4-Methylphenol	--	--	--	--
2,4-Dimethylphenol	--	--	--	--
Pentachlorophenol	--	--	--	--
Dibenzofuran	--	--	--	--
N-Nitrosodiphenylamine	--	--	--	--
Benzyl alcohol	--	--	--	--
Benzoic acid	--	--	--	--
Hexachloroethane	--	--	--	--
Hexachlorobenzene	--	--	--	--
Hexachlorobutadiene	--	--	--	--

Notes:

(a) Mercury data were rejected based on the fo

i) Leachate output between pore volumes

ii) A filter was not installed in theTCLT bas

iii) Mercury concentrations were highly vai

The COPCs mercury and TBT were regularly detected in the TCLT leachate, and exhibited peak concentrations in the test shortly after the salinity decline, a result consistent with colloidal mobilization or "salt wash-out" mechanisms (Myers et al. 1996). Temporal variations in salinity, total mercury, and TBT in leachate are summarized in Figure 8. Peak TCLT leachate concentrations of mercury and TBT were compared to the following criteria:

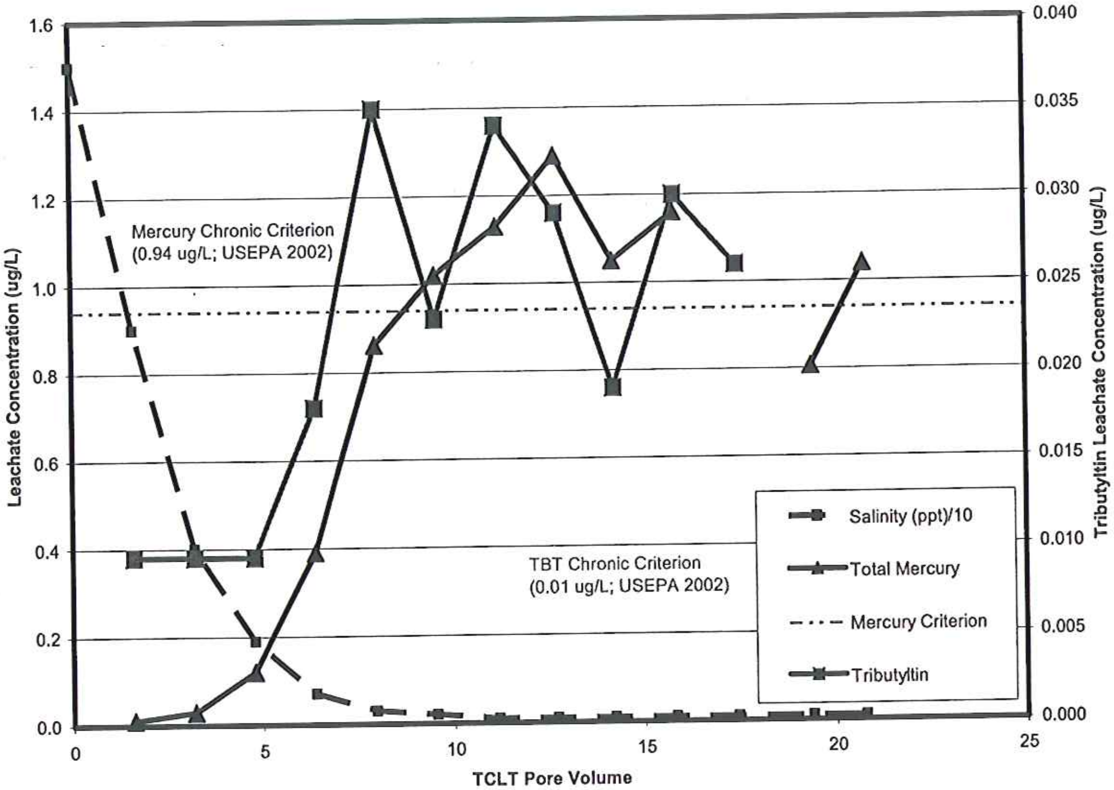
- Mercury acute (1.8 μg/L) and chronic (0.94 μg/L) marine water quality criteria (USEPA 2002)
- TBT chronic (0.01 μg/L) marine quality criteria (USEPA 2002)
- TBT Puget Sound no adverse effects level (0.05 μg/L) (Michelsen et. al. 1996)

The exposure averaging times where a detrimental response would be predicted were based on Washington State Water Quality Standards (WAC 173-201A). The acute mercury criterion is a 1-hour average concentration not to be exceeded more than once every three years on the average. The averaging times for the chronic criterion and the Puget Sound TBT no adverse effects level was a 4-day average concentration not to be exceeded more than once every three years on the average.

Peak mercury concentrations in the TCLT leachate did not exceed the acute criterion, but did exceed the 0.94 μg/L chronic toxicity criterion by less than twofold. Peak TBT levels exceeded the 0.01 μg/L chronic aquatic life criterion (USEPA 2002) but was less than the TBT chronic toxicity criteria of 0.05 μg/L derived by Michelsen et al. (1996). Because only a single detection of 4-methylphenol occurred in the TCLT leachate (to 57 μg/L), and also because no water quality criterion has been promulgated for this chemical, 4-methylphenol was not verified as a leachate COPC in the Bellingham Bay sediment composite.

The results of the TCLT will support subsequent remedial design evaluations of long-term water quality protection, including control of potential bioaccumulation pathways, provided by the prospective confined disposal facility.

Figure 8
Variation of Salinity, Mercury, and TBT Concentrations in TCLT Leachate



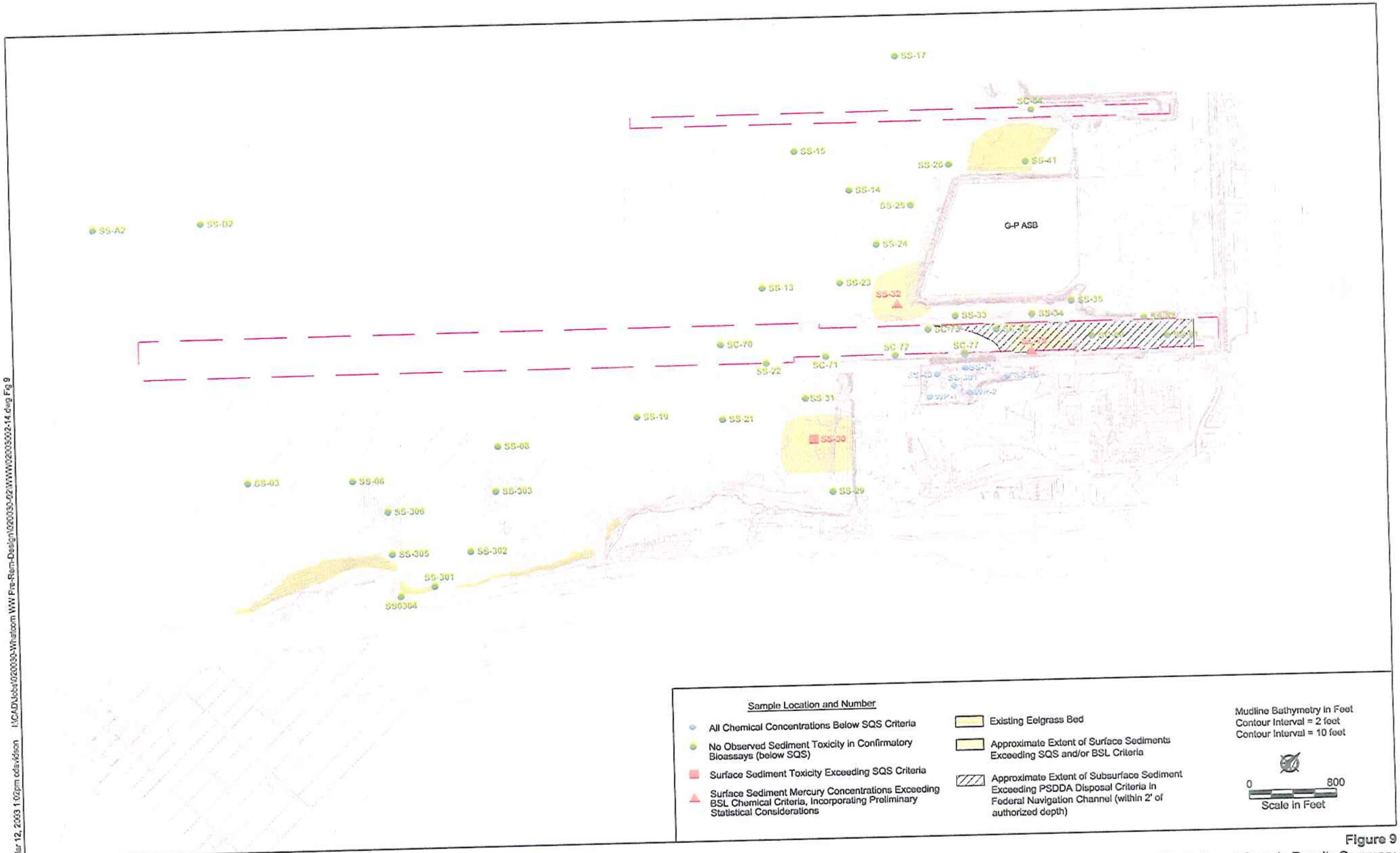


Figure 9
Whatcom Waterway Site Sediment Sample Results Summary
Whatcom Waterway Pre-Remedial Design Evaluation

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5 BIOLOGICAL TESTING

Confirmatory bioassays were conducted on 16 test sediments collected from the Whatcom Waterway (Figure 2), three reference sediments obtained from Carr Inlet, and one control sediment obtained from Lower Yaquina Bay, Oregon. Northwestern Aquatic Sciences (NAS) in Newport, Oregon performed the following bioassays:

- Polychaete 20-Day Growth (*Neanthes* sp.)
- Bivalve Larval Development (*Crassostrea* sp.)
- Bivalve Larval Development (*Mytilus* sp.)
- Amphipod 10-Day Survival (*Eohaustorius* sp)

All bioassays were conducted using standardized protocols (PSEP 1995) as specified by the SMS and updated by the Sediment Management Annual Review Meetings (SMARM). Table 9 summarizes the SMS bioassay performance standards and interpretative guidelines applied to this study. All test sediments were stored under nitrogen at 4°C in the dark in sealed containers until test initiation.

5.1 Bulk Sediment Physical/Chemical Results

Bulk sediment was analyzed for grain size, total solids, total volatile solids, ammonia as nitrogen, and sulfide. Grain size is an important consideration for bioassay testing because of potential influences on organism performance. Percent fines, the combined percentage of silt and clay, were evaluated in test and reference sediments because excessive fine-grained material can have negative effects on bioassay performance.

Percent fines in test sediments ranged from 11.6 percent at station AN-SS-26 to 96.9 percent at station AN-SS-22. The percent fines results were used to match test and reference sediment samples for comparison to SMS bioassay criteria. The percent fines content in the three reference sediments were 14, 35, and 87 percent. Table 10 presents the test-to-reference pairs used for SMS interpretation.

Table 9
Sediment Management Standards Biological Effects Criteria for Puget Sound

Biological Test	Test Performance Standards	Sediment Quality Standards	Sediment Minimum Cleanup Levels
Amphipod	The control sediment shall have less than 10 percent mortality over the test period. The reference sediment shall have less than 25 percent mortality.	The test sediment has a significantly higher (t test, P≤ 0.05) mean mortality than the reference sediment, and the test sediment mean mortality exceeds 25 percent on an absolute basis	The test sediment has a significantly higher (t test, P≤ 0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30 percent greater, on an absolute basis, than the reference sediment mean mortality
Larval	The seawater control sample shall have less than 30 percent combined abnormality and mortality (i.e., a 70 percent normal survivorship at time final). The reference sediment shall have a seawater-normalized effective mortality less than 35 percent	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤ 0.05) than the mean normal survivorship in the reference sediment, and the combined abnormality and mortality in the test sediment is more than 15 percent greater, on an absolute basis, than the reference sediment	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤ 0.05) than the mean normal survivorship in the reference sediment, and the combined abnormality and mortality in the test sediment is more than 30 percent greater, on an absolute basis, than that in the reference sediment
Juvenile polychaete	The control sediment shall have less than 10 percent mortality and mean individual growth (MIG) of ≥ 0.72 mg/ind/day per dry weight basis. The reference sediment shall have a MIG which is at least 80 percent of the MIG found in the control sediment.	The MIG of polychaetes in the test sediment is less than 70 percent of the MIG of the polychaetes in the reference sediment, and the test sediment MIG is significantly different (t-test, P≤ 0.05) from the reference sediment MIG	The MIG of polychaetes in the test sediment is less than 50 percent of the MIG of the polychaetes in the reference sediment, and the test sediment MIG is significantly different (t-test, P≤ 0.05) from the reference sediment MIG

Table 10
Summary of Grain Size and Reference-to-Test Sediment Matching

Station ID	% Clay	% Fines	Reference Pair
AN-SS-03	38.5	92.9	CR-10
AN-SS-08	44.2	92.3	CR-10
AN-SS-13	37.3	94.4	CR-10
AN-SS-22	41.7	96.9	CR-10
AN-SS-23	35.0	83.9	CR-10
AN-SS-25	31.0	79.8	CR-10
AN-SS-26	11.6	11.6	MSMP 43
AN-SS-29	21.0	60.5	CR-10
AN-SS-30	41.6	86.9	CR-10
AN-SS-31	42.0	94.3	CR-10
AN-SS-32	13.1	30.2	CR-23
AN-SS-33	26.8	55.4	CR-23
AN-SS-34	13.6	28.3	CR-23
AN-SS-35	14.0	50.3	CR-23
AN-SS-80	40.7	84.8	CR-10
AN-SS-81	22.8	60.6	CR-23

Ammonia and sulfide are byproducts of wood decomposition and are potentially toxic to benthic invertebrates including amphipods, bivalves, and polychaetes. The dissolved sulfide concentrations for all PRDE test sediments was below the detection limit (0.05 mg/L). Ammonia (as nitrogen) was detected in bulk sediment porewater at concentrations ranging from 0.01 mg/L to 0.08 mg/L, well below the potential amphipod toxicity threshold for unionized ammonia of 0.4 mg/L (SMARM 2002) that was used as a trigger value for implementing purging procedures in the amphipod test. From a cleanup perspective, purging may not alleviate concerns regarding in situ toxicity due to "natural" toxicants such as ammonia (Adolphson 2002a). Because of the low concentrations, potential ammonia and/or sulfide toxicity was not likely to have affected the PRDE sediment bioassays, and there was no need to implement purging procedures.

The following sections describe the water quality, control performance, and test and reference sediment performance results for each of the test series, and also describe any deviations that occurred from the Work Plan/SAP (Anchor 2002). The test data were reviewed by the Quality Assurance Unit of NAS to assure that the studies were performed in accordance with the protocol and standard operating procedures.

5.2 Juvenile Polychaete Test

The juvenile polychaete sediment toxicity test was performed using two to three week post-emergence juvenile *Neanthes arenaceodentata* following standardized protocols as specified by the SMS. The test organisms were shipped to NAS from the Department of Biology at California State University, Long Beach on June 18, 2002, and the 20-day test was initiated on June 19, 2002.

5.2.1 Water Quality

The temperature, dissolved oxygen, salinity, and pH were measured in the overlying water on test days 0, 2, 3, 6, 9, 12, 15, 18, and 20, prior to test solution renewal. Total ammonia-N and dissolved sulfide were measured in the overlying water on test days 0 and 20. The water quality measurements were mostly within acceptable PSEP guidelines (PSEP 1995) but some deviations for temperature and dissolved oxygen occurred. The only deviation of any consequence was one instance of low (0.8 mg/L) dissolved oxygen. Dissolved sulfides were not detected in the overlying water and total ammonia-N concentrations ranged from less than 0.5 mg/L to 5.5 mg/L.

5.2.2 Control Performance

The mean control survival in the polychaete test was 100 percent, and the mean individual growth rate (MIG) of 1.10 mg/ind./day met the SMS test performance minimum requirement of 0.72 mg/ind./day. The average initial weight of the worms was 0.68 grams, within the recommended range of 0.5 to 1.0 milligram. The 96-hr EC50 was 8.67 mg/L Cd, within the laboratory's control chart limits of 3.8 to 11.6 mg/L.

5.2.3 Test and Reference Sediment Performance

The test and reference sediment performance for the juvenile polychaete bioassay are summarized in Table 11. The reference sediment MIG was at least 80 percent of the control sediment MIG, passing the SMS test performance standards. All juvenile polychaete bioassays met SQS biological criteria.

Table 11
Test and Reference Sediment Performance Summary – *Neanthes* sp.

Sample ID	Mean Individual Growth Rate (mg/ind/day)	Standard Deviation	Applicable Reference Sediment	Percent of Reference	SMS Hit?
AN-SS-03	1.09	0.10	CR-10	111%	Pass
AN-SS-08	0.91	0.12	CR-10	93%	Pass
AN-SS-13	0.93	0.17	CR-10	95%	Pass
AN-SS-22	0.88	0.21	CR-10	89%	Pass
AN-SS-23	0.93	0.17	CR-10	95%	Pass
AN-SS-25	0.95	0.15	CR-10	97%	Pass
AN-SS-26	0.78	0.09	MSMP 43	76%	Pass
AN-SS-29	1.03	0.11	CR-10	104%	Pass
AN-SS-30	0.94	0.11	CR-10	96%	Pass
AN-SS-31	0.90	0.09	CR-10	92%	Pass
AN-SS-32	1.03	0.12	CR-23	89%	Pass
AN-SS-33	0.92	0.04	CR-23	79%	Pass
AN-SS-34	0.89	0.16	CR-23	77%	Pass
AN-SS-35	1.03	0.12	CR-23	89%	Pass
AN-SS-80	0.86	0.15	CR-10	87%	Pass
AN-SS-81	0.90	0.16	CR-23	77%	Pass
control	1.10	0.25	---	---	---
Ref CR-10	0.98	0.10	---	---	---
Ref CR-23 West	1.16	0.12	---	---	---
Ref MSMP 43	1.02	0.07	---	---	---

5.3 Bivalve Larval Test

The bivalve larval development (BLD) sediment toxicity test was performed in two batches following standardized protocols as specified by the SMS. The Batch 1 test species was *Mytilus galloprovincialis* and the Batch 2 test species was *Crassostrea gigas*. The Batch 2 test was run due to uncertainty in the outcome of the Batch 1 test due to poor reference performance and information from the laboratory relating that *Mytilus* spawning stocks are generally approaching the end of the spawning season by July. The Batch 2 test was run only with all three reference samples and the two test sediment samples that had not met performance standards.

The Batch 1 test organisms were shipped to NAS from Carlsbad Aquafarms, Carlsbad, California on June 7, 2002, and the tests were initiated on June 19, 2002. The Batch 2 test organisms were shipped to NAS from Oregon Oyster Farms, Newport, Oregon on August 7, 2002, and the tests were initiated on August 9, 2002.

5.3.1 Water Quality

The temperature, dissolved oxygen, salinity, and pH were measured daily and total dissolved sulfide and total ammonia-N were measured on days 0 and 2. The water quality measurements for both tests were within acceptable PSEP guidelines (PSEP 1995). Dissolved sulfide and total ammonia-N were not detected in the overlying bioassay water for either test.

5.3.2 Control Performance

The mean normal survivorship for the BLD was 80.3 percent for the Batch 1 test (*Mytilus*) and 80.5 percent for the Batch 2 test (*Crassostrea*). Both tests met the SMS test performance standard of 70 percent. The 48-hour EC50 for the Batch 1 positive control test was 11.0 µg/L Cu , which was within the control chart limit of 8.33 to 12.6 µg/L Cu. The 48-hour EC50 for the Batch 2 positive control test was 0.82 mg/L Cd, which was within the control chart limit of 0.14 to 2.17µg/L Cd.

5.3.3 Test and Reference Sediment Performance

For the Batch 1 test, the mean seawater control-normalized effective mortalities in the three reference sediments were:

- MSMP-43 = 27.4 percent
- CR-23 West = 54.9 percent
- CR-10 = 60.4 percent

Because the reference samples CR-23 West and CR-10 had greater than 35 percent seawater control-normalized effective mortality (SMARM 1994), they were not used for comparison to test sediment samples. As the only acceptable reference sample in the first larval test, sample MSMP-43 was used for comparison to all of the test sediment samples. Comparison of all of the test samples to MSMP-43 was deemed to be preferable to comparison to the seawater-only control, because the evaluation was based on a sediment-to-sediment comparison. Although the desired range of reference grain sizes were not available, the comparison to a sediment reference was considered to be more ecologically relevant than a comparison to a seawater-only control. Using this approach, sample stations AN-SS-03 and AN-SS-31 did not meet the SQS performance criteria.

As noted above, the second bivalve test was run due to uncertainty regarding the *Mytilus* spawning stocks. At the time the decision to retest was made, positive control data were not available. Following discussions with Ecology (Adolphson 2002b) sediment toxicity tests were re-run using *Crassostrea* sp for the samples that did not meet the SQS performance criteria. The decision described above was made with incomplete information. Subsequently, after the positive control data became available, there was no explanation for the poor performance of reference samples CR-10 or CR-23 West observed in the first larval test.

For the second test, all reference sediments were within SMS performance standards and both AN-SS-03 and AN-SS-31 met the SQS test performance standards when compared to the matched reference sediment (CR-10). Because of better reference test performance characteristics and consistency with SMS acceptability criteria, the sediment retest results (Batch 2) provide a more accurate and representative assessment of larval bioassay performance. Thus, all bivalve larval bioassays met SQS biological criteria.

Table 12
Test and Reference Sediment Performance Summary – Bivalve Species

Sample ID	Combined Percent Normal Survivorship	Standard Deviation	Applicable Reference Sediment	Percent of Reference	t test P Value[1]	SMS Hit?[2]
Batch 1 - *Mytilus* sp.						
AN-SS-03	45.0	10.6	MSMP 43[3]	77.3	0.028	*(SQS)*
AN-SS-08	64.1	10.1	MSMP 43	110.1	---	---
AN-SS-13	75.1	8.4	MSMP 43	129.0	---	---
AN-SS-22	68.7	1.1	MSMP 43	117.9	---	---
AN-SS-23	62.1	5.8	MSMP 43	106.6	---	---
AN-SS-25	65.9	2.7	MSMP 43	113.2	---	---
AN-SS-26	63.5	4.2	MSMP 43	109.1	---	---
AN-SS-29	66.3	7.6	MSMP 43	113.8	---	---
AN-SS-30	67.2	6.1	MSMP 43	115.4	---	---
AN-SS-31	40.7	4.5	MSMP 43	69.9	0.001	*(CSL/MCUL)*
AN-SS-32	66.9	3.7	MSMP 43	114.8	---	---
AN-SS-33	67.4	9.2	MSMP 43	115.7	---	---
AN-SS-34	71.2	8.0	MSMP 43	122.3	---	---
AN-SS-35	65.3	6.8	MSMP 43	112.2	---	---
AN-SS-80	61.8	6.4	MSMP 43	106.2	---	---
AN-SS-81	62.2	10.1	MSMP 43	106.7	---	---
CR-10	31.8	8.5	---	---	---	---
CR-23 West	36.2	13.3	---	---	---	---
MSMP 43	58.2	8.0	---	---	---	---
Control	80.3	4.7	---	---	---	---
Batch 2 - *Crassostrea* sp.						
AN-SS-03	84.9	4.4	CR-10	102.2	---	---
AN-SS-31	88.3	11.8	CR-10	106.3	---	---
CR-10	83.1	11.9	---	---	---	---
CR-23 West	83.8	3.0	---	---	---	---
MSMP 43	91.2	10.7	---	---	---	---
Control	80.5	3.8	---	---	---	---

Notes:

1 - 1-tailed t test ($\alpha = 0.05$) assuming unequal variance. Compared to closing matching reference sediment on the basis of grain size if the combined abnormal and normal mortality was greater than 15 percent of the reference sediment.

2 - Statistically significant percent normal survivorship less than 85 percent of the reference constitutes a SQS-level hit; less than 70 percent of the reference is a CSL-level hit. Initial (Batch 1) test interpretations identified in parentheses were later overridden by Batch 2 retests with improved reference sediment performance (see text).

3 - Due to low mean normal survivorship of the reference sediments, all test sediments were compared to the reference sediment with the highest mean percent normal survivorship (i.e., MSMP 43).

5.4 Amphipod Tests

The amphipod survival sediment toxicity test was performed using *Eohaustorius estuaries*, following standardized protocols as specified by the SMS. The organisms were shipped to NAS from West Beach, Whidbey Island, Washington on July 18, 2002, and the tests were initiated on July 23, 2002. The Batch 2 test organisms were collected adjacent to the EPA laboratory at South Beach, Oregon on June 20, 2002, and the tests were initiated on June 25, 2002.

5.4.1 Water Quality

Temperature, dissolved oxygen, salinity and pH were measured daily in overlying water. Dissolved sulfide and total ammonia-N were measured in the overlying water at day-0 and day-10 of the test. In addition, the total ammonia-N concentration in the interstitial water was measured on day 0 and day 10 of the test. The water quality measurements were within acceptable PSEP guidelines (PSEP 1995). Dissolved sulfide was not detected in the overlying water and total ammonia-N in the overlying water ranged from <0.5mg/L to 6.5 mg/L. Interstitial total ammonia-N concentrations ranged from 2.5 mg/L to 15 mg/L on day 0, and from 2.5 mg/L to 7.5 mg/L on day 10 (unionized ammonia concentrations were well below the 0.4 mg/L threshold).

5.4.2 Control Performance

The mean control normal survivorship for the amphipod toxicity test was 99 percent and met the SMS test performance standard of greater than 90 percent. The 96-hour LC50 for the reference toxicant test was 3.50 mg/L Cd, falling within the laboratory's control chart limits of 0.64 to 3.68 mg/L Cd..

5.4.3 Test and Reference Sediment Performance

The test and reference sediment performance for the amphipod bioassays is summarized in Table 13. The three reference sediments met the performance criterion of less than or equal to 20 percent mortality over the negative control sediment and less than 25 percent overall mortality. All test sediments met the SQS performance levels except station AN-SS-30, which also exceeded the CSL/MCUL performance criterion.

Table 13
Test and Reference Sediment Performance Summary – *Eohaustorius* sp.

Sample ID	Percent Mortality	Standard Deviation	Reference	t test P value (1)	SMS hit? (2)
AN-SS-03	2.0	2.7	CR-10	0.273	Pass
AN-SS-08	15.0	5.0	CR-10	0.000	Pass
AN-SS-13	5.0	6.1	CR-10	0.102	Pass
AN-SS-22	6.0	4.2	CR-10	0.025	Pass
AN-SS-23	10.0	10.6	CR-10	0.068	Pass
AN-SS-25	10.0	7.9	CR-10	0.021	Pass
AN-SS-26	5.0	5.0	MSMP 43	0.254	Pass
AN-SS-29	5.0	5.0	CR-10	0.090	Pass
AN-SS-30	39.0	22.2	CR-10	0.001	CSL/MCUL
AN-SS-31	6.0	4.2	CR-10	0.025	Pass
AN-SS-32	5.0	3.5	CR-23	0.096	Pass
AN-SS-33	9.0	8.9	CR-23	0.021	Pass
AN-SS-34	10.0	5.0	CR-23	0.006	Pass
AN-SS-35	13.0	8.4	CR-23	0.005	Pass
AN-SS-80	6.0	6.5	CR-10	0.087	Pass
AN-SS-81	4.0	4.2	CR-23	0.238	Pass
Control	1.0	2.2	---	---	---
Ref CR-10	1.0	2.2	---	---	---
Ref CR-23 West	2.0	2.7	---	---	---
Ref MSMP 43	5.0	0.0	---	---	---

Notes:

[1] - 1-tailed t test ($\alpha = 0.05$) assuming unequal variance. Compared to closing matching reference sediment on the basis of grain size if the combined abnormal and normal mortality was greater than 15 percent of the reference sediment.

[2] - The test sediment has a significantly higher (t test, $P \leq 0.05$) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30 percent greater, on an absolute basis, than the reference sediment mean mortality (see text)

Thus, of the 16 confirmatory bioassays conducted within the Whatcom Waterway (Figure 2), only one station – AN-SS-30 – did not meet SQS biological criteria during the PRDE study. At this station, only the wood waste degradation product 2,4-dimethylphenol exceeded SQS (and also MCUL) chemical criteria (Table 4). Sediment toxicity observed at station AN-SS-30 may be potentially attributable to the presence of wood wastes at this location.

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APPENDIX A

DATA VALIDATION REPORTS

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Sayler Data Solutions

DATA VALIDATION REPORT

Whatcom Waterway - June 2002 Porewater Data

Prepared for:
Anchor Environmental LLC
1411 Fourth Avenue, Suite 1210
Seattle, WA 98101

August 19, 2002

1.0 Introduction

Sediment samples were collected June 13th through 19th, 2002. Porewater samples were extracted June 14 through June 20, 2002 Analyses were performed by Analytical Resources, Inc. (ARI) in Tukwila, Washington, and Columbia Analytical Services (CAS) in Kelso, Washington. Samples were assigned ARI batch numbers EL83 and EM37 and CAS batch number K2204118. Data is presented in ARI laboratory reports dated June 28 and July 19, 2002, and a CAS report dated July 15, 2002.

A summary validation was performed on the analytical results. Validation was performed by Melissa Swanson and Cari Sayler.

In the following report, a checked box (☑) indicates that the data requirement was met; and an empty box (☐) indicates that a discussion of the data requirement follows. The data may or may not be qualified.

2.0 Semivolatile Organic Analyses

Analyses were performed by EPA Method 8270. The following data requirements were evaluated:

☐ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☐ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries

No matrix spike analysis was performed, possibly due to insufficient sample volume. Quality control samples did not include a duplicate, and precision could not be evaluated. Quality control samples were sufficient to evaluate accuracy.

Each analysis was completed within the required holding times. No blank contamination was detected.

The surrogate recoveries for 1,2-dichlorobenzene-d4 were below the project data quality objectives of 50% to 140% as follows: DRET (U) (38.6%), MET (U) (47.1%), DRET (F) (41.7%), and MET (F) (49.0%). However, these recoveries were within the laboratory control limit of 32 to 89%, and no qualifiers are assigned.

All LCS recoveries were within the acceptable range.

Semivolatile organic data, as reported, are acceptable for use.

3.0 Tributyl Tin Analyses

Analyses were performed by a modified Krone method. The following data requirements were evaluated:

☐ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☐ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries
☑ LCS/LCSD relative percent differences (RPDs)

No matrix spike analysis was performed, possibly due to insufficient sample volume. Batch EM37 did not include a duplicate analysis, and precision is evaluated based on the LCS/LCS duplicate results from batch EL83.

Each analysis was completed within the required holding times. No blank contamination was detected.

The surrogate recoveries for Tripropyl Tin were below the project data quality objective of 50% to 140% in three of the four samples as follows: MET (U) (42.9%), DRET (F) (44.5%), and MET (F) (38.5%). However, these recoveries were within the laboratory control limit of 10 to 141%, and no qualifiers are assigned.

All LCS and LCSD recoveries were within the acceptable range. The LCS/LCSD RPDs are within limits.

Tributyl tin data, as reported, are acceptable for use.

4.0 Metals Analyses

Analyses were performed by EPA Methods 6010B and 7471A. The following data requirements were evaluated:

☐ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination

☑ Laboratory control sample (LCS) recoveries
☑ Matrix spike (MS) and MS duplicate (MSD) recoveries (mercury only)
☑ MS/MSD relative percent differences (RPDs) (mercury only)

No ICP metals matrix spike analysis was performed, and no ICP metals duplicate analysis was performed. ICP metals accuracy evaluation is based on laboratory control sample results and ICP metals precision could not be evaluated.

Adequate mercury laboratory quality control samples were analyzed.

Each analysis was completed within the required holding times. No blank contamination was detected. All LCS recoveries were within the acceptable range. Mercury MS/MSD recoveries and RPDs were within acceptable limits.

Metals data, as reported, are acceptable for use.

5.0 General Chemistry

Analyses were performed by EPA Method 160.2 (total suspended solids) and the Plumb method (TOC). The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☑ MS recoveries (TOC only)
☐ Standard reference material (SRM) results (TOC only)
☑ Laboratory duplicate RPDs

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. No blank contamination was detected. The MS recovery was within the acceptable range. Laboratory duplicate RPDs were within applicable limits.

SRM confidence limits were not provided, and results could not be evaluated.

General chemistry data, as reported, are acceptable for use.

6.0 Abbreviations and Definitions

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
MS	Matrix spike
MSD	Matrix spike duplicate
RPD	Relative percent difference
Surr	Surrogate

7.0 References

USEPA Contract Laboratory Program National Functional Guidelines For Organic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, October 1999, EPA540/R-99/008.

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DATA VALIDATION REPORT

Whatcom Waterway - June 2002 Sediment Data

Prepared for:
Anchor Environmental L.L.C.
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September 3, 2002

1.0 Introduction

Sediment samples were collected June 5 through 13, 2002. Analyses were performed by Analytical Resources, Inc. in Tukwila, Washington and Rosa Environmental and Geotechnical Laboratory in Seattle, Washington. Samples were assigned laboratory batch numbers EL34, EL84, and EO63. Data is presented in laboratory reports dated July 1, 10, and 31, 2002.

A summary validation was performed on the analytical results. Validation was performed by Melissa Swanson and Cari Sayler.

In the following report, a checked box (☑) indicates that the data requirement was met; and an empty box (☐) indicates that a discussion of the data requirement follows. The data may or may not be qualified.

2.0 Semivolatile Organic Analyses

Analyses were performed by EPA Method 8270. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☑ Analysis holding times
☐ Blank contamination
☐ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries
☐ Matrix spike (MS) and MS duplicate (MSD) recoveries
☑ MS/MSD relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times.

The method blank for laboratory batch EL84 contained bis(2-ethylhexyl)phthalate at a concentration of 91 ug/kg. All associated samples except AN-TC-CMP2 contained bis(2-ethylhexyl)phthalate at an on-column concentration within five times the detected blank concentration. These results should be considered not detected at the reported concentration and are qualified "U". No additional contamination was detected in the method blanks or filter blanks.

Surrogate recoveries were below the project data quality objective (DQO) of 50 to 140% as follows: Dichlorobenzene in AN-TC-CMP4 (49.1%), 2-chlorophenol-d4 in AN-SS-35 (45.6%) and AN-SS-81 (49.8%). However, these recoveries were within the laboratory control limits of 18 to 96% and 20 to 108%; and the remaining surrogate recoveries in those samples were within the DQO. No qualifiers are assigned.

All LCS recoveries were within the acceptable range.

The recoveries for pentachlorophenol in AN-TC-CMP5MS (29.2%) and AN-TC-CMP5MSD (28.3%) were below the DQO of 50-140%. The pentachlorophenol result in sample AN-TC-CMP5 is qualified as estimated.

All other MS and MSD recoveries were within control limits. The MS/MSD RPDs were within applicable limits.

SRM confidence limits were not provided, and results could not be evaluated.

The following results exceeded the calibration range of the instrument:

Sample	Analyte	Result (ug/kg)
AN-TC-CMP4	Fluoranthene	6,100 E
AN-TC-CMP4	Pyrene	4,800 E

Appropriate dilutions were performed with concentrations within the calibration range. These results have been rejected in the initial analyses due to the availability of an onscale result. All analytes except these have been rejected in the diluted analyses due to the availability of a less dilute result.

Semivolatile data qualifiers are summarized in section 9.0 of this report. Semivolatile organic data are acceptable for use as qualified.

[Note: PSDDA does not qualify results as non-detect due to blank contamination, bis(2-ethylhexyl)phthalate results were qualified as 'B'. – Michelle McClelland, 18Sept2002]

3.0 Tributyl Tin Analyses

Analyses were performed by Krone modified, 1989. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Blank contamination

☐ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries
☑ Matrix spike (MS) and MS duplicate (MSD) recoveries
☑ MS/MSD relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. No contamination was detected in the method or filter blanks.

Surrogate recoveries of Tripropyl Tin (40 to 70%) were consistently lower than recoveries of Tripentyl Tin (90 to 125%). Although some of the Tripropyl Tin recoveries were below the project DQO of 50 to 140% and some of the Tripentyl Tin recoveries were above the lab control limit of 13-113%, an out of control situation is not indicated. Surrogates were also not detected in two samples due to necessary dilution. No qualifiers are assigned.

The LCS recovery was within the acceptable range. The MS and MSD recoveries were within control limits. The MS/MSD RPD was within applicable limits.

The following results exceeded the calibration range of the instrument:

Sample	Analyte	Result (ug/kg)
AN-TC-CMP4	Tributyl Tin	2,600 E
AN-TC-CMP6	Tributyl Tin	3,300 E

Appropriate dilutions were performed with concentrations within the calibration range. These results have been rejected in the initial analyses in favor of the diluted analysis result.

Tributyl tin data qualifiers are summarized in section 9.0 of this report. Tributyl tin data are acceptable for use as qualified.

4.0 Pesticide Analyses

Analyses were performed by EPA Method 8081. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Blank contamination
☑ Surrogate recoveries
☑ Laboratory control sample (LCS) recoveries
☑ Matrix spike (MS) and MS duplicate (MSD) recoveries
☑ MS/MSD relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. No contamination was detected in the method blanks or filter blanks. All surrogate recoveries were within acceptable recovery limits. All LCS recoveries were within the acceptable range. All MS and MSD recoveries were within control limits. The MS/MSD RPDs were within applicable limits. SRM confidence limits were not provided, and results could not be evaluated.

Pesticide data are acceptable for use as reported.

5.0 PCB Analyses

Analyses were performed by EPA Method 8082. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies

☑ Analysis holding times

☑ Blank contamination

☑ Surrogate recoveries

☑ Laboratory control sample (LCS) recoveries

☑ Matrix spike (MS) and MS duplicate (MSD) recoveries

☑ MS/MSD relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. No contamination was detected in the method blanks or filter blanks. All surrogate recoveries were within acceptable recovery limits. All LCS recoveries were within the acceptable range. All MS and MSD recoveries were within control limits. The MS/MSD RPDs were within applicable limits. SRM confidence limits were not provided, and results could not be evaluated.

PCB data are acceptable for use as reported.

6.0 Metals Analyses

Analyses were performed by EPA Methods 6010B and 7471A. The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies

☐ Analysis holding times

☑ Blank contamination

☐ Matrix Spike (MS) recoveries

☑ Standard Reference Material (SRM) results

☐ Laboratory duplicate relative percent differences (RPDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch.

The two samples in batch EO63, AN-SS-32 and AN-SS-305, were analyzed for mercury at 54 and 55 days after sampling, exceeding the holding time of 28 days. These samples are qualified as estimated. All other samples were analyzed within the required holding times.

No contamination was detected in the preparation or filter blanks.

The recovery for antimony was very low in both matrix spikes: AN-PC-CMP1 MS (11.9%) and AN-TC-CMP1 MS (12.2%). These recoveries are below the DQO of 65 to 135% and the functional guidelines action level of 40%. Antimony was not detected in the project samples. All antimony results are rejected and are unusable for any purpose.

The SRM results were within the acceptable range.

The mercury AN-SS-305 laboratory duplicate RPD (33.3%) from batch EO63 exceeded the control limit of 20%. This mercury result is qualified as estimated. All other duplicate RPDs were within limits.

With the exception of antimony, metals data are acceptable for use as qualified.

7.0 General Chemistry

Analyses were performed by methods EPA 160.3 (total solids), EPA 160.4 (total volatile solids), and Plumb, 1981 (TOC). The following data requirements were evaluated:

☑ Sample and quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory blank contamination
☑ Matrix spike (MS) and MS duplicate (MSD) recoveries (TOC only)
☑ Laboratory duplicate RPDs and triplicate relative standard deviations (RSDs)

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. No blank contamination was detected. All MS and MSD recoveries were within the acceptable range. The laboratory duplicate RPDs and triplicate RSDs were within applicable limits. TOC SRM confidence limits were not provided, and results could not be evaluated.

General chemistry data are acceptable for use as reported.

8.0 Grain Size Analyses

Analyses were performed by Method PSEP. The following data requirements were evaluated:

☑ Quality control analysis frequencies
☑ Analysis holding times
☑ Laboratory triplicate RSDs

Adequate laboratory quality control samples were analyzed with each laboratory batch. Each analysis was completed within the required holding times. The laboratory triplicate RSDs were within applicable limits.

Grain size data are acceptable for use as reported.

9.0 Qualifier Summary Table

Sample ID	Analyte	DV Qual	Reason
Semivolatile Organic Analyses			
AN-TC-CMP1	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP3	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP4	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP5	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP6	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP-MCMP	Bis(2-Ethylhexyl)phthalate	U [B]	Blank contamination
AN-TC-CMP5	Pentachlorophenol	UJ	Low MS/MSD recovery
AN-TC-CMP4	Fluoranthene	R1	Exceeded cal. range
AN-TC-CMP4	Pyrene	R1	Exceeded cal. range
AN-TC-CMP4 DL	All except fluoranthene and pyrene	R1	Undiluted result available
Metals Analyses			
All	Antimony	R	Very Low MS recovery
AN-SS-32 (EO65)	Mercury	J	Holding time exceeded, High duplicate RPD
AN-SS-305 (EO65)	Mercury	J	Holding time exceeded
Tributyl Tin Analyses			
AN-TC-CMP4	Tributyl Tin	R1	Exceeded cal. range
AN-TC-CMP6	Tributyl Tin	R1	Exceeded cal. range

[Note: PSDDA does not qualify results as non-detect due to blank contamination, bis(2-ethylhexyl)phthalate results were qualified as 'B'. – Michelle McClelland, 18Sept2002]

10.0 Abbreviations and Definitions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R1	This sample result has been rejected in favor of a more accurate and/or precise result. The other result should be used.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.

Abbreviation	Definition
DV	Data validation

Abbreviation	Definition
LCS	Laboratory control sample
MS	Matrix spike
MSD	Matrix spike duplicate
RPD	Relative percent difference
Surr	Surrogate

11.0 References

USEPA Contract Laboratory Program National Functional Guidelines For Organic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, October 1999, EPA540/R-99/008.

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, February 1994, EPA540/R-94/013.

DATA VALIDATION REVIEW REPORT

WHATCOM WATERWAY / PCLT

2002

This report summarizes the review of analytical results for PCLT leachate samples collected June through November, 2002. The original sediment sample AN-TC-Master Composite was collected from the Whatcom Waterway site in Bellingham, Washington. Samples were collected by Anchor Environmental and submitted to Rosa Environmental (REG) in Tukwilla, Washington for the PCLT procedure. Samples were analyzed by Analytical Resources, Inc. (ARI) and Columbia Analytical Services (CAS) for one or more of the following: semivolatile organic compounds (SVOCs) by U.S. Environmental Protection Agency (USEPA) method 8270C; cadmium, chromium, copper and zinc by USEPA method 6010B; arsenic, lead, and nickel by USEPA method 200.8; silver by USEPA method 7761 and tributyltin (TBT) by USEPA 8270 SIM.

Sample ID	Lab ID	Matrix	Analysis Requested
C3-01	EM54A	leachate	SVOCs
C3-02	EM98A	leachate	TBT, metals
C3-03	EN48A	leachate	SVOCs
C3-04	EN65A	leachate	TBT, metals
C3-05	EO22A	leachate	SVOCs
C3-06	EO86A	leachate	TBT, metals
C3-07	EP24A	leachate	SVOCs
C3-08	EQ08A	leachate	TBT, metals
C3-09	EQ56A	leachate	SVOCs
C3-10	ER70A	leachate	TBT, metals
C3-11	ES08A	leachate	SVOCs
C3-12	ES78A	leachate	TBT, metals

Sample ID	Lab ID	Matrix	Analysis Requested
C3-13	ET74A	leachate	SVOCs
C3-14	EU31A	leachate	TBT, metals
C3-15	EU85A	leachate	SVOCs
C3-16	EV38A	leachate	TBT, metals
C3-17	EW03A	leachate	SVOCs
C3-18	EW57A	leachate	TBT, metals
C3-19	EX12A	leachate	SVOCs
C3-20	EX58A	leachate	TBT, metals
C3-21	EX92A	leachate	SVOCs
C3-22	EY33A	leachate	TBT, metals
C3-23	EY97A	leachate	total and dissolved mercury
C3-24	EZ75A	leachate	mercury only
C3-25a	FA09A	leachate	mercury only
C3-25b	FA09B	leachate	metals (no mercury)
C3-26	FA55A	leachate	metals, mercury

Data Validation and Qualifications

The following comments refer to the laboratory's performance in meeting the method specific quality assurance/quality control (QA/QC) guidelines. Laboratory results were reviewed following USEPA guidelines (USEPA, 1999, 2002). Unless noted in this report, laboratory results for the samples listed above were within QC criteria.

Laboratory Data Package and Field Documentation

The laboratory checked the field documentation for completeness and accuracy. The following were noted by the laboratory at the time of sample receipt: the samples were received in good condition and were consistent with the accompanying chain of custody.

Holding Times and Sample Preservation

Samples were appropriately preserved and analyses were conducted within holding times. No data were qualified.

Laboratory Method Blanks

Laboratory method blanks were analyzed at the required frequencies. No analytes were detected in the laboratory method blanks with the following exceptions.

- Tributyltin was detected in laboratory method blank ER70 at 0.034 ug/L. The associated sample, C3-10, was qualified as 'B' for TBT and TBT ion.

- Tributyltin was detected in laboratory method blank ES78 at 0.01 ug/L. The samples was re-extracted and re-analyzed for TBT, however the blank contamination remained. The associated sample, C3-12, was qualified as 'B' for TBT and TBT ion.

Field Quality Control

Field Blanks

No field blanks were collected or analyzed due to the nature of the PCLT tests.

Field Duplicates

No field duplicates were collected or analyzed due to the nature of the PCLT tests.

Surrogate Recoveries

Surrogate recoveries for organic analyses were performed at the required frequencies. Surrogate recoveries were within the laboratory control limits with the following exceptions.

- Both TBT surrogate %Rs were below the control limits for sample C3-10. Even though the surrogate recoveries were less than 10%, sample results were qualified as estimated (J), not rejected as the sample results were consistent with previous and continuing leachate results.

- Both TBT surrogate %Rs were below the control limits for sample C3-12. The sample was re-extracted and re-analyzed, with only sightly better surrogate recoveries. Sample results were qualified as estimated (J), but are consistent with previous and continuing leachate results.

- One SVOC surrogate %R was below the control limits for sample C3-19. The remaining seven surrogate recoveries were acceptable; therefore, no data were qualified.

- One SVOC surrogate %R was below the control limits for sample C3-21. The remaining seven surrogate recoveries were acceptable; therefore, no data were qualified.

Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

Matrix spike (MS) and matrix spike duplicate (MSD) samples, were analyzed at the required frequency. All MS and MSD percent recoveries (%Rs) were within the laboratory control limits; no data were qualified.

Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

Laboratory control samples were analyzed at the required frequencies. All LCS and LCSD percent recoveries were within laboratory control limits, with the following exception.

- ER70: The LCS and LCSD %Rs for TBT were below the laboratory control limits. Sample C3-10 TBT results were qualified as estimated (J).

Method Reporting Limits

Sample results were reported using the laboratories method reporting limits. Reporting limits were acceptable.

Overall Assessment

The following table summarizes the qualified data; no data were rejected. The data are judged to be acceptable for their intended use, as qualified.

Sample ID	Analyte	Qualified Result	Reason
C3-10	tributyltin tributyltin ion	0.045 JB 0.035 JB	low LCS/surr %R & blank contamination
C3-12	tributyltin	0.030 JB	low surr %R &

Sample ID	Analyte	Qualified Result	Reason
	tributyltin ion	0.023 JB	blank contamination

Precision, Accuracy, and Completeness

Precision: All precision goals were met.

Accuracy: All accuracy goals were met.

Completeness: Completeness was 100 percent, all data are useable as qualified.

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APPENDIX B

COLUMN SETTLING, CONSOLIDATION, AND GEOTECHNICAL TESTING DATA

Data are available from Anchor on request

APPENDIX C

COLUMN LEACHING TESTING DATA

Data are available from Anchor on request

APPENDIX D

BIOLOGICAL TESTING DATA

Data are available from Anchor on request