EXHIBIT A

I & J WATERWAY SITE

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

WORK PLAN

Sediments RI/FS Work Plan

I & J Waterway
Bellingham, Washington

Prepared by:

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RETEC Project Number: PORTB-18449-100

Prepared for:

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1801 Roeder Avenue
Bellingham, Washington 98225

July 27, 2005

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July 27, 2005

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1 Introduction

This document summarizes the work to be performed during a sediments Remedial Investigation and Feasibility Study (RI/FS) at the I & J Waterway Site (Site) in Bellingham, Washington. This work will be performed by The RETEC Group, Inc. (RETEC) under a Professional Services Agreement with the Port of Bellingham (Port).

The RI/FS will be conducted to determine appropriate remedial measures to address contaminated sediments within the Site and to select a final remedy for sediment cleanup in compliance with the requirements of the Model Toxics Control Act (MTCA) and the Sediment Management Standards (SMS).

1.1 Site Description and Ownership

The Site is located between Hilton Avenue and Bellwether Way on the Bellingham waterfront and was formerly called the "Olivine-Hilton sediment Site" (Figure 1-1). The Site includes areas of contaminated marine sediments in both the I & J Waterway and nearby berthing areas. The Waterway is located primarily on a state-owned aquatic land. The Port owns the berthing areas on the south side of the waterway and the surrounding uplands. The Waterway includes a federally authorized navigation channel with a current authorized channel depth of 18 feet below Mean Lower Low Water (MLLW). The U.S. Coast Guard owns the property north of the Site and berths vessels within the waterway and northern berth areas.

The upland areas near the Site include the former Olivine Corporation lease area and a property to its southwest that is currently leased to Bornstein Seafoods.

The ownership and history for the Site and adjacent upland properties were defined in the Phase 2 Sediment Sampling Report (ThermoRetec, 2001). The Whatcom Falls Mill Company owned and operated a lumber mill in the vicinity of the Site between the early 1900's and 1940. In 1944, these properties were acquired by the Port and leased to tenants, including Bayshore Lumber, who operated a lumber company (1947-1962) and H&H Products, who managed the same lumber mill (1963-1972) at the head of the waterway. The Olivine Corporation operated a rock crushing plant for the mineral olivine between 1963 and 1992. During that period, dust and wastewater were periodically released to the waterway. North Pacific Frozen Products managed a food processing plant between 1946 and 1959 in the location of the current Bornstein lease. Bornstein Seafoods has operated a seafood processing plant from 1959 to present in that location. Bornstein Seafoods provided diesel fuel to boats at its dock between 1960 and the early 1980s. A fire destroyed the main Bornstein Seafoods building in July of 1985. Fire

suppression efforts lasted for two days, during which time fire control water was discharged directly to the Site.

Environmental impacts to the Site as documented by previous studies include contaminated surface sediments containing elevated concentrations of bis(2-ethylhexyl)phthalate. The elevated phthalate concentrations are located around the Bornstein Seafoods lease area in the vicinity of the 1985 fire.

Additional sources of phthalate contamination were previously investigated in leachate from the Roeder Avenue landfill and compressor oil from a compressor on the Bornstein dock. Concentrations of bis(2-ethylhexyl)phthalate in leachate from the Roeder Avenue landfill were determined to be below MTCA criteria under a direct discharge scenario (ThermoRetec, 2001b). In addition, as part of the Port's Environmental Compliance Assessment Program (ECAP) following the Phase 2 investigation, phthalates were measured in trace amounts in compressor oil from a compressor located on Bornstein's dock. It was determined that thousands of gallons of compressor oil would have needed to have been spilled to create the existing condition in the sediments.

Surface sediments are also contaminated with nickel in the southeastern portion of the waterway adjacent to the former Olivine Corporation lease area. Nickel is a constituent within olivine ore. Additional contaminants present in subsurface sediments include mercury, phenols, and polynuclear aromatic hydrocarbon (PAH) compounds (ThermoRetec, 2001).

1.2 Objectives of the RI/FS

As owner of the berthing areas and properties adjacent to the waterway, the Port is performing this RI/FS to evaluate Site cleanup requirements under applicable regulations. The RI/FS will comply with cleanup requirements administered by the Department of Ecology (Ecology) under MTCA and SMS regulations. The RI/FS will be used to define the remedial measures required to clean up the I & J Waterway sediments under these regulations.

Sediments in the I & J Waterway will be investigated in two phases. The first phase consists of determining the surficial extent of contamination. Appendix A provides sampling and analysis methods for the initial phase of field activities, which includes surface sediment sampling. The second phase consists of subsurface sampling. As described in Appendix B, data will be collected to quantify depths and volumes of impacted sediment.

Each phase together is intended to collect sufficient data to fully characterize the extent of surface and subsurface contamination and to comply with MTCA and SMS requirements for RI/FS evaluations. However, the second phase is also intended to characterize the sediments for suitability of open-water disposal under the Puget Sound Dredged Disposal Analysis Program

(PSDDA). This assessment will be used to evaluate remedial alternatives as part of the Feasibility Study for the Site.

The I&J Waterway Site is one of several cleanup sites being addressed as part of the Bellingham Bay Demonstration Pilot; a bay-wide, multi-agency initiative integrating sediment cleanup, control of pollution sources, habitat restoration, and aquatic/shoreline land use.

The RI/FS is being performed under an Agreed Order with Ecology (No. DE 1090). At the completion of the RI/FS, the Port and Ecology will evaluate the administrative options for implementing any necessary remedial actions. It is anticipated that the final cleanup action will be conducted under a MTCA Consent Decree.

This document provides an overview of the investigation and engineering tasks to be performed during the RI/FS. Investigation tasks are described in Section 2 and 3 of this report. Engineering tasks are described in Section 4. Appendices A and B describe sampling plans for surface and subsurface investigations, respectively.

2 Basis and Rationale for RI/FS Scope

This section provides an overview of previous investigation findings in and around the Site and presents the rationale on which the scope of work for the Site RI/FS is based. Sections 3 and 4 of this Work Plan provide a description of the sampling, analysis, and engineering tasks to be completed, consistent with the rationale presented in this section.

2.1 Incorporation of Previous Findings

This document incorporates and builds upon sediment sampling data collected in previous investigations. The most recent sampling effort consisted of Phase 2 sediment sampling at the Site during summer of 2000 (ThermoRetec, 2001a). That study provided extensive baseline information about the history of the Site and the types and distribution of sediment contamination. That information has been integrated, along with other existing information to focus the efforts of this RI/FS. A brief description of these existing data and conclusions is provided below.

RI/FS Focus Area

The focus of this investigation is a contiguous area within the Site where elevated concentrations of sediment contaminants have been detected (Figure 1-1). Phase 2 sampling involved a preliminary characterization of the lateral extent of contamination within the bioactive zone (top 0 to 12 cm) in the Site sediments. Figure 1-2 shows the locations and extent of contamination quantified during the Phase 2 sampling event, including delineations for values exceeding numeric Sediment Quality Standards (SQS) and Minimum Clean-Up Levels (MCUL), as defined in SMS regulations (ThermoRetec, 2001a).

The investigation area of the RI/FS (Figure 1-1) includes all contiguous areas within the Site where exceedances of the SQS or MCUL chemical criteria have been detected. The RI/FS activities will also include sampling of adjacent areas to confirm the lateral extent of surface contamination.

Contaminants of Concern

Table 2-1 summarizes the list of contaminants for which exceedances of the current SQS or MCUL values have been noted from the Phase 2 Investigation (ThermoRetec, 2001a) and from previous Hart Crowser (1997) and Anchor Environmental (1999) investigations. These contaminants will be carried forward as the contaminants of concern for the RI/FS investigations. The testing program described in Section 3 incorporates testing for all compounds and related compounds shown in Table 2-1.

Table 2-1 Contaminants of Concern for the I&J Waterway Sediments

Group	Compound	Number of Samples >SQS	Number of Samples >MCUL	Maximum Enrichment Ratio
		Surface Sediment Quality		
Heavy Metals	Mercury	2	0	1.1
	Nickel	0*	0*	--*
Phthalates	Bis(2-ethylhexyl)phthalate	1	8	31.1
LPAHs	Acenaphthene	0	1	2.0
	Anthracene	1	0	0.2
	Fluorene	2	0	0.6
	Phenanthrene	2	0	2.3
	Total LPAH	1	0	1.3
HPAHs	Chrysene	2	0	0.6
	Benzo(a)anthracene	1	0	0.6
	Fluoranthene	1	0	0.8
	Total HPAH	1	0	1.1
Miscellaneous	Phenol	1	1	1.3
	Dibenzofuran	1	0	0.5
		Subsurface Sediment Quality		
Heavy Metals	Mercury	0	1	1.5
Miscellaneous	2,4-methylphenol [1]	1	1	21.0
	2-methylphenol [1]	0	1	6.3
	4-methylphenol [1]	0	1	2.2

NOTE:

SQS = Sediment Quality Standards

MCUL = Minimum Clean Up Level

LPAH = low molecular weight polynuclear aromatic hydrocarbons

HPAH = high molecular weight polynuclear aromatic hydrocarbons

Maximum Enrichment Ratio = the ratio between the highest detected concentration and the MCUL

[1] Concentrations of 2,4-methylphenol, 2-methylphenol, and 4-methylphenol are included as COCs on Table 2-1, however, they were measured at values above the linear range of the detector (E-flagged) and are not necessarily considered valid data. These compounds will be measured in each sample as part of the full list of SMS chemicals.

* = SQS and MCUL values for nickel are not currently defined. Consistent with Ecology policies, biological effects criteria defined under SMS are used to evaluate the SMS compliance of constituents for which SQS and MCUL chemical criteria are not defined.

Table 2-1 summarizes measured enrichment ratios for Site surface sediments. The "enrichment ratio" is the ratio between a measured sediment chemical concentration and the MCUL numeric criteria for that chemical. An enrichment ratio of 2.0 means that a chemical is present at a concentration

twice the MCUL value. Enrichment ratios are simplified ways to express the relative concentrations of different chemicals in Site sediments.

At the Site, bis(2-ethylhexyl)phthalate is the compound with the highest measured enrichment ratios. It is also the compound present in excess of MCUL values in the greatest number of samples. Areas of elevated phthalate concentrations were localized around the Bornstein Seafoods dock area as shown in Figure 1-2. Two surface sediment samples collected from phthalate-impacted areas were tested for biological effects using SMS bioassays in 1998. These samples were collected from stations AN-SS-45 and from station AN-SS-47, confirming the presence of biological effects in Site sediments and defining a preliminary correlation between the level of biological effects and the sediment phthalate concentrations.

Other contaminants include LPAHs with enrichment values ranging from 0.2 to 2.3, and HPAHs with enrichment values ranging from 0.6 to 1.1. Nickel was detected in surface sediment samples in the southeastern portion of the waterway above PSDDA screening levels (SL), however, there are no SMS criteria for nickel. Mercury was below SQS criteria in surface sediments in 2000, but contained slightly elevated concentrations in 1996 and 1998. This is consistent with other reports that suggest mercury contamination is absent in the surface but present in subsurface sediments. Mercury contamination in the I&J Waterway Site is associated with elevated mercury concentrations located in sediment in the Whatcom Waterway. Several methylphenol compounds (2,4-methylphenol, 2-methylphenol, and 4-methylphenol) were also elevated above MCUL criteria in subsurface sediments, although the concentrations were above the linear range of the detector (ThermoRetec, 2001). Based on these previous findings, mercury and methylphenols will be carried forward as contaminants of concern for the Site in subsurface sediments.

2.2 Evaluation of Cleanup Requirements under SMS and MTCA

The Sediment Management Standards (SMS) provide a uniform set of rules and procedures to evaluate the clean up of contaminated sediment sites (WAC 173-204). The SMS regulations are enforced under the Model Toxics Control Act (MTCA; Chapter 70.105D RCW). All activities performed under this RI/FS will be consistent with those regulations.

Under the SMS, two sets of cleanup criteria are established. The first of these, the Sediment Quality Standard (SQS), is a criterion below which no adverse effects occur, "including no acute or chronic adverse effects on biological resources and no significant health risk to humans" (Ecology, 1995). The SQS are a regulatory and management goal for the quality of sediments throughout the state. The second criterion, the Minimum Cleanup Level (MCUL), is a minor adverse effects level, which is the minimum level to be achieved in all cleanup actions under the SMS. SQS and MCUL standards

apply to surface sediments, and to subsurface sediments which could be exposed by natural or anthropogenic processes.

Compliance with SMS criteria can be assessed using chemical and/or biological sampling data. Protocols for both chemical and biological testing are defined under the Puget Sound Protocols (Puget Sound Estuary Program, 1986) and in amendments to those protocols as established by Ecology. As described in Section 3, chemical testing methods developed under the PSDDA program will also be incorporated where appropriate for evaluation of dredged material management options.

Sediment surface sampling will be used during the RI/FS to better define the spatial extent of contaminated surface sediments. Surface samples, or "grabs" will be located throughout the Site, including on the eastern, northern, and western boundaries of the Site. Chemical testing will be used to evaluate compliance of surface sediment samples with SMS numeric criteria. Any surface sediment samples with chemical concentrations in excess of SQS chemical criteria or as determined by Ecology will be tested for biological effects. Biological testing will be performed using appropriate bioassays as specified in WAC 173-204-310(2)a and WAC 173-204-315 and recent Ecology revisions to those testing protocols. Sediment samples that exceed the SMS chemical criteria but which pass the confirmatory bioassays will be designated as passing the SQS or MCUL, consistent with SMS regulations. For nickel, the PSDDA screening level (SL) will be used as a conservative screening level analogous to the SQS. Samples exceeding the nickel PSDDA SL will be tested for biological effects.

The definition of the nature and extent of subsurface sediments is necessary in order to evaluate potential sediment management options and remedial alternatives. Sediment remedial alternatives can include the use of natural recovery, capping or removal with treatment or disposal. The thickness and characteristics of subsurface sediments in impacted Site areas will be defined as part of the RI/FS. Specifically the Site has been divided into a series of potential dredged material management units (DMMU) for evaluation of suitability of sediment for open-water disposal under the PSDDA program. Within each DMMU containing impacted sediments, subsurface testing will be performed. Although core locations are designed to comply with the PSDDA program, the subsurface data collected will aid in determining vertical extent of contamination for the RI/FS. Testing results will be compared to SMS criteria and to the criteria applicable to potential treatment or disposal alternatives. Results of surface and subsurface testing will then be used to assess the need for Site remediation, screen potential remedial technologies, and evaluate remedial alternatives consistent with the MTCA and SMS regulations.

2.3 Rationale for RI/FS Scope of Work

The scope of investigation and engineering activities to be performed during the RI/FS is consistent with MTCA and SMS requirements. Principal investigation tasks to be performed include the following:

- Collect surface sediment data in areas where existing data are inadequate to determine compliance with SMS chemical criteria, such that the lateral extent of surface sediment contamination can be characterized.
- Perform confirmatory biological testing in those areas that exceed the SMS chemical criteria and in those areas that may cause deleterious benthic impacts, as determined by Ecology.
- Use core sampling to characterize the vertical extent of contamination in subsurface sediments and to evaluate sediment management alternatives, including the suitability of unconfined, open-water disposal under PSDDA.
- Collect bathymetric information at each sampling location in support of the engineering analysis for remedial alternatives.
- Collect additional site information as required to support the analysis of remedial alternatives.

The feasibility study will evaluate remedial alternatives in compliance with SMS, and MTCA remedy selection requirements. This analysis will address the effectiveness, implementability and cost of different cleanup technologies, ranging from aggressive removal technologies to containment and natural recovery technologies. Where appropriate, the feasibility study will evaluate different remedial technologies for specific areas of the site or for different contamination levels. Specific analyses to be performed during the feasibility study include the following:

- Analysis of prop wash effects and bathymetric limitations relevant to the use of capping or natural recovery technologies.
- Evaluation of logistical constraints (e.g., presence of docks and pilings) relevant to dredging activities, as well as the evaluation of methods, which could be used to overcome those constraints.
- Evaluation of current and future land uses for each remedial alternative.
- Evaluation of remedial costs for different cleanup levels (i.e., costs associated with remediation to the SQS versus those associated with cleanup to the MCUL and human health criteria).
- Evaluation of total remedial costs for a range of alternatives.

Collection of surface sediment and subsurface sediment samples are described in more detail in Section 3 and in the Sampling & Analysis Plans included as Appendices A and B, respectively.

3 Remedial Investigation Tasks

This section contains an overview of the field investigation tasks to be performed as part of the RI/FS. These activities will be performed within the RI/FS investigation area identified in Figure 1-1.

The RI/FS investigations will be used to define any Site areas requiring remediation. The sampling activities will include the collection of surface grab samples for chemical analysis and bioassay testing. Surface samples will define the lateral extent of chemical contamination and biological effects. The extent of subsurface coring will be contingent upon surface grab results. Subsurface samples will define the vertical extent of chemical contamination and will provide data necessary for evaluation of potential remedial alternatives.

3.1 Primary Investigation Tasks

The RI/FS sediment investigations will be conducted in two phased field efforts. The first phase will consist of surface sampling, chemical analysis, and bioassay testing. The second phase will consist of subsurface sampling and chemical analysis to determine the composition and thickness of contaminated sediments. The subsurface data will be used to first evaluate the nature and extent of contamination and (secondarily) to evaluate sediment management alternatives as part of the FS. The program of surface sampling is defined in detail in Appendix A. The subsurface coring program is defined in detail in Appendix B.

All investigation activities will be conducted consistent with a Site Health and Safety Plan (HASP). The Site HASP will be prepared consistent with state regulatory requirements. The project HASP will be submitted to Ecology at least 30-days prior to mobilization for field investigation activities.

Surface Grab Sampling

Surface sediment samples will be collected within the RI/FS investigation area to help define the extent of surface contamination. Samples will be collected within the area of SMS exceedances and beyond these boundaries. Grab samples will be analyzed for chemical parameters, and those that fail SQS chemical criteria will be tested with bioassays.

Chemical Analysis of Grab Samples

Thirteen locations within the Site will be sampled for surface sediments by van Veen grabs, as described in Appendix A. These samples will be analyzed for SMS chemical parameters, including volatile and semivolatile organics, pesticides and PCBs, metals, total organic carbon (TOC), ammonia, total sulfides, grain size, and total solids. Metals analysis will include nickel.

Bioassay Sampling

At each of the grab sampling locations, additional volume will be collected and archived to be used for bioassay testing. If any of the surface sediments should fail SQS chemical criteria, those stations will be subjected to bioassay testing along with those requested by Ecology. Bioassays will be performed as described in Appendix A. As described in section 2.2, samples with nickel at concentrations in excess of the PSDDA screening level will be tested using bioassays, along with those samples requested by Ecology.

Under SMS regulations, the interpretation of bioassay data requires the collection and analysis of clean reference sediment, similar in physical characteristics to the test sediments. One of more reference samples will be collected for use in the RI/FS confirmational bioassays, based *a priori* on the grain size and organic carbon content of test sediments. These samples will be analyzed for bioassays as well as for the same chemical parameters as grab samples at the Site.

Subsurface Core Sampling

The composition and thickness of the contaminated sediments will be determined in the area defined by surface sediment sampling. Coring will be conducted with a vibracore, as described in Appendix B, and will be tested for the full suite of SMS chemicals. All chemicals tested will be compared to SMS and PSDDA criteria. Biological testing of subsurface sediments will be performed on samples from dredged material management units if PSDDA screening levels are exceeded.

3.2 Additional Investigation Tasks

As part of the field investigation program, additional data will be collected to support the engineering analyses to be performed as part of the RI/FS.

Analysis of Current and Future Land Uses

Land use information and anticipated navigation requirements of the I&J Waterway and berth areas will be collected for the current primary users of the waterway. The users include Bornstein Seafoods, the US Coast Guard, and users of the marina entrance at the opening of the waterway. Additional analysis of impacts of each remedial alternative on existing and future habitat, land use, and mitigation issues will be carried out as part of the feasibility study, as discussed in Section 4.3.

Bathymetric Data

A complete bathymetric survey will be conducted as part of the RI/FS investigation. Water depths will be measured from a boat using a transducer suspended from the boat while travelling first parallel and then perpendicular to track lines. Positions will be recorded using a DGPS unit at time of data collection. Water depths will be measured from a boat using lead line or

transducer equipment, depending on site conditions. Discrete measurements will be collected every 10 feet along transect survey lines spaced approximately 100 feet apart oriented perpendicular to shore. Positions will be recorded using a DGPS unit at time of collection. At least one longitudinal track line will be run parallel to shore to cross-reference the track lines.

Documentation of General Site Features

During the RI/FS investigations, additional data will be collected regarding the site features that may impact remediation activities. Specific observations include the following:

- Dock piling locations and types
- Over-water utilities or structures
- Shoreline armoring, bulkheads or other features relevant to Site remedial alternatives
- Bottom characteristics and sediment grain size

An updated base map will be prepared as part of the RI/FS for use during remedial alternatives evaluation.

3.3 Data Management, Reporting and QA/QC

Data collected during the field investigation program will be summarized in the RI/FS document. That document will include tabular and graphical summaries of all collected data. All laboratory reports and QA/QC summaries will be attached to the document as appendices. All chemical and biological testing data will be reported to Ecology electronically in SEDQUAL database format prior to final RI/FS approval.

4 Feasibility Study Tasks

4.1 Remedial Technology Screening

Once the areas and volumes of contaminated sediments have been determined, cleanup technologies will be screened for their ability to remediate these sediments. The screening will evaluate the implementability, effectiveness, and cost of each technology. Based on data collected to date, likely sediment remedial technologies which will be carried forward for further consideration at the Site include:

- Natural recovery
- Capping of contaminated sediments
- Dredging and disposal in an upland Subtitle D landfill
- Dredging with upland treatment
- Dredging with beneficial reuse or PSDDA disposal
- Mixtures of the above-listed technologies

Capping Technologies

As part of the technology screening for sediment capping, particular attention will be paid to the long-term effectiveness of this technology, as well as land use considerations.

Given the size of the vessels entering and exiting the I & J Waterway, prop wash is likely to be the dominant mechanism affecting the long-term effectiveness of sediment capping. An analysis of prop wash will be conducted using the methodology presented by the U.S. Army Corps of Engineers (ACOE). This analysis will specify minimum capping requirements at the Site.

Results of the bathymetry information collected during investigation activities will be used to evaluate the areas where capping is an option, given the need for a minimum depth of water at the Site. Where capping is determined to be impracticable, the technology will be excluded from further consideration in that area. The required cap thicknesses and any associated armoring will be assessed for each area for which capping is determined to be feasible.

Natural Recovery

Due to the presence of an active federal navigation channel and navigation berth areas within the site, natural recovery is not likely to be the primary remedial approach for the Site. However, it may impact the area and volume of sediments for which active remediation technologies are used. As part of the FS, the potential impact of natural recovery to the areas and the volumes requiring active remediation will be evaluated. The results of the prop wash

analyses performed as part of the capping analysis will be incorporated in the screening of natural recovery, along with natural recovery evaluations that were performed in the immediate vicinity of the Site as part of the Whatcom Waterway RI/FS (Anchor, 2000). The influence of natural recovery on contaminant concentrations will be assessed for each of the site areas.

Sediment Dredging Analysis

Dredging of contaminated sediments will be evaluated as part of the technology screening. The analysis will be used to define the procedures, practicability, and costs associated with removal of impacted sediments.

Knowledge of site bathymetry and sediment thicknesses collected during sampling and the location of fixed features at the Site (e.g., pilings) will be used to determine which areas are amenable to the use of dredging technologies. Structural stability of existing pilings and structures will be considered in evaluating remedial alternatives. Specific types of dredges that can be used (e.g., hydraulic or mechanical), rates of dredging, and issues involving water quality management will be assessed in this analysis.

The dredging analysis will be performed in parallel with the analysis of sediment treatment and disposal options. Where the costs and engineering alternatives associated with dredging are affected by the type of treatment/disposal alternative selected, these differences will be identified. The format of the cost estimates will permit direct comparison between technologies. The sampling plan in Appendix B evaluates the potential for beneficial reuse and for unconfined, open-water disposal under the PSDDA program. Appendix B includes maps defining preliminary dredged material management units based on existing site data and historical dredge records and bathymetric maps.

Beneficial Reuse and/or PSDDA Sediment Disposal

The disposal of the sediments at an established PSDDA disposal site will be evaluated as part of the RI/FS. Sediment must meet PSDDA requirements in order to qualify for unconfined, open-water disposal. These requirements are also used to evaluate beneficial reuse options.

Upland Treatment, Reuse and Disposal Technologies

Upland treatment, reuse and/or disposal technologies will be screened for application to the Site sediments. Specific treatment, reuse and/or disposal options to be evaluated include the following:

- Beneficial reuse as industrial soil consistent with applicable federal and state regulations
- Treatment and reuse as construction aggregate or cement admixture
- Treatment in a thermal desorption unit

- Disposal in a Subtitle D landfill
- Other commercially-available treatment/disposal alternatives as appropriate

4.2 Development of Remedial Alternatives

Following screening of remedial technologies, the technologies will be combined to create remedial alternatives for further evaluation in the feasibility study. The range of alternatives is expected to span technologies from natural recovery to complete removal. The range of alternatives will include consideration of special subareas of the Site (e.g., under-pier contaminated areas), which may require special technologies or for which remedial costs may be substantially different from other similarly contaminated site areas with different physical characteristics.

Detailed cost estimates and drawings will be prepared for each alternative evaluated. The format of the cost estimates will allow for direct comparison of costs between each alternative. Each alternative will be evaluated consistent with MTCA remedy selection requirements as defined in WAC 173-340-360.

Cost estimates will include both short-term and long-term costs, including the costs of mitigation for land use or habitat impacts as described below. The analysis of effectiveness will address the issue of long-term risks. Options to reduce these long term risks will be discussed where appropriate.

4.3 Analysis of Habitat, Land Use and Mitigation Issues

As part of the remedial alternatives analysis, habitat, land use and mitigation issues will be evaluated. The habitat analysis will address potential habitat impacts of each alternative, and will address any required mitigation measures under existing regulations. This analysis will address potential concerns associated with the Endangered Species Act.

Land use issues will be evaluated for each of the alternatives. Potential impacts on each of the following will be addressed:

- Existing uses and anticipated navigation for the I&J Waterway and berth areas
- Existing and anticipated uses of the adjacent upland properties
- Potential future uses of the site and neighboring properties, with a weighting toward those uses that are consistent with the City of Bellingham Shoreline Master Plan and the Washington State regulations for the management of state-owned aquatic lands (WAC

332), including the results of ongoing land use planning efforts and SMP revision.

- Consistency with the State Environmental Policy Act (SEPA) and with the Environmental Impact Statement (EIS) prepared by Ecology and cooperating agencies under the Bellingham Bay Demonstration Pilot (Ecology, 2000).

Where impacts to habitat or land uses would require mitigation, and where reasonable mitigation alternatives for mitigation are available, the costs and other requirements of these actions will be defined, discussed, and included as part of the alternatives evaluation process.

4.4 Selection of a Preferred Alternative

Selection of a preferred alternative will be performed after coordination with Ecology. The preferred alternative will be selected consistent with MTCA and SMS regulatory requirements.

4.5 Preparation of the RI/FS Report

The RI/FS report will be prepared as a draft for review and comment by Ecology. The draft RI/FS report will be submitted to Ecology for review. RETEC expects that Ecology will provide written comments on the RI/FS report. Written responses to these comments will be provided.

After the comments from Ecology have been addressed, a revised RI/FS report will be prepared by RETEC. The revised report will reflect the comments and responses from the draft RI/FS. This version of the RI/FS will be made available for public and stakeholder review during a 30-day public comment period as described in the Public Participation Plan (Ecology, 2004). The RI/FS will be finalized after completion of a public comment period.

5 Project Schedule

An overview of the project schedule is provided below in Table 5-1.

Table 5-1 Project Schedule

Key Dates	Project Tasks
September 2005	Surface sediment sampling and associated laboratory analysis
October 2005	Prepare Spatial Extent Report summarizing surface sediment results
January 2006	Sediment coring sampling and associated laboratory analysis
January 2006	Preparation of RI data summaries, Discussion of site cleanup levels with Ecology
February 2006	Technology Screening & Analysis of Remedial Alternatives
March 2006	Selection of Preferred Remedial Alternative, and Submittal of Draft RI/FS
June 2006	Submittal of Revised RI/FS

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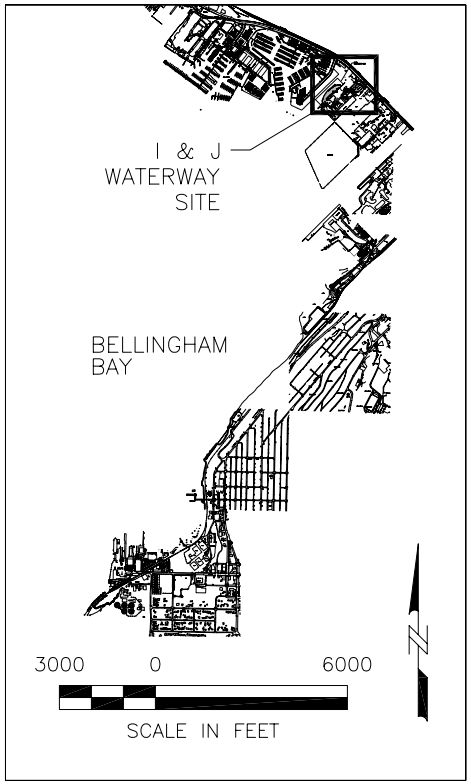


RI/FS
INVESTIGATION AREA

CURRENT EXTENT OF
SMS CHEMICAL AND
BIOLOGICAL EXCEEDANCES

I & J WATERWAY

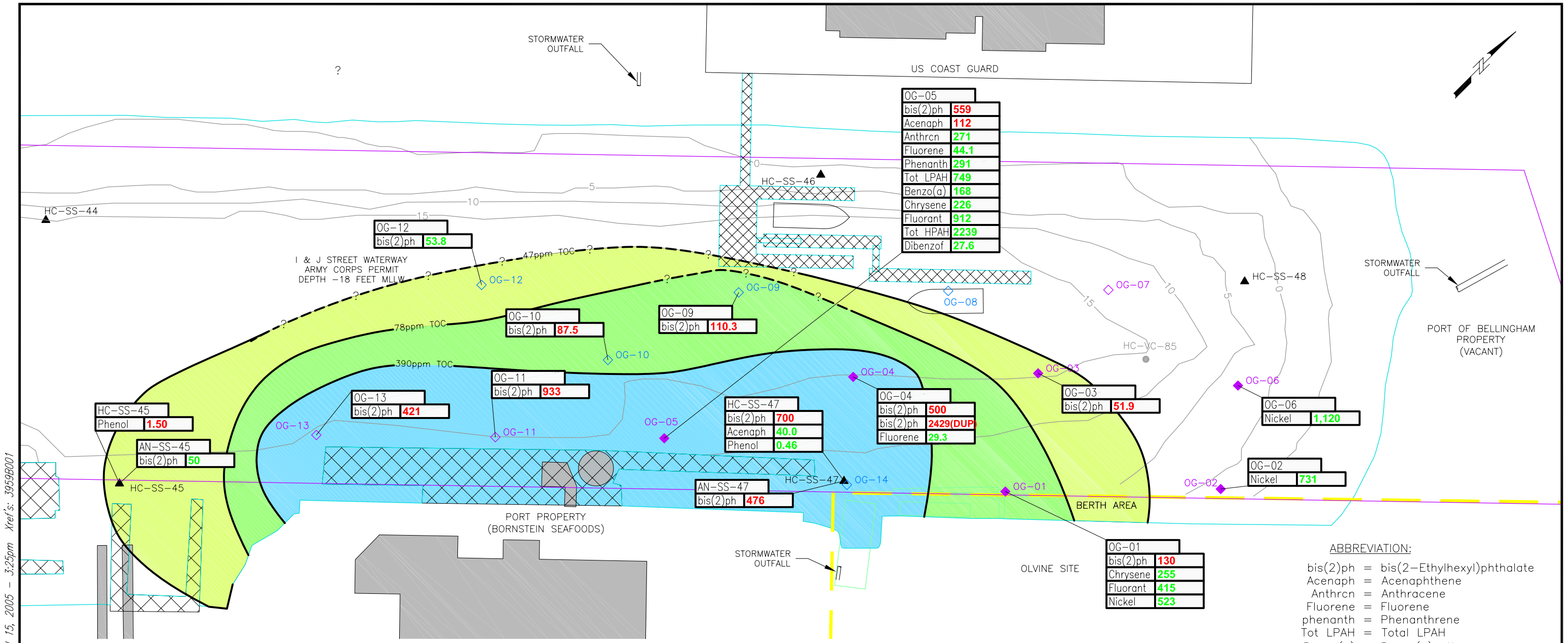
Pipe
Paved
Conc
FH
Rails Obscured
Dock
Unpaved Parking
Storage
Boat Storage
Stack
RTV

N
100
0
200
SCALE IN FEET

NOTE:
THE INVESTIGATION AREA MAY BE EXPANDED IF CONTAMINATION APPEARS TO EXTEND BEYOND THE CURRENT INVESTIGATION AREA.

RETEC

I&J WATERWAY RI/FS WORK PLAN PORTB-18449-100	**SITE LOCATION MAP**
DATE: 06/15/05 DRWN: A.S./SEA	**FIGURE 1-1**



LEGEND

- 271 — PREVIOUS CHEMICAL DATA DETECTED BETWEEN SQS AND MCUL
- 476 — PREVIOUS CHEMICAL DATA DETECTED ABOVE MCUL
- DOCKS OR PIERS
- EXISTING STRUCTURES
- EXISTING SHORELINE
- 25 — BATHYMETRY (FEET BELOW MLLW PER WHATCOM WATERWAY RI/FS REPORT)
- CURRENT OLIVINE UPLAND SITE BOUNDARY
- I & J WATERWAY BOUNDARY
- ▲ HC-SS-47 — PREVIOUS SEDIMENT GRAB SAMPLE (HART CROWSER, 1997)
- ◆ OG-3 — PHASE 2 SURFACE SEDIMENT GRAB SAMPLE
- ◇ OG-10 — PHASE 2 SVOC/TOC ANALYSIS ONLY
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL SQS CRITERIA (47ppm TOC)
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL MCUL CRITERIA (78ppm TOC)
- bis(2-Ethylhexyl)phthalate EXCEEDS 5 TIMES CHEMICAL MCUL CRITERIA (390ppm TOC)

PARAMETER	SQS	MCUL
Acenaphthene (ppm TOC)	16	57
Anthracene (ppm TOC)	220	1200
Fluorene (ppm TOC)	23	79
Phenanthrene (ppm TOC)	100	480
Total LPAH (ppm TOC)	370	780
Benzo(a)anthracene (ppm TOC)	110	270
Chrysene (ppm TOC)	110	460
Fluoranthene (ppm TOC)	160	1200
Total HPAH (ppm TOC)	960	5300
Dibenzofuran (ppm TOC)	15	58
bis(2-Ethylhexyl)phthalate (ppm TOC)	47	78
Phenol (mg/kg)	0.42	1.2
Nickel (mg/kg) PSDDA SL= 140*		

ABBREVIATION:

bis(2)ph = bis(2-Ethylhexyl)phthalate
Acenaph = Acenaphthene
Anthrcn = Anthracene
Fluorene = Fluorene
phenanth = Phenanthrene
Tot LPAH = Total LPAH
Benzo(a) = Benzo(a)anthracene
Chrysene = Chrysene
Fluorant = Fluoranthene
Tot HPAH = Total HPAH
Dibenzof = Dibenzofuran

NOTES:

PAHs, dibenzofuran, AND/OR phenol SQS EXCEEDANCES WERE DETECTED AT OG-01, OG-04, OG-05, HC-SS-45, AND HC-SS-47.

CONCENTRATIONS ARE SHOWN IN TOC-NORMALIZED UNITS (ppm TOC OR mg/kg O.C.)

EXCEEDENCES OF SQS BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-45. EXCEEDENCES OF MCUL BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-47.

*SMS DOES NOT DEFINE A NICKEL NUMERIC SQS OR MCUL. THE NICKEL PSDDA SL WILL BE USED TO ASSESS WHETHER OR NOT TO PERFORM BIOLOGICAL EFFECTS TESTING IN SURFACE SEDIMENT SAMPLES.

RETEC

0 30 60 120
SCALE IN FEET

I & J WATERWAY
RI/FS WORK PLAN
PORTB-18449-100

SUMMARY OF PREVIOUS SURFACE SEDIMENTS EXCEEDENCES

DATE: 07/15/05 | DRWN: A.S./SEA | **FIGURE 1-2**

File: H:\18449\184495008.dwg Layout: Layout1 User: astenberg Plotted: Jul 15, 2005 - 3:25pm Xref's: J959B001

Appendix A
Sediment Sampling and Analysis Plan and Quality Assurance/ Quality Control Plan

I & J Waterway Sediments RI/FS
Bellingham, Washington

Prepared by:

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RETEC Project Number: PORTB-18449-100

Prepared for:

Port of Bellingham
1801 Roeder Avenue
Bellingham, Washington 98225

July 27, 2005

Sediment Sampling and Analysis Plan and Quality Assurance/ Quality Control Plan

I & J Waterway Sediments RI/FS
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Prepared by:

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Daniel J. Berlin, Environmental Scientist

Reviewed by:

_____
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July 27, 2005

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List of Acronyms

CLP	Contract Laboratory Program
COC	Chain of Custody
CVAA	Cold Vapor Atomic Absorption
DGPS	Differential Global Positioning System
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
HSP	Health and Safety Plan
ICP	Inductively-Coupled Plasma Emission Spectroscopy
MDL	Method Detection Limit
MLLW	Mean Lower Low Water
MS/MSD	Matrix spike/matrix spike duplicate
MSS	Marine Sampling Systems
MTCA	Model Toxics Control Act
NAD	North American Datum
PSAMP	Puget Sound Ambient Monitoring Program
PSDDA	Puget Sound Dredge Disposal Analysis
PSEP	Puget Sound Estuary Program
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SMARM	Sediment Management Annual Review Meetings
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
TAD	Total Acid Digestion
TOC	Total Organic Carbon
VOCs	Volatile Organic Compounds

1 Introduction

1.1 Purpose

This Sampling and Analysis Plan (SAP) summarizes the methods for field investigations to be performed during a remedial investigation and feasibility study (RI/FS) for sediments at the I & J Waterway Site (Site) in Bellingham, Washington. Figure 1-1 shows the Site location map. These methods will be used to implement the scope of work defined in the attached RI/FS Work Plan.

Expanding upon previous studies, the RI/FS investigations described in this document will define the areas and volumes of impacted sediments and will collect additional information needed to support the analysis of remedial alternatives for the Site. The RI/FS is being performed in compliance with the requirements of the Model Toxics Control Act (MTCA) and the Sediment Management Standards (SMS).

The field activities will be conducted by The RETEC Group, Inc. (RETEC), on behalf of the Port of Bellingham (Port). Field sampling activities are currently scheduled to begin in August 2005.

This document includes the elements of a sediment SAP and a quality assurance and quality control plan (QAPP) consistent with Sediment Management Standards (SMS) requirements contained in Washington Administrative Code (WAC) Chapter 173-204 (Ecology, 1995).

1.2 Investigation Areas and Tasks

The RI/FS sediment investigations will be conducted in two phased events. The first phase will consist of surface grabs and bioassay testing as described in this document. The second phase will consist of subsurface coring and required biological testing as designated under PSDDA guidelines. The second phase of sampling is attached in a separate SAP in Appendix B. If the spatial extent of contamination has not been determined in the first phase of grabs, additional investigation may be necessary. Phasing of discrete tasks and laboratory analyses are described below. Locations of surface sediment sampling locations are depicted in Figure 1-2.

Surface Grab Sampling

The spatial extent of contaminated sediments will be determined by collecting 13 surface grab samples (0-12 cm) located throughout the Site, including the inner waterway, outer waterway, and northwestern (opposite shore) boundaries. Surface grab samples will be analyzed for the chemical parameters listed below.

Chemical Analysis of Surface Grab Samples

Thirteen locations will be sampled by hydraulic van Veen. Sampling methods are described in Section 2 of this document.

The surface grabs will be analyzed for SMS chemical parameters, including semivolatile organics, metals (including nickel), total organic carbon (TOC), total sulfides, grain size, and total solids. If any surface samples should exceed SQS chemical criteria, those stations will be subjected to bioassay testing as will those determined by Ecology. Samples with nickel exceeding the PSDDA screening levels will also be tested for potential biological effects.

Bioassay Sampling

At each of the grab sampling locations shown in Figure 1-2, additional volume will be collected and archived. These archived samples will be used to perform bioassays if exceedances of the chemical SQS criteria are detected or as determined by Ecology. These bioassays will be performed as described in Section 4 of this document.

Under SMS regulations, the interpretation of bioassay data requires the collection and analysis of clean reference sediment, similar in physical characteristics to the test sediments. One or more reference samples will be collected from Samish Bay *a priori* based on similar grain size and organic carbon content of site sediment. These samples will be analyzed for chemical parameters during the first phase of sample analysis, with bioassay testing to be conducted in parallel with the test samples as described above.

Subsurface Core Sampling

A second phase of fieldwork will occur following establishment of the spatial extent of surface sediment contamination. The sediment sampling and analysis plan for subsurface cores is contained in Appendix B. The outlines of the preliminary dredged material management units developed for the RI/FS and used as the basis for the subsurface sampling effort are shown in Figure 1-2 for reference.

2 Sediment Sample Collection

This section outlines the activities, procedures, and objectives for surface sediment sampling at the Site. Field activities will be conducted in accordance with the SAP. Surface sediment will be collected from each of the proposed locations provided on Figure 1-2. Table 2-1 lists the proposed station coordinates (in both state plane coordinates and latitude/longitude). Table 2-2 lists samples to be collected at each station and the associated chemical, biological, and physical analyses. These activities are discussed below.

Specific sampling equipment and methodology may change based on sediment characteristics and Site conditions. Modifications and/or deviations from the approved SAP will be documented in the summary report and revised RI/FS. Sampling and analysis will follow PSEP (PSEP, 1986, 1995, 1996a, 1996b, 1996c, 1996d).

2.1 Navigation, Positioning, and Location Control

Positioning and navigation for sediment sample locations will be accomplished using a Real Time Kinematic (RTK) Differential Global Positioning System (DGPS) that allows sub-meter horizontal and vertical accuracy. For this project, a Trimble 4000 global positioning system (GPS) or similar device will be employed. The objectives for the sample station positioning require an accuracy of plus or minus 3 meters. To meet these requirements, the instrument calibration and quality control procedures described below will be followed.

The positioning system will be calibrated over a known location prior to the initiation of any field activities. Datum for all survey data will be reported under North American Datum 1983 (NAD83), Washington State Plane Coordinates (SPC), North 4601. National Geodetic Vertical Datum of 1929 (NGVD29) will be used as the vertical datum for survey data. Data deliverables will include latitude/longitude, northing/easting, and elevation, where applicable. Ecology's SEDQUAL database is maintained in SPC in feet NAD83 North Zone and Geographic Information System (GIS) maps use latitude/longitude decimal degrees projected into NAD83 North Zone. Locations will likely be displayed in these formats. A previously established, land-surveyed DGPS benchmark located near the sampling area will be used prior to initiating field sampling and daily to check the system accuracy.

All samples will be collected within 20 feet of the proposed sample coordinates. If an adequate sample cannot be collected within this radius, the Field Team Leader (FTL) may choose to move 50 feet from the proposed sample coordinates without notifying the Project Manager (PM). The new

location must be moved laterally and remain equidistant from the current cleanup boundary. No sample will be collected outside of a 50-foot radius from the proposed sample coordinates without prior consent from the PM.

Vertical elevation will be determined for all sample locations and will be reported as depth to sediment ([DTS] mudline). When applicable, the DTS will be measured before and after each sampling event. Measurements will be taken by weighted tape and echo sounder. The incremented tape will be pulled taut from the bottom and measured to the nearest tenth of foot. These measurements will then be confirmed with an electronic echo sounder onboard the vessel. The echo sounder method determines depth by bouncing sound waves off the mud layer and back to a receiver. These readings will be correlated to mudline elevations in mean lower low water (MLLW) datum to the nearest 0.1 foot using tide measurements obtained for Bellingham Bay for each of the sampling dates and times.

2.2 Surface Sediment Sampling

Surface sediment samples will be collected using a 0.1 square-meter stainless steel hydraulic van Veen sampler, operated by Marine Sampling Services (MSS). Surface sediment samples will be collected according to the procedures outlined in RETEC SOP 260 (Attachment A).

The surface sediment samples (0 to 12 centimeters [cm]) will be collected for the chemical, physical, and biological testing listed in Table 2-2. This table contains a list of analyte groups, along with analysis methods, holding times, preservatives, and container requirements. Table 2-3 provides a complete list of analytes measured as part of chemical analysis. Specific details on the sediment sampling procedures are described below. Visual classification of sediment samples will be according to the American Society for Testing and Materials (ASTM) standards listed in Table 2-4.

2.2.1 Sample Nomenclature

Each sediment sample location will be assigned a unique 6-digit alpha-numeric label. This 6-digit system will facilitate the identification and tracking of each unique sample. The code will be divided into the following sets of character designations as follows:

- The first characters identify the study location:
  - IJW - I & J Waterway;
- The next characters identify the type of sample taken and will be separated from the study location symbol with a dash (-):
  - SS – Surface Grab sample

- The final two characters identify a unique sample number according to location and will be separated from the previous characters by a dash (-):
  - 01-13 - Sites in the I & J Waterway
  - R1-R2 - Bioassay Reference Station samples
- Blind field duplicates will be identified as a unique sample location and/or sub-sample number (e.g., IJW-SS05-100)

An example ID for a surface grab at station 8 is "IJW-SS-08".

2.2.2 Surface Sample Collection

The *R/V Nancy Anne*, owned and operated by MSS, equipped with a modified hydraulic van Veen sampling device, will be used to collect surface sediment samples. Sampling locations will be approached at slow boat speeds with minimal wake to minimize disturbance of bottom sediments prior to sampling. Sediment samples will be handled carefully to minimize disturbance during collection and transportation to the laboratory.

The grab sampler will be lowered over the side of the boat from a cable wire at an approximate speed of 0.3 feet per second. When the sampler reaches the mudline, the cable will be drawn taut and DGPS measurements recorded. Each surface grab sample will be retrieved aboard the vessel and evaluated for the following acceptance criteria:

- Overlying water is present and has low turbidity;
- Adequate penetration depth is achieved;
- Sampler is not overfilled;
- Sediment surface is undisturbed; and
- No signs of winnowing or leaking from sampling device.

Grab samples not meeting these criteria will be rejected near the location of sample collection and steps repeated until criteria have been met. Deployments will be repeated within a 20-foot radius of the proposed sample location. If adequate penetration is not achieved after multiple attempts, less volume will be accepted and noted in the field notebook. Once accepted, overlying water will be siphoned off and a decontaminated stainless steel trowel, spoon, or equivalent, will be used to collect only the upper 12 cm of sediment from inside of the sampler without touching the sidewalls. The sampler will be decontaminated between stations and rinsed with Site water between grabs.

After sample collection, the following information will be recorded on the Field Log Sheet, Sediment Sampling Form, and/or the field notebook (Appendix B).

- Date, time, and name of person logging sample;
- Weather conditions;
- Sample location number and coordinates;
- Project designation;
- Depth of water at the location and surface elevation;
- Sediment penetration and depth;
- Sediment sample interval;
- Sample recovery; and
- Physical observations such as apparent grain size, color, odor, density, layering, anoxic contact, and presence of sheen, shells and/or debris.

2.2.3 Sample Processing

Sulfide samples will be collected from discrete grabs prior to compositing to minimize potential loss of volatiles. Each sulfide sample jar must be completely filled with sediments followed by 2 milliliters (ml) of ZnAc added on top. In addition, the sample jar must be sealed with a Teflon-lined cap to ensure proper preservation of the sample.

Homogenized sediment will be spooned immediately into appropriate pre-cleaned, pre-labeled sample containers, placed in coolers filled with ice or equivalent, and maintained at 4 degrees centigrade (°C). Materials over 0.5-inch-diameter and debris will be omitted from the sample containers. Any material removed from the sediment will be noted on the field forms. Surface sediment samples will be submitted for chemical analysis and bioassay testing.

In addition to the location information collected in the field, sample logging of bulk samples will involve physical characterization in general accordance with the visual-manual description procedure (Method ASTM D-2488 modified), details of which are provided in Table 2-4. Physical characterization includes the following:

- Grain size distribution;
- Density/consistency;
- Plasticity;
- Color and moisture content;
- Biological structures (e.g., shells, tubes, macrophytes, bioturbation);
- Presence of debris (e.g., woodchips or fibers, paint chips, concrete, sand blast grit, metal debris);
- Presence of oily sheen; and
- Odor (e.g., hydrogen sulfide).

This information will be recorded on the Sediment Sampling Forms (Attachment B).

Surface sediment samples collected for chemical and physical analysis will be packed and shipped to Analytical Resources, Inc. (ARI) in Tukwila, Washington, in accordance with RETEC SOP 110 (Attachment A). The surface sediment samples for bioassay analysis will be shipped under the same protocol to the bioassay laboratory, as appropriate.

2.2.4 Grain Size Rapid Wet Sieving

This process separates the sediment sample into size fractions greater than 62.5 micrometers (µm) (i.e., sand and gravel) and less than 62.5 µm (i.e., silt and clay) for rapid classification of sand and silt/clay fractions. This process helps determine appropriate reference stations with similar grain size fractions (by volume) during field operations. This procedure requires a 62.5-µm sieve, a funnel with diameter slightly greater than that of the sieve frame, a 100-ml graduated cylinder, a squirt bottle, a supply of distilled water, and a bowl for collecting rinse water.

- Place a 62.5-µm (4-phi or 0.0025-inch mesh or #230 mesh size) sieve in a funnel, with a bowl underneath. Moisten the sieve using a light spray of distilled water.
- Place exactly 50 ml of sample in the 100-ml graduated cylinder, add 20 to 30 ml of distilled water, and stir to fluidize the sample.

- Pour the sample into the sieve and thoroughly rinse any residue from the 100-ml graduated cylinder and stir into the sieve.

- Wash the sediment on to the sieve with distilled water using a water pique or squirt bottle having low water pressure. Aggregates can be gently broken using a rubber policeman.

- Continue wet sieving until only clear water passes through the sieve. Take care to ensure that the rinsate does not exceed approximately 950 ml. This is accomplished by sieving an appropriate sample quantity (i.e., a sample volume that is not too large) and by efficient use of rinse water. Both of these techniques may require experimentation before routine wet sieving is started.

- Upon completion of sieving, carefully return the contents (i.e., sand and gravel fraction) of the sieve to the 100-ml graduated cylinder.

- Tap the graduated cylinder gently to settle the solid material.

- Read the volume of solid material from the scale on the side of the graduated cylinder and record the value. The fraction of sample with grain size greater than 62.5 µm is the ratio of the volume of material retained in the sieve to the original volume (50 ml).

2.3 Reference Sample Collection

Toxicity testing requires that appropriate reference sediment be collected and tested with Site sediments. Concurrent test on reference sediment are conducted to control for possible sediment grain size effects on bioassay organisms. Bioassays will be run with reference sediment that is well matched to the test sediments for grain size and total organic carbon (TOC). One or more reference samples will be collected for bioassay analysis based on grain size and TOC content of Site samples.

Reference stations for bioassay testing are collected to analyze the response of the tests to sediments that are known to be unimpacted from chemical contamination. In addition, it is favorable to collect reference samples that have similar grain size distribution and TOC content as the sediment samples taken from the study area to assure that the reference stations are representative of the sediments in the study area. One reference station sample will be collected from Samish Bay, just south of Bellingham, in order to determine the response of bioassay test organisms to sediments of physical characteristics similar to those of the test sediments. Chemical testing will also be evaluated in the reference sediment to confirm test organism response is not due to chemical contamination.

2.4 Chemistry Analysis Methods

Sediment samples will be analyzed according to PSEP as outlined in the following methods, listed in Table 2-2:

- **VOCs:** VOCs by US EPA Method 8260;
- **SVOCs:** SVOCs by United States Environmental Protection Agency (EPA) Method 8270;
- **PCBs:** EPA Method 8081;
- **Metals:** Various metals by EPA Methods 6010/7471;
- **Conventional Parameters:** Total solids, total volatile solids, TOC, total sulfides, and ammonia by PSEP methods;
- **Bioassays:** Infaunal *Neanthes arenaceodentata* 20-day infaunal growth test, *Eohaustorius estuarius* 10-day acute mortality test, and sediment larval test with *Dendraster excentricus* or *Mytilus (edulis) galloprovincialis*; and
- **Grain Size:** By PSEP methods.

2.5 Bioassay Testing Methods

Marine bioassay testing species selection depends on grain size, salinity, and season in which testing will be performed. Based on the currently proposed project schedule, the following bioassay tests will likely be performed:

- *Neanthes arenaceodentata* (Los Angeles karyotype);
- *Eohaustorius estuarius, Rhepoxynius abronius, or Ameplisca abdita*; and
- *Dendraster excentricus* or *Mytilus (edulis) galloprovincialis*.

Bioassay testing will be performed according to PSEP guidelines (PSEP, 1995) by Vizon Scitec bioassay laboratory in Vancouver, British Columbia. Vizon Scitec is accredited by Ecology to perform each of the above testing procedures according to PSEP guidelines. If species substitutions are required due to the acceptability, availability, or other factors, such substitutions will be confirmed with Ecology prior to test initiation.

2.5.1 Species Selection

Amphipod Test

The amphipod *Rhepoxynius abronius* has demonstrated sensitivity to high percent fines in sediments, particularly high clay content sediments, and has exhibited mortalities greater than 20 percent in clean, reference area sediments (DeWitt et al., 1988; Fox, 1993). *Eohaustorius estuaries* has also exhibited sensitivity to high clay content (>30%) despite being relatively insensitive to salinity changes and other effects of grain size. *E. estuarius* will be the preferred amphipod species unless clays are greater than 30 percent clay. *A. abdita* is relatively insensitive to grain size up to concentrations of fines greater than 60 percent (USACE, 2000). If clay is greater than 30% and fines are greater than 60 percent, *A. abdita* will be the preferred amphipod test species. If clay is more than 30% and fines are less than 60%, *R. abronius* will be used for testing.

Larval Test

For the sediment larval test, adults must be collected in spawning condition or must be induced to spawn in the laboratory. Therefore, seasonality plays a role in selecting a test organism. The preferred species for larval testing is the sand dollar *Dendraster excentricus*. According to the Users Manual for the PSDDA program, *D. excentricus* spawns naturally in Puget Sound from April through December. Larvae of *D. excentricus* do not show an adverse response to increasing silt and clay fractions, and under conditions of expected high silts and clay, the sand dollar test is preferable (EPA, 1993). The bioassay laboratory has had success inducing spawning in *D. excentricus*, however, if spawning is unable to be induced, another species deemed acceptable for test sediments containing at least 60% fines is *Mytilus* (*edulis*) *galloprovincialis*. Although they spawn naturally in Puget Sound between March and July, (USACE, 2000), AMEC bioassay laboratory has had success inducing spawning in *M. galloprovincialis*.

Prior to initiating bioassay testing, sediment grain size and interstitial salinity will be determined to confirm selection of the appropriate test species. If there is headspace in the jars, nitrogen will be added prior to storage (PSEP, 1995).

2.5.2 Procedures

Amphipod Bioassay

This test involves exposing the amphipod *Rhepoxynius abronius* to test sediment for ten (10) days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well.

Sediment Larval Bioassay

This test monitors larval development of a suitable echinoderm or bivalve species in the presence of test sediment. The test is run until the appropriate stage of development is achieved in a sacrificial seawater control (PSDDA MPR-Phase II, pp. 5-20). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality.

Initial counts will be made for a minimum of five 10-ml aliquots. Final counts for seawater control, reference sediment and test sediment will be made on 10-ml aliquots. The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) that is determined by the developmental stage of organisms in a sacrificial seawater control (PSDDA MPR Phase II, page 5-20).

Ammonia and sulfides toxicity may interfere with test results for this bioassay. Aeration will be conducted throughout the test to minimize these effects.

Neanthes Growth Test

This test utilizes the polychaete *Neanthes arenaceodentata*, in a 20-day growth test. The growth rate of organisms exposed to test sediments is compared to the growth rate of organisms exposed to a reference sediment.

2.5.3 Negative Controls

Negative control sediments are used in the amphipod and *Neanthes* bioassays to check laboratory performance. Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low mortality. The sediment larval test utilizes a negative seawater control rather than a control sediment. The negative control to be used for the sediment toxicity test will be a clean control (i.e., inert material with Site seawater) or native sediment where the organisms reside.

2.5.4 Reference Sediment

Reference sediments will also be included with each bioassay. Reference sediments provide toxicity data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size and total organic carbon. Bioassay testing requires that test sediments be matched and tested simultaneously with an appropriate Ecology-approved reference sediment to factor out sediment grain size effects on bioassay organisms.

One or more reference samples will be collected from Samish Bay or a similar reference site in Washington if substantially different grain sizes and organic carbon contents are encountered in the Site sediment samples. Reference sediments will be collected using a 0.1-square-meter stainless van Veen grab

sampler deployed by boat. Upon reaching the designated reference sediment location, a test grab sample will be collected and a subsample will be wet-sieved to determine grain size. If the grain size is not appropriate, the vessel position will be adjusted and another test grab will be collected. This procedure will be conducted until sediments with the proper grain size have been located. Multiple grab samples will then be taken until enough reference sediment is collected. A subsample of the final composite will be wet-sieved to verify the appropriate grain size.

Locations of reference station coordinates will be reported, with an accuracy of ± 3 meters. Reference sediment samples will also be tested for total solids, total volatile solids, total organic carbon, grain size, ammonia, and sulfides.

2.5.5 Replication

Five laboratory replicates of test sediments, reference sediments, and negative controls will be run for each bioassay.

2.5.6 Positive Controls

A positive control will be run for each bioassay. The positive control to be used for the sediment toxicity test will be a toxic control in which a reference toxicant is used to establish the relative sensitivity of the test organism. Cadmium chloride will be the positive control reference toxicant used for the amphipod and juvenile polychaete bioassays. Copper sulfate will be the positive control reference toxicant used for the bivalve larvae bioassay.

2.5.7 Water Quality Monitoring

Bioassays require that proper water quality conditions be maintained to ensure survival of the organisms, and to ensure that undue stress is not exerted on the organisms unrelated to test sediments. Daily water quality measurements include salinity, temperature, pH, and dissolved oxygen for the amphipod and sediment larval tests. These measurements will be made every three days for the *Neanthes* bioassay. Ammonia and total sulfide concentrations in both porewater and overlying water will be measured at test initiation and termination for all three tests. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls).

Parameter measurements must be within the limits specified for each bioassay. Interstitial salinity will be documented at test initiation for the amphipod bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

3 Decontamination Procedures

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross contamination between samples and helps to maintain a clean working environment. The purpose of decontamination is to remove contaminated materials clinging to gloves, boots, equipment, and sample containers prior to their removal from the work area. Decontamination also includes the removal and disposal of contaminated clothing and gloves.

Decontamination is achieved mainly by rinsing with soap or detergent solutions, tap water, deionized water, methanol, dilute acids, or acetone. Equipment will be allowed to air dry after being cleaned. Decontamination will be accomplished between each sample collection station and/or depth.

The following is a list of supplies needed provide decontamination of equipment and personnel:

- Clean gloves – inner and outer;
- Cleaning liquids and dispensers: soap and/or a powdered detergent solution such as Alconox™, tap water, deionized water, and technical grade hexane;
- Waste storage containers: drums, boxes, and plastic bags;
- Plastic ground cover;
- Chemical-free paper towels;
- Cleaning containers: plastic or galvanized steel pans and buckets; and
- Cleaning brushes.

3.1 Sampling Equipment

At a minimum, sampling equipment will be decontaminated prior to initial use and between sampling stations. Sampling equipment (i.e., spoons, bowls) decontaminated prior to field use will be wrapped in aluminum foil and stored in a sealed plastic bag to prevent contamination. Monitoring equipment (i.e., pH probe, tape measures) will be rinsed with distilled water and wiped dry with paper towels. Decontamination methods are detailed in RETEC SOP 120. Decontamination procedures include washing and scrubbing with an Alconox™ soap solution, rinsing with tap water, rinsing with distilled water, and air drying. If heavy, oily substances are found on sampling equipment, Simple Green™ or isopropanol will be used to clean the equipment. Cross

contamination will be minimized by sequencing sampling events from areas of suspected lower concentrations to areas suspected of relatively high concentrations, or from downstream to upstream locations as appropriate.

3.2 Personnel

RETEC has performed prior to sampling at the Site. The current investigations will be conducted under Level D protection (disposable Tyvek™ coveralls, steel-toe boots, hardhat, and protective gloves). The following steps will be used for personnel decontamination when using Level D equipment:

1) Wash boots and outer gloves with brush and detergent water, then rinse twice with tap water.

2) Remove disposable Tyvek™ coveralls, then remove outer gloves and place both coveralls and gloves in a disposal container.

3) Wash and remove inner gloves.

4) Wash and rinse face and hands with potable water or waterless cleaner.

5) Shower and shampoo as soon as possible at end of each workday.

All field participants must follow procedures and guidelines contained in the Site-Specific Health and Safety Plan. They must recognize the Site health and safety hazards and the protocols required to minimize exposure to such hazards by signing the Acknowledgement Form before beginning work.

3.3 Sediment Sampling Equipment

Equipment used to sample sediment that comes into contact with sediment will be decontaminated before collection of samples. The van Veen sampler will be decontaminated on site following methods outlined in RETEC SOP 120. The deck of the sampling vessel will be hosed down with site water in between sampling stations to minimize cross contamination and tracking of sediment to support zone areas.

4 Project Organization and Responsibilities

The specific roles, activities, and responsibilities of project participants are summarized below. The Port of Bellingham has the primary responsibility for managing the work completed at the Site. The primary contact for the Port is Mike Stoner. RETEC is the primary consultant for the Port and is responsible for the activities associated with implementing the supplemental sampling. The daily management of the project will be completed by RETEC staff members including Mark Larsen (PM) and Dan Berlin.

4.1 Project Team

The following additional personnel have been identified for the field investigation.

Field Team Leader

The FTL, Nick Bacher, will support the PM. The FTL is responsible for implementing and coordinating the day-to-day activities of the field team, including health and safety in the field. The FTL will report directly to the PM and will:

- Implement field-related work plans and schedules;
- Coordinate and manage field staff;
- Implement QA/QC for technical data provided by the field staff including field-measurement data;
- Conduct peer reviews of the field performance and reporting products of field crews;
- Write and approve text and graphics required for field-team effort;
- Coordinate and oversee technical efforts of subcontractors assisting the field team;
- Identify problems at the field-team level, resolve issues in consultation with the PM, implement and document corrective action procedures, and communicate with team members and upper management; and
- Participate in preparation of the project deliverables.

The field technical staff will be utilized to mobilize equipment, obtain samples, and gather field data. All designated technical team members will be experienced professionals who possess the degree of specialization and

technical competence required to effectively and efficiently perform the required work.

Project Manager

The PM, Dan Berlin, is responsible for ensuring completion of project objectives and Quality Assurance (QA) standards. The PM communicates with the Port and DNR and manages schedule, budget, and resources.

Quality Control Manager

The Quality Control Manager (QCM), Jennifer Fetting, for this project will review and document project performance as it relates to the Work Plan. He will be supported by Anne Fitzpatrick, RETEC's Technical Advisor for the project. As appropriate, the QCM will:

- Assist with laboratory coordination for scheduled analyses;
- Assure that the specified field, analytical, and data management procedures are followed and documented;
- Assess the precision, accuracy, and completeness of the data derived from the investigations;
- Schedule and oversee data validation; issue laboratory audit reports; retain laboratory audit records; and follow up on corrective actions; and
- Finalize electronic data deliverables (EDDs) and import data into the project database.

Health and Safety Officer

The Office Health and Safety Officer will be responsible for the health and safety aspects of this project.

Subcontractors

Local subcontractors will be used as appropriate and when available, without compromising quality, schedule, and cost.

Samples will be collected by RETEC. Chemical analyses of all media and physical analysis will be conducted by ARI, of Tukwila, Washington. Vizon Scitec of Vancouver, British Columbia, will be responsible for biological analysis. Individual laboratory QAPPs and SOPs for each laboratory are on file at RETEC.

MSS of Burley, Washington, under the direction of Bill Jaworski, will be responsible for the sediment collection for the investigation.

4.2 Special Training Requirements/Certification

Specific training requirements for performing fieldwork at the Site are as follows:

- All field personnel assigned to the Site must have successfully completed 40 hours of training for hazardous site work in accordance with Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(e)(3) and be current with their 8-hour refresher training in accordance with OSHA 29 CFR 1910.120(e)(8). Documentation of OSHA training is required prior to personnel being permitted to work on Site.

- Personnel managing or supervising work on site will also have successfully completed 8 hours of manager/supervisor training meeting the requirements of OSHA 29 CFR 1910.120(e)(4).

- Personnel assigned to the site must be enrolled in a medical surveillance program meeting the requirements of OSHA 29 CFR 1910.120(f). Personnel must have successfully passed an occupational physical during the past 12 months and be medically cleared to work on a hazardous waste site and capable of wearing appropriate personal protective equipment (PPE) and respiratory protection as may be required.

- Personnel assigned to the site who must wear a respirator must be familiar with the OSHA respiratory standard (29 CFR 1910.134). Personnel who are required to wear respirator protection must have successfully passed a respirator fit test within the last 12 months.

It is the responsibility of the employing organization to provide their employees with the required training, medical monitoring, and fit testing prior to assigning them to work at this site. Each employing organization will be responsible for providing documentation of training, monitoring, and fit testing (with make/model of respirator) to the RETEC Project Manager and Field Team Leader prior to sending their employees to the site to work.

All field participants must follow procedures and guidelines contained in the Site-Specific Health and Safety Plan (HASP). The HASP will be completed and submitted to Ecology 30-days prior to initiation of field sampling. All participants in the sampling effort must recognize the site health and safety hazards and the protocols required to minimize exposure to such hazards by signing the Acknowledgement Form before beginning work.

5 Quality Assurance/Quality Control Plan

To verify that the data produced during the sediment investigation are of sufficient quality, specific QA/QC requirements will be addressed by field personnel and the analytical laboratory. All laboratory data will be validated, as described below, prior to their use in project reporting.

5.1 Field QA/QC Protocol and Record Keeping

Proper sample collection, identification, preservation, storage and handling procedures, and chain of custody records are necessary for sampling data to be valid and usable. Procedures for these steps are discussed in the previous sections of this sampling plan. The field sampling crew is also responsible for ensuring that the required QA/QC analyses are requested, as indicated in Table 5-1.

5.1.1 Documentation

In addition to sample labels and chain of custody forms, a field logbook will be maintained by the field supervisor to provide a daily record of significant events. All entries will be signed and dated, made in nonerasable ink, and errors will be crossed out and initialed with a single line. The logbook will be kept as a permanent record. All field measurements will be recorded on the appropriate sampling log forms.

5.1.2 Sample Chain of Custody

Samples are considered to be in one's custody if they are: (1) in the custodian's possession or view; (2) in a secured location (under lock) with restricted access; or (3) in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). The principal documents used to identify samples and to document possession are chain of custody (COC) records, field logbooks, and field tracking forms. COC procedures will be used for all samples at all stages in the analytical or transfer process and for all data and data documentation, whether in hard copy or electronic format.

5.1.3 Location Control

DGPS locations and sampling times will be recorded electronically and on the project sampling logs. The DGPS system will be checked using the control point established for the project at least once daily. Any variability of measurements will be recorded in the field logbook. Measurements of water depth will be repeated, with the depth measured to the nearest 0.1 foot. After tidal corrections, mudline elevations will be reported to the nearest 1.0 foot.

5.2 Laboratory QA/QC Requirements

Sediment samples will be stored and analyzed in accordance with the holding time requirements of PSEP (Table 2-2). QA/QC samples will be performed in accordance with PSEP (1996d) and Table 5-1.

At a minimum, the laboratory will comply with the QA/QC requirements shown in Table 4-1. In addition, the analytical laboratory also has separate, instituted internal QA/QC plans. Analyses will be required to conform to accepted standard methods and rigorous internal QA/QC checks prior to final approval and reporting by the laboratory.

The analytical laboratory will provide data reports that will include a cover letter describing any problems or deviations from standard protocols, analytical results, and associated QA/QC materials. The laboratory will retain electronic data necessary to report chromatograms for each sample, mass spectra of detected target compounds, calibration summaries, appropriate sample information (weights, final volumes, and dilutions), and the results of the QC samples.

The final report will include QA2 deliverables, surrogate recoveries where appropriate, and sample chain of custody information (as required by Ecology for SEDQUAL database). Any QA problems (i.e., calibrations, internal standards) must be noted in the laboratory report narrative. Chemical data will be qualified in accordance with PSEP guidelines. The "J" qualifier will be applied to all concentrations that fall between the reporting detection limit (RDL), or practical quantitation limit (PQL) and the laboratory's method detection limit (MDL). Dilution volumes, sample sizes, percent moisture, and surrogate recoveries will be presented on each summary sheet with the analytical results in the data packages. Similar information will also be assembled for each QC sample (method blanks, matrix spikes, etc.).

5.3 Chemical Data Validation

RETEC will review all raw data to verify that the laboratory has supplied the required QA/QC deliverables. The data will then be validated against QA2 level review for acceptable inclusion into the regional SEDQUAL database. All data will be submitted to Ecology's Sediment Management Unit in electronic SEDQUAL format prior to final approval of the report. The review will be performed using EPA CLP guidelines, RETEC SOP 410 (Appendix A), and methods specified in this SAP. QA review of conventional data will be performed using the Data Validation Guidance Manual by PSEP.

The review will evaluate the data for completeness, format, holding conditions, and laboratory QA sample results (e.g., blanks, matrix spikes).

The data validation will also include a review of surrogate recovery values for each of the organic samples. Data validation checklists will be prepared.

Where data fail criteria provided in the QA2 manual, the laboratory will be contacted, and the data will be: (1) reanalyzed, (2) qualified, or (3) discarded. Data quality issues will be summarized in a data validation report.

5.4 Bioassay Data Quality Review

A review of the bioassay tests that will be conducted on surface sediment samples collected from Bellingham Bay is necessary to confirm that appropriate and thorough laboratory testing procedures and documentation procedures were followed. Bioassay test data should be compiled and reviewed for validity using the appropriate guidelines and directives set forth in this SAP, and data should be reported according to the established QA/QC procedures. The bioassay laboratory should document and provide an explanation of any exceptions to the established procedures. Overall data usability must be determined if any of the bioassay results are to be used in the decision-making process.

The data quality review will compare bioassay testing holding conditions, test setup, test implementation, and test termination to pertinent bioassay protocols. The review of test setup procedures includes reference sediment collection, organism procurement, number of organisms, number of replicates, volume of sediment, and general test initiation conditions. The review of test implementation includes an evaluation of standard parameters like the length of photoperiod, type of aeration, water replacement, and other daily monitoring variables, including the validity of test termination procedures. It also includes summaries of information pertinent to negative and positive control samples and reference sediment relative to requirements for test success.

The bioassay test validation is based on a RETEC Level II verification protocol. RETEC Level II data verification protocol is followed for preliminary site investigations or ongoing site monitoring events that do not require full documentation and data validation. With Level II data validation, the laboratory is entrusted to follow all internal quality control procedures (i.e., calibrations, performance checks) as directed in the analytical methods reported. A definitive assessment of analytical precision, accuracy, and completeness can be made.

Composited surface samples will be collected for both sediment chemistry analyses and bioassay tests. Samples for bioassay testing will be sent to Vizon Scitec for the following bulk sediment toxicity tests:

- *Eohaustorius estuarius* 10-day mortality;

- *Neanthes arenaceodentata* 20-day growth; and
- *Dendraster excentricus* sediment larval test.

Checklists will be used during bioassay test validation to assess the acceptability of the following major test elements:

- Custody, preservation, and holding times;
- Test setup;
- Implementation, including test, control, and reference samples; and
- Reporting.

6 Field Data Management and Reporting

6.1 Field Data Management

Field measurements and observations recorded in field notebooks, on field data forms, or on similar permanent records by field technicians are to become part of the permanent file. Field data is to be recorded directly and legibly in the notebooks or forms with all entries signed and dated.

Managerial documentation consists of:

- Data processing and storage records;
- Sample identification and chain-of-custody records;
- Field changes and variances;
- Document control, inventory, and filing records;
- QA/QC records;
- Health and safety records; and
- Financial and project tracking records.

6.2 Field Data Evaluation

Initial responsibility for verification of accurate entries will lay with the field data logger. At the end of the sampling day, the data logger must sign and date the notebook. Data will then be verified by the FTL or PM, who will review all collected data to ensure that all pertinent information has been entered, and that correct codes and units have been used. The FTL will direct the field data logger to make any necessary corrections to the record and initial them.

After data are reduced into tables or arrays, the task managers will review data sets for anomalous values. Any inconsistencies will be resolved by seeking clarification from the field personnel responsible for data collection.

Managerial and technical data will be verified by the PM for reasonableness and completeness. Random checks of sampling and field conditions will be made by the task managers. The designated QA officer will review selected field data and procedures during random site visits to ensure adherence to the SAP and RETEC SOPs. Whenever possible, peer review will also be incorporated into the data evaluation process in order to maximize consistency among field personnel. All data evaluation will be verified by a dated signature.

The QA officer will monitor and audit performance of the QA procedures to assure that the project is performed in accordance with approved quality assurance procedures. The QA officer or authorized representative will

conduct audits to evaluate the execution of sample identification, field notebooks, and sampling procedures. The field audit program will have preventative maintenance procedures to ensure vital equipment is functioning properly. These procedures include cleaning/decontamination of equipment, daily visual inspection, and routine maintenance of parts depending on the type of equipment used.

6.3 Corrective Actions

The purpose of the evaluation process is to qualify or eliminate field information or samples that were not collected or documented in accordance with specified protocols outlined in the SAP/SOP. The Field Team Leader will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, labeling, etc., will be checked for completeness. Where procedures are not in compliance with the specified protocols, the deviations will be field documented and reported to the Task Manager. Corrective actions will be defined by the Field Team Leader and Task Manager and documented and implemented as appropriate.

6.4 Field Sampling Quality Control Report and Schedule

At the end of the field investigations, a report will be prepared and submitted to the task manager. This report will include copies of the field notebook, Chain-of-Custody Forms, or any other pertinent field records. Any deviations from the SAP or SOPs that will result in a compromise of the project goals will be flagged and discussed in the report.

7 References

ASTM D 2487, 1993. Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). Prepared by ASTM Committee D-18.

ASTM D 2488, 1993. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Prepared by ASTM Committee D-18.

DeWitt, T.H., G.R. Ditsworth, and R.C. Schwartz, 1988. Effects of Natural Sediment Features on Survival of the Phoxocepalid Amphipod, Rhepoxynius Abronius. Mar. Env. Res. 25:99-124.

Ecology, 1995. Washington State Sediment Management Standards, Chapter 173-204 Washington Administrative Code (WAC). Prepared by the Washington State Department of Ecology, Olympia, Washington. April.

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PSDDA, 1996. Sediment Management Program Biennial Report: Dredging Years 1994/1995. Puget Sound Dredge Disposal Analysis Program and Sediment Management Program. March.

PSDDA, 2000. User's Manual. Puget Sound Dredge Disposal Analysis Program. Revised February.

PSEP, 1986. Puget Sound Estuary Program: Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound. Prepared for U.S. Environmental Protection Agency, Region 10, and the Puget Sound Water Quality Authority. Puget Sound Water Quality Authority, Olympia, Washington.

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PSEP, 1996a. Puget Sound Estuary Program: Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. Prepared for U.S. Environmental Protection Agency, Region 10, and the Puget Sound Water Quality Authority. Puget Sound Water Quality Authority, Olympia, Washington.

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Samples. Prepared for U.S. Environmental Protection Agency, Region 10, and the Puget Sound Water Quality Authority. Puget Sound Water Quality Authority, Olympia, Washington.

PSEP, 1996c. Puget Sound Estuary Program: Recommended Protocols for Measuring Metals in Puget Sound Sediment and Tissue Samples. Prepared for U.S. Environmental Protection Agency, Region 10, and the Puget Sound Water Quality Authority. Puget Sound Water Quality Authority, Olympia, Washington.

PTI Environmental Services, 1989 . Data Validation Guidance Manual for Selected Sediment Variables. Draft. Prepared for the Washington Department of Ecology. June.

Tables

Table 2-1 Proposed Station Coordinates

Station	NAD27, Washington State		Global Positioning	
	Northing (y axis)	Easting (x axis)	Latitude	Longitude
Test Stations				
IJW-SS-01	644171	1599581	48.76576608	121.0026447
IJW-SS-02	644340	1599613	48.76622934	121.0025129
IJW-SS-03	644191	1599674	48.76582201	121.0022568
IJW-SS-04	644324	1599702	48.76618566	121.0021435
IJW-SS-05	644472	1599738	48.76659123	121.0019942
IJW-SS-06	644355	1599804	48.76627174	121.0017185
IJW-SS-07	644628	1599910	48.76701885	121.0012812
IJW-SS-08	644591	1599992	48.76691924	121.0009418
IJW-SS-09	644667	1600029	48.76712818	121.0007892
IJW-SS-10	644622	1600114	48.76700356	121.000437
IJW-SS-11	644766	1600035	48.76739835	121.0007645
IJW-SS-12	644507	1599994	48.76668896	121.0009335
IJW-SS-13	644536	1599855	48.76676762	121.0015101

Notes:

Proposed coordinates are in Washington State Plane North Zone (feet) North American Datum (NAD) 1927 and converted to World Geodetic System (WGS), 1984.
One or more reference samples will be collected from Samish Bay based on similar grain size and organic carbon content.

Table 2-2 Analyte Categories, Analysis Methods, Holding Times, and Container Requirements

Analyte Category	Analysis Method	Holding Time 4°C	Holding Time -11°C	Jar Requirements
Volatile Organics	USEPA 8260	14 days to extraction, 40 days from extraction to analysis	1 year	4-ounce Glass with septa
Semivolatile Organics	USEPA 8270	14 days to extraction, 40 days from extraction to analysis	1 year	16-ounce Glass
PCBs	USEPA 8081	14 days to analysis	NA [1]	8-ounce Glass
Metals (including nickel)	USEPA Methods 6010/7471	6 months (28 days for mercury)	NA [1]	4-ounce Glass
Conventionals				
Total Solids	PSEP	7 days	6 months	4-ounce Glass
Total Volatile Solids	PSEP	7 days	6 months	
pH	USEPA 9045	NA	6 months	
Total Organic Carbon	PSEP	28 days	6 months	
Ammonia	PSEP	28 days	6 months	
Total Sulfides	PSEP	7 days dark	NA	4-ounce Glass topped with 2 ml 2N ZnAc headspace free
Physical				
Physical Grain Size	PSEP	6 months	NA [1]	16-ounce Glass
Biological [2]				
Neanthes Arenaceodentata 20-day Growth	PSEP	2 months	NA [1]	(3) - 2-liter Plastic headspace free
Eohaustorius estuarius 10-day Mortality	PSEP			
Dendraster excentricus larvae	PSEP			

Notes:

[1] Holding parameters only specify that the sample must be processed within a period of time that does not allow water loss (per Harold Benny, Rosa Environmental).

[2] Samples will be stored at 4 °C to maximize sample integrity and minimize changes from the presence of biota and/or organic carbon.

Table 2-3 Sediment Chemical Analysis Methods, Target Detection Limits, and Criteria

Parameter	Preparation Method	Analysis Method	Target RDL [1]	SMS Criteria [2] SQS	SMS Criteria [2] MCUL
Conventionals					
Total Solids (%)	--	PSEP [4a]	0.1	nv	nv
Total Volatile Solids(%)	--	PSEP [4a]	0.1	nv	nv
Total Organic Carbon (%)	--	PSEP [4b]	0.1	nv	nv
Ammonia (mg/kg)	--	EPA 350.1 [5]	1	nv	nv
Total Sulfides (mg/kg)	--	PSEP [4a]	10	nv	nv
Grain Size (%)	--	PSEP [4a]	1	nv	nv
Metals					
Antimony	Appendix D [4]	GFAA [6]	5	nv	nv
Arsenic	Appendix D [4]	ICP [7]	5	57	93
Cadmium	Appendix D [4]	ICP [7]	0.2	5.1	6.7
Chromium	Appendix D [4]	ICP [7]	0.5	260	270
Copper	Appendix D [4]	ICP [7]	0.2	390	390
Lead	Appendix D [4]	ICP [7]	2	450	530
Mercury	MER [8]	7471 [8]	0.05	0.41	0.59
Nickel	Appendix D [4]	ICP [7]	0.01	nv	nv
Silver	Appendix D [4]	ICP [7]	0.3	6.1	6.1
Zinc	Appendix D [4]	ICP [7]	1.0	410	960
LPAH					
Naphthalene	3550 [9]	8270 [10]	0.02	99	170
Acenaphthylene	3550 [9]	8270 [10]	0.02	66	66
Acenaphthene	3550 [9]	8270 [10]	0.02	16	57
Fluorene	3550 [9]	8270 [10]	0.02	23	79
Phenanthrene	3550 [9]	8270 [10]	0.02	100	480
Anthracene	3550 [9]	8270 [10]	0.02	220	1200
2-Methylnaphthalene	3550 [9]	8270 [10]	0.02	38	64
Total LPAH				370	780
HPAH					
Fluoranthene	3550 [9]	8270 [10]	0.02	160	1200
Pyrene	3550 [9]	8270 [10]	0.02	1000	1400
Benzo(a)anthracene	3550 [9]	8270 [10]	0.02	110	270
Chrysene	3550 [9]	8270 [10]	0.02	110	460
Benzofluoranthenes	3550 [9]	8270 [10]	0.02	230	450
Benzo(a)pyrene	3550 [9]	8270 [10]	0.02	99	210
Indeno(1,2,3-cd)pyrene	3550 [9]	8270 [10]	0.02	34	34
Dibenzo(a,h)anthracene	3550 [9]	8270 [10]	0.02	12	33
Benzo(g,h,i)perylene	3550 [9]	8270 [10]	0.02	31	78
Total HPAH				960	5300
Chlorinated Hydrocarbons					
1,3-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	nv	nv
1,4-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	3.1	9
1,2-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	2.3	2.3
1,2,4-Trichlorobenzene	3550 [9]	8270 [10]	0.006	0.81	1.8
Hexachlorobenzene	3550 [9]	8270 [10]	0.012	0.38	2.3
Phthalates					
Dimethyl phthalate	3550 [9]	8270 [10]	0.02	53	53
Diethyl phthalate	3550 [9]	8270 [10]	0.02	61	110
Di-n-butyl phthalate	3550 [9]	8270 [10]	0.02	220	1700
Butyl benzyl phthalate	3550 [9]	8270 [10]	0.02	4.9	64
Bis(2-ethylhexyl)phthalate	3550 [9]	8270 [10]	0.02	47	78
Di-n-octyl phthalate	3550 [9]	8270 [10]	0.02	58	4500
Phenols					
Phenol	3550 [9]	8270 [10]	0.020	0.42	1
2-Methylphenol	3550 [9]	8270 [10]	0.020	0.063	0.063
4-Methylphenol	3550 [9]	8270 [10]	0.020	0.67	0.67
2,4-Dimethylphenol	3550 [9]	8270 [10]	0.020	0.029	0.029
Pentachlorophenol	3550 [9]	8270 [10]	0.100	0.36	0.69
Miscellaneous Extractables					
Benzyl alcohol	3550 [9]	8270 [10]	0.020	0.057	0.073
Benzoic acid	3550 [9]	8270 [10]	0.200	0.65	0.65
Miscellaneous Extractables					
Dibenzofuran	3550 [9]	8270 [10]	0.020	15	58
Hexachloroethane	3550 [9]	8270 [10]	0.020	nv	nv
Hexachlorobutadiene	3550 [9]	8270 [10]	0.020	3.9	6.2
N-Nitrosodiphenylamine	3550 [9]	8270 [10]	0.020	11	11
Volatile Organics					
Trichloroethene	P&T [11]	8260 [12]	0.0032	nv	nv
Tetrachlorethene	P&T [11]	8260 [12]	0.001	nv	nv
Ethylbenzene	P&T [11]	8260 [12]	0.001	nv	nv
Total xylenes	P&T [11]	8260 [12]	0.001	nv	nv
Pesticides					
DDT	3550 [9]	8081 [13]	0.003	nv	nv
Aldrin	3550 [9]	8081 [13]	0.0017	nv	nv
alpha-chlordane	3550 [9]	8081 [13]	0.0017	nv	nv
dieldrin	3550 [9]	8081 [13]	0.0023	nv	nv
heptachlor	3550 [9]	8081 [13]	0.0017	nv	nv
alpha-BHC	3550 [9]	8081 [13]	0.0017	nv	nv
gamma-BHC (Lindane)	3550 [9]	8081 [13]	0.0017	nv	nv
Total PCBs	3550 [9]	8081 [13]	0.160	12	65

Notes:

1 Reporting detection limit (MDL) values are equivalent to Ecology's term Practical Quantitation Limit (PQL) - from Analytical Resources, Inc. (ARI) laboratory - expressed on a dry weight basis.

Note that some SMS criteria are expressed as the carbon-normalized value (ppm TOC) - see note 2 below - direct comparison to the detection limits cannot be made without a TOC conversion factor.

2 Sediment Management Standards (SMS), includes Sediment Quality Levels (SQL) [low screen] and Maximum Chemical Criteria (MCUL) [high screen] expressed as mg/kg dw; The following are TOC normalized: LPAH, HPAH, Chlorinated hydrocarbons, phthalates, misc.e

3 Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Organic Compounds in Puget Sound, 1996. TBT extraction method is Krone, 1988.

4a Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Conventional Sediment Variables in

4b Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Conventional Sediment Variables in

5 Plumb, 1981. EPA/U.S. Army Corps of Engineers procedures for measuring ammonia.

6 Graphite Furnace Atomic Absorption (GFAA) Spectrometry. SW-846. EPA, 1986.

7 Inductively Coupled Plasma (ICP) Emission Spectrometry. SW-846. EPA, 1986.

8 Mercury Digestion and Cold Vapor Atomic Absorption (CVAA) Spectrometry, Method 7471. SW-846. EPA 1986.

9 Sonication Extraction of Sample Solids, Method 3550 (Modified). SW-846. EPA, 1986. Method is modified to add matrix spikes before, rather than after, the dehydration step.

10 GCMS Capillary Column, Method 8270. SW-846. EPA, 1986.

11 Purge and Trap Extraction and GCMS Analysis, Method 8240. EPA, 1986.

12 Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique,

13 Organochlorine Pesticides and PCBs as Arochlors by Gas Chromatography and Capillary Column Technique, Method

nv - No value currently established under SMS.

Table 2-4 Key for Physical Description of Sediment Samples

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D-2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL	Standard Penetration Resistance (N) in Blows/Foot	Visual Description	SILT or CLAY	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF	Visual Description
Density			***Consistency***			
Very loose	0–4	freefall	Very soft	0–2	<0.125	ooze, no shape
Loose	4–10	easy penetration	Soft	2–4	0.125–0.25	saggy shape
Medium dense	10–30		Medium stiff	4–8	0.25–0.5	holds shape
Dense	30–50	low penetration	Stiff	8–15	0.5–1.0	holds shape
Very dense	>50	refusal	Very stiff	15–30	1.0–2.0	low penetration
			Hard	>30	>2.0	refusal

Moisture	
Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum; subcategories include soupy and flocculant for increasing moisture content

Minor Constituents	***Percentage (by weight)***
Not identified in description	0–5
Slightly (clayey, silty, etc.)	5–12
Clayey, silty, sandy, gravelly	12–30
Very (clayey, silty, etc.)	30–50
MAJOR CONSTITUENTS	Majority or >50

Surface Sediment Sample Acceptability Criteria (PSEP)

1. Overlying water is present.
2. Water has low turbidity.
3. Sampler is not overfilled.
4. Surface is flat.
5. Penetration depth is acceptable.

Core Sample Acceptability Criteria

1. Core tube not overfilled.
2. Overlying water is present and surface interval is intact.
3. Estimated compaction is not greater than 25%.
4. Core tube appears intact without obstruction and blocking.

Estimated Percentage of Other Minor Constituents

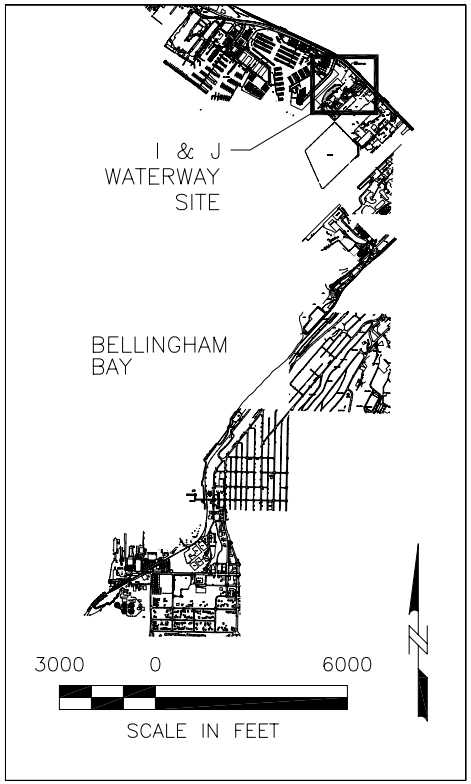
(i.e., shells, wood, organics, plastic, metal brick, refuse)

Estimated Percentage (by volume)	
Dusting	Trace on Surface
Trace	0–5
Occasional	5–10
Moderate	10–30
Substantial	30–50
Majority	>50

Table 5-1 Method QA/QC Sample Frequencies for Analytical Sampling

QA/QC Sample Type	Sampling and Analysis Frequency
Laboratory QA/QC (to be reported and validated)	
Method Blanks	One per 20
Laboratory Control Samples	One per 20
Laboratory Control Duplicates	One per 20
Laboratory triplicates for TOC/Grain Size	One per 20
Detection Limits	Table 2-3
Holding Times	Table 2-2
Surrogate Compounds	Every field & QA/QC sample
Blind certified reference material	One per 20
Laboratory QA/QC (internal lab requirements)	
Initial Calibration	Following Lab SOP
Continuing Calibration	Following Lab SOP
Internal Standards	Following Lab SOP

Figures



RI/FS
INVESTIGATION AREA

CURRENT EXTENT OF
SMS CHEMICAL AND
BIOLOGICAL EXCEEDANCES

I & J WATERWAY

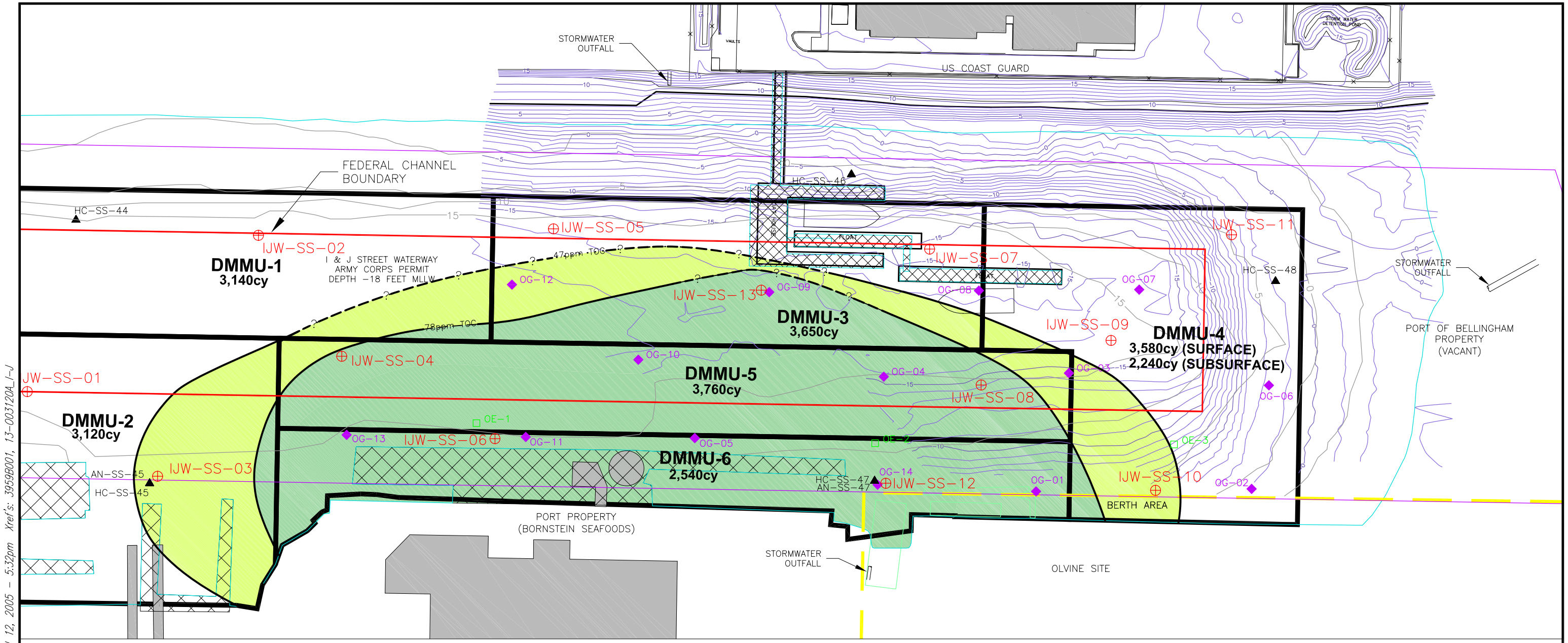
Pipe
Paved
Conc
FH
Rails Obscured
Dock
Unpaved Parking
Storage
Boat Storage
Stack
RTV

N
100
0
200
SCALE IN FEET

NOTE:
THE INVESTIGATION AREA MAY BE EXPANDED IF CONTAMINATION APPEARS TO EXTEND BEYOND THE CURRENT INVESTIGATION AREA.

RETEC

I&J WATERWAY RI/FS WORK PLAN PORTB-18449-100	**SITE LOCATION MAP**
DATE: 06/15/05 DRWN: A.S./SEA	**FIGURE 1-1**



LEGEND

- DOCKS OR PIERS
- EXISTING STRUCTURES
- EXISTING SHORELINE
- 25 — BATHYMETRY (FEET BELOW MLLW PER WHATCOM WATERWAY RI/FS REPORT)
- CURRENT OLIVINE UPLAND SITE BOUNDARY
- I & J WATERWAY BOUNDARY

- ▲ HC-SS-47 — WHATCOM WATERWAY STATION SEDIMENT GRAB SAMPLE (HART CROWSER, 1997)
- ◆ OG-10 — 2001 RETEC STATION SURFACE SEDIMENT GRAB SAMPLE
- □ OE-1 — PRE-REMEDIAL DESIGN TESTING STATION (COMPOSITE FOR LEACHING TESTS 2002) (SAMPLE TO BE COLLECTED 0-3FT BELOW MUDLINE)
- ⊕ IJW-SS-02 — PROPOSED RI/FS SAMPLE LOCATION
- ▲ AN-SS-47 — ANCHOR BIOASSAY SAMPLE LOCATION

- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL SQS CRITERIA (47ppm TOC)
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL MCUL CRITERIA (78ppm TOC)

NOTE:

EXCEEDENCES OF SQS BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-45. EXCEEDENCES OF MCUL BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-47.

30 0 60

SCALE IN FEET

RETEC

I & J WATERWAY RI/FS SAMPLING AND ANALYSIS PLAN PORTB-18449-100			PROPOSED I & J WATERWAY RI/FS SURFACE SEDIMENT SAMPLE LOCATIONS	
DATE: 07/12/05	DRWN: A.S./SEA			FIGURE 1-2

File: H:\18449\184495004.dwg Layout: Layout1 User: astenberg Plotted: Jul 12, 2005 - 5:32pm Xref's: J959B001, 13-0031204_I-J

Attachment A

Standard Operating Procedures

SOP 110—Packing and Shipping Samples

1 Purpose and Applicability

RETEC SOP 110 describes proper packaging methods and shipment of samples to minimize the potential for sample breakage, leakage, or cross contamination, and provide a clear record of sample custody from collection to analysis. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health and Safety Plan will take precedence over the procedures described in this document.

The United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA) regulations (40 CFR Section 261.4[d]) specify that samples of solid waste, water, soil, or air collected for the purpose of testing are exempt from regulation when any of the following conditions apply:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis; and
- Samples are being stored: (a) by the collector prior to shipment for analyses, (b) by the analytical laboratory prior to analyses, or (c) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Samples collected by RETEC are generally qualified for these exemptions. RETEC SOP 110 deals only with these sample types.

2 Responsibilities

The field sampling coordinator is responsible for the enactment and completion of the chain-of-custody, and the packaging and shipping requirements outlined here and in project-specific sampling plans.

3 Supporting Materials

The following materials must be on hand and in sufficient quantity to ensure that proper packing and shipping methods and procedures may be followed:

- Chain-of-custody forms and seals;
- Sample container labels;
- Coolers or similar shipping containers;
- Duct tape or transparent packaging tape;
- Ziploc-type bags;
- Protective wrapping and packaging materials;
- Ice or cold packs;
- Shipping labels for the exterior of the ice chest; and

- Transportation carrier forms (Federal Express, Airborne, etc.).

4 Methods and Procedures

All samples must be packaged so that they do not leak, break, vaporize, or cause cross-contamination of other samples. Waste samples and environmental samples (e.g., groundwater, soil, etc.) should not be placed in the same container. Each individual sample must be properly labeled and identified. A chain-of-custody record must accompany each shipping container. When refrigeration is required for sample preservation, samples must be kept cool during the time between collection and final packaging.

All samples must be clearly identified immediately upon collection. Each sample bottle label will include the following information:

- Client or project name, or unique identifier, if confidential;
- A unique sample description;
- Sample collection date and time;
- Sampler's name or initials;
- Indication of filtering or addition of preservative, if applicable; and
- Analyses to be performed.

After collection, identification, and preservation (if necessary), the samples will be maintained under chain-of-custody procedures as described below.

5 Chain of Custody

A sample is considered to be under custody if it is in one's possession, view, or in a designated secure area. Transfers of sample custody must be documented by chain-of-custody forms (ThermoRetec, 2000). The chain-of-custody record will include, at a minimum, the following information:

- Client or project name, or unique identifier, if confidential;
- Sample collector's name;
- Company's (RETEC) mailing address and telephone number;
- Designated recipient of data (name and telephone number);
- Analytical laboratory's name and city;
- Description of each sample (i.e., unique identifier and matrix);
- Date and time of collection;
- Quantity of each sample or number of containers;
- Type of analysis required; and
- Date and method of shipment.

Additional information may include type of sample containers, shipping identification air bill numbers, etc.

When transferring custody, both the individual(s) relinquishing custody of samples and the individual(s) receiving custody of samples will sign, date, and

note the time on the form. If samples are to leave the collector's possession for shipment to the laboratory, the subsequent packaging procedures will be followed.

6 Packing for Shipment

To prepare a cooler for shipment, the sample bottles should be inventoried and logged on the chain-of-custody form. At least one layer of protective material should be placed in the bottom of the container. As each sample bottle is logged on the chain-of-custody form, it should be wrapped with protective material (e.g. bubble wrap, matting, plastic gridding, or similar material) to prevent breakage. Each sample bottle should be placed upright in the shipping container. Each sample bottle cap should be checked during wrapping and tightened if needed. Avoid over tightening, which may cause bottle cap to crack and allow leakage. Additional packaging material such as bubble wrap or Styrofoam pellets should be spread throughout the voids between the sample bottles.

Most samples require refrigeration as a minimum preservative. Reusable cold packs or ice placed in heavy-duty Ziploc-type bags should be distributed under the bottom and over the top of the samples. Two or more cold packs or bags should be used. Additional packing material should then be placed to fill the balance of the cooler or container.

Place the original completed chain-of-custody record in a Ziploc-type plastic bag and place the bag on the top of the contents within the cooler or shipping container. Alternatively, the bag may be taped to the underside of the container lid. Retain a copy of the chain-of-custody record with the field records.

Close the top or lid of the cooler or shipping container and rotate/shake the container to verify that the contents are packed so that they do not move. Add additional packaging if needed and reclose.

Place signed and dated chain-of-custody seal at two different locations (front and back) on the cooler or container lid and overlap with transparent packaging tape. The chain-of-custody seal should be placed on the container in such a way that opening the container will destroy the seal. Packaging tape should encircle each end of the cooler at the hinges.

Sample shipment should be sent via an overnight express service that can guarantee 24-hour delivery. Retain copies of all shipment records as provided by the shipper.

7 Quality Assurance/Quality Control (QA/QC)

Recipient of sample container should advise shipper and/or transporter immediately of any damage to container, breakage of contents, or evidence of tampering.

8 Documentation

The documentation for support of proper packaging and shipment will include RETEC or the laboratory chain-of-custody records and transportation carrier's air bill or delivery invoice. All documentation will be retained in the project files.

9 Reference

ThermoRetec, 2000. *Quality Assurance Project Plan for the Phase II RCRA Facility Investigation, BP Amoco North Properties Area, Casper, Wyoming.* ThermoRetec Consulting Corporation, Golden, Colorado. March 31.

SOP 120—Decontamination

1 Purpose and Applicability

RETEC SOP 120 describes the methods to be used for the decontamination of items that may become contaminated during field operations. Decontamination is performed as a QA measure and as a safety precaution. It prevents cross contamination between samples and also helps maintain a clean working environment. Equipment requiring decontamination may include hand tools, monitoring and testing equipment, personal protective equipment, or heavy equipment (e.g., loaders, backhoes, drill rigs, etc.).

Decontamination is achieved mainly by rinsing with liquids that may include soap and/or detergent solutions, tap water, distilled water, and methanol. Equipment may be allowed to air dry after being cleaned or may be wiped dry with paper towels or chemical-free cloths.

All sampling equipment will be decontaminated prior to use and between each sample collection point. Waste products produced by the decontamination procedures, such as rinse liquids, solids, rags, gloves, will be collected and disposed of properly based on the nature of contamination and site protocols. Any materials and equipment that will be reused must be decontaminated or properly protected before being taken off site.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health and Safety Plan will take precedence over the procedures described in this document.

2 Responsibilities

It is the responsibility of the field sampling coordinator to ensure that proper decontamination procedures are followed and that all waste materials produced by decontamination are properly managed. It is the responsibility of any subcontractors (e.g., drilling or sampling contractors) to follow the proper designated decontamination procedures that are stated in their contracts and outlined in the project Health And Safety Plan. It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that no contaminants are negligently introduced into the environment.

3 Supporting Materials

The following materials should be on hand in sufficient quantity to ensure that proper decontamination methods and procedures may be followed:

- Cleaning liquids and dispensers (soap and/or detergent solutions, tap water, distilled water, methanol, or isopropyl, etc.);
- Personal safety gear, as defined in the project Health And Safety Plan;
- Paper towels or chemical-free cloths;

- Disposable gloves;
- Waste storage containers (e.g., drums, boxes, plastic bags);
- Drum labels, if necessary;
- Cleaning containers (e.g., plastic and/or galvanized steel pans or buckets);
- Cleaning brushes; and
- Plastic sheeting.

4 Methods and Procedures

The extent of known contamination will determine the degree of decontamination required. When the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated.

Standard operating procedures listed below describe the method for full field decontamination. If different technical procedures are required for a specific project, they will be spelled out in the project plans.

Such variations in decontamination may include all or an expanded scope of these decontamination procedures:

- Remove gross contamination from the equipment by brushing and then rinse with tap water from top to bottom;
- Wash with detergent or soap solution (e.g., Alconox and tap water);
- Rinse with tap water from top to bottom;
- Rinse with methanol or isopropyl from top to bottom;
- Rinse with distilled water from top to bottom;
- Repeat entire procedure or any parts of the procedure, as necessary; and
- After decontamination procedure is completed, avoid placing equipment directly on ground surface to avoid recontamination.

Downhole drilling equipment, such as augers, split spoons, Shelby tubes, and sand lines, will be decontaminated with pressurized hot water or steam wash, followed by a fresh water rinse. No additional decontamination procedures will be required if the equipment appears to be visually clean. If

contamination is visible after hot water/steam cleaning, then a detergent wash solution with brushes (if necessary) will be used.

5 Quality Assurance/Quality Control

To assess the adequacy of decontamination procedures, rinsate blanks should be collected and analyzed for the same parameters as the field samples. Specific number of blanks will be defined in the project-specific sampling plan. In general, one rinsate blank will be collected per ten samples.

6 Documentation

Field notes describing procedures used to decontaminate equipment/personnel and for collection of the rinsate blanks will be documented by on-site personnel. Field notes will be retained in the project files.

SOP 260—Aquatic Sediment Sampling

1 Purpose and Applicability

This SOP 260 describes sampling of sediments from stream and lake bottoms. Lake and stream sediment sampling is performed to define the chemical, physical, and/or biological composition of the sediments. Sediment samples may be obtained directly from shallow, slow moving waters using trowels or shovels or from deep water bodies using dredge/clam shell type samplers. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health and Safety Plan will take precedence over procedures described in this document.

2 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sediment sampling is performed in accordance with the project-specific sampling program and SOP 260. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of SOP 260.

3 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper sampling procedures may be followed.

- Project-specific sampling program;
- Personal protection equipment as specified in the Project Health and Safety Plan;
- Paper towels or chemical-free cloths;
- Coolers and ice;
- Dredges (e.g. Ponar) and rope;
- Shovels and/or trowels;
- Sample bottles, containers, and labels;
- Sampling implements (e.g. spoons, scoops, etc);
- Decontamination equipment and solutions;
- Field data sheets and field book;
- Waders or boat;
- Measuring tape; and

- Boating safety gear (e.g., life jackets).

4 Methods and Procedures

Select sample locations and method(s) in accordance with the project-specific sampling plan. Determine and record the depth of water at each sample location. Collect samples using appropriate sampling equipment and proper health and safety gear.

Refer to SOP 210 for guidance when using a trowel or shovel. Retrieve the sample slowly and carefully through the water column to minimize sample loss. If using a dredge, first secure the rope to the dredge. Open the dredge and lock it into position. Slowly lower the dredge through the water column to the bottom sediments. Close the jaws of the dredge by jerking the dredge rope once or twice. Pull the dredge back up through the water column at a steady, even pace. Repeat if sediment recovery is inadequate. Several attempts may be necessary to obtain sufficient sample volume. If, after several attempts, sample volume is still inadequate, adjust the sampling location. All equipment will be decontaminated after each use following the procedures outlined in SOP 120.

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination. A representative sample will be placed in the sampling container using a clean implement such as a scoop, spoon or tongue depressor. Sample containers shall be labeled with the following information:

- Client or project name, or unique identifier, if confidential;
- Unique sample description (i.e., sampling point number and horizontal/vertical location);
- Sample collection date and time;
- Sample collector's name or initials; and
- Analyses to be performed.

These data shall be recorded on the sediment sampling form (Figure 1) and/or field book.

If sampling from a boat, all appropriate boating safety regulations must be understood and followed by the sampling crew.

5 Quality Assurance/Quality Control

QA/QC requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected

on a frequency of one QA/QC sample per ten field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project-specific sampling plan.

6 Documentation

Documentation may consist of all or part of the following:

- Sediment sampling forms;
- Field log book;
- Chain-of-custody forms; and
- Shipping receipts.

Field records should contain sufficient detail which provide a clear understanding of and where samples were taken. A description of sediments using the Unified Soil Classification system should be included. All documentation shall be placed in the project files and retained following completion of the project.

SOP 410—Quality Assurance/Quality Control Data Validation

1 Purpose and Applicability

RETEC SOP 410 describes the method to be used for evaluating analytical laboratory data collected during field investigations. This evaluation is performed in order to establish the validity of the data generated. The laboratory analytical data will be evaluated for precision, accuracy, and completeness. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2 Responsibilities

The project manager will be responsible for ensuring that procedures set forth in the sampling program documents are followed in the field, and in the analytical laboratory. Where procedures differ, the most stringent project-specific document(s) will apply.

The Project Quality Assurance/Quality Control (QA/QC) Officer will be responsible for validating the analytical data for precision, accuracy, and completeness. The QA/QC Officer will work in conjunction with the project manager and Laboratory Coordinator to produce the final report

3 Supporting Materials

Section 3 is not applicable.

4 Methods and Procedures

This section presents the method and procedure for implementation of the RETEC Quality Assurance/Quality Control process for data evaluation. Analytical data will be reviewed for precision, accuracy, and completeness. The following sections provide a detailed discussion of the steps necessary to meet these criteria. The following criteria are recommended and should be evaluated on a project-specific basis.

A preliminary evaluation of the analytical data will include:

- A review of the Work Plan or Quality Assurance Project Plan (QAPP);
- A review of the laboratory project narrative;
- A review of holding times, detection limits, methods of analysis; and

- A check of data flags, reporting units, and sample matrices.

Any deviations from the requirements of the QAPP will be identified in the data evaluation report and the Project Manager will be notified. Additionally, the laboratory will be contacted, if necessary, and appropriate corrective actions will be implemented.

4.1 Evaluation of Precision

Precision is the measure of variability of individual sample measurements. Precision is determined through the analysis of replicate samples, field blanks, trip blanks, and equipment rinseate blanks. A replicate sample represents two or more separate samples collected at the same location. A replicate sample is are often referred to as a duplicate. Additionally, replicates are often submitted to the laboratory as blind samples. Field blanks consist of deionized water poured into sample bottles in the field. These blanks are used to determine whether airborne contamination is present at the site. Trip blanks are laboratory generated analyte-free water samples for volatiles analysis which travel to and from the site with the sample coolers. These blanks are used to document contamination attributed to bottle preparation and/or shipping and handling procedures. Equipment rinseate blanks consist of reagent water exposed directly to sampling equipment. The equipment rinseate blank is useful in documenting adequate decontamination of sampling equipment.

4.1.1 Duplicates

Duplicates, when collected, will be evaluated at the frequency of ten percent (10%) of samples collected for each matrix. Evaluation of replicates for precision will be done using the Relative Percent Difference (RPD). The RPD is defined as the difference between two duplicate samples divided by the mean and expressed as a percent. The RETEC advisory limit for RPDs is 50% for soil samples and 30% for groundwater. When the RPD exceeds the advisory limit, consideration will be given to the possibility of matrix effect. If however professional judgement indicates a potential laboratory error, the positive results will be "J" flagged.

4.1.2 Field Banks

Collection of a field blank is recommended for one in every 20 samples, or one sample per batch if less than 20 samples are collected. However, on a project-specific basis, analysis of field blanks may not be appropriate.

4.1.3 Trip Blanks and Rinseate Blanks

Preparation of a trip blank is recommended at one blank for each cooler if volatile analysis has been requested. Equipment rinseate blanks should be collected during each day of sampling or at a 10% frequency.

4.2 Evaluation of Accuracy

The accuracy of data is a measure of the system bias. The level of accuracy is determined through examination of a Blank Spike (BS), laboratory Matrix Spike/Spike duplicate analyses (MS/MSD), surrogate recoveries for organic analyses, and method blanks. A blank spike is a laboratory QC sample which is introduced with the sample batch to monitor the performance of the system. The BS is used to document laboratory performance and is also referred to as a Lab Control Sample (LCS), Ongoing Precision Recovery (OPR), or Lab Spike (LS). The MS/MSD is an environmental field sample which is spiked with method or client specific analytes. The MS/MSD indicates how well the lab can reproduce the analytical results on field samples. The MS/MSD can indicate matrix effects. Surrogates are compounds that are structurally similar to the compounds requested for analysis, but are not found in nature (i.e., deuterated compounds). hey are analyzed to demonstrate the percent recovery of the method by the laboratory and are applicable only for organic analysis. Method blanks or reagent blanks are analyte-free blank samples that monitor contamination introduced by the laboratory during sample preparation or analysis.

Blank spikes are recommended for one in every twenty sample analyses. A MS/MSD set is recommended for one in every twenty samples. Surrogates are compounds spiked into every sample submitted to the laboratory for organic analysis and have method specific recovery limits. A method blank will be prepared for one in every 20 samples per matrix. Method blanks are used to check on process contamination, carry over, and purity of reagents used by the laboratory.

When a BS is outside of the control limits, the laboratory should first re-analyze the sample. If it is still outside of the control limits, the laboratory should then reextract all samples in the set. If neither of the above have been done by the laboratory, then all of the data should be qualified with either a "J", indicating that the values are estimates, or an "R" which indicates that the results are unusable. The severity of flagging will be based on the professional judgement of the data reviewer and the ultimate use of the data.

MS/MSD percent recoveries and RPDs are compared to published QC limits. If the MS/MSD recoveries and/or RPDs are outside QC limits, but the BS recovery is acceptable, the samples likely have matrix interference problems. If the precision is acceptable between the MS and the MSD, then the reliability of the data is good. If the recovery in the MS or MSD is less than 10%, the corresponding unspiked sample should be qualified with a "J" for positive hits, and an "R" for non-detected results. Note that this action is taken on the sample alone, not the entire batch of samples.

When surrogate recoveries are outside QC limits, procedures described below will be followed:

- If one Base/Neutral (B/N) and/or one Acid surrogate is outside of the QC limits, and the surrogate recoveries are all greater than

10%, the positive results should then be estimated as "J", while the non-detected results should be estimated as "UJ".

- If two Base/Neutral (B/N) or two Acid surrogates (or more) are outside of the QC limits, or surrogate recovery is less than 10%, the sample should then be re-analyzed.

- If a volatile surrogate is out of QC limits, the sample should be re-analyzed.

- After the laboratory has re-analyzed the surrogates are they still outside of the QC limits, both results should be reported and the outlying recoveries attributed to matrix interference.

- If the laboratory does not re-analyze or re-extract and re-analyze, then the positive results should be flagged with a "J" and the non-detected results flagged with an "R".

- If the surrogates are outside of the QC limits for any blank, then validity of the data should be considered questionable.

4.3 Evaluation of Completeness

Completeness is a measure of the amount of data actually collected, analyzed, and validated compared to the amount specified in the sampling plan. The overall measure of completeness is the ratio of samples planned to valid analyses received. The data quality objective for the data is to achieve 90-100% accuracy and completeness of data collected, unless otherwise stated in the QAPP.

5 Quality Assurance/Quality Control

RETEC will review all data validation procedures on a yearly basis and update OA/QC procedures annually if necessary.

6 Documentation

During the data review/validation process, problems with analytical procedures, analytical results outside QC limits, or other unusual conditions will be documented. In many cases this information will be contained in the laboratory project narrative accompanying the analytical data. Where additional explanations from the laboratory are required, the information will be documented by the laboratory and provided to RETEC. The QA/QC Officer will summarize the information for inclusion into the QA/QC summary. Documentation of data review/ validation will vary depending upon the level of review required by the individual project.

7 References

Analyses, EPA (1990)

CLP Organic Data Review, EPA (1992)

EPA Contract Laboratory Program (CLP) Guidelines:
Statement of Work : Organdies 2/88
Statement of Work : Organdies 3/90
Statement of Work : Inorganic 9/91
Statement of Work : Dioxin 8/87

Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyzes, EPA Region I (1988)

Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyzes, EPA Region I (1989)

Modified Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyzes, EPA Region III (1992)

Modified Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyzes, EPA Region III (1993)

RARA Laboratory Audit Inspection Guidance Document, EPA (1988)

Superfund Analytical Methods for Low Level Water Organic

Three Levels of Data Review, EPA (1989)

Test Methods for Evaluating Solid Waste, SW-846, Third Edition (1993)

Attachment B

Field Forms

DAILY FIELD REPORT

RETEC

: Date:	Arrival Time:
Location/Client:	Departure Time:
Job Number:	Weather:
Purpose of Observations:	
RETEC Representative:	RETEC Project Manager:
Contractor:	Permit No.:
Contractor Rep:	Job Phone:

ATTENDEES:

SCOPE:

:TIVITIES:

ACTION ITEMS:

Surface Sediment Field Log

Job:
Job No:
Field Reps:
Contractor:

Core Location:
Date:
Sample Method:
Proposed Coordinates:

Water Height

DTS Boat: DTS Lead Line:

Tide Measurements
Time/Height: _____
Time/Height: _____

Sample Acceptability Criteria:
1) Overlying water is present
2) Water has low turbidity
3) Sampler is not overfilled
4) Surface is flat
5) Desired penetration depth

Mudline Elevation (datum): _____

Notes: _____

Grab #	Time	Confirmed Coordinates (datum)		Sample Accept (Y/N)	Recovery Depth	Comments: winnowing, jaws close, biota, overfill, good seal, and sample depth
		Northing	Easting			

Sample Description: surface cover, (density), moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota)

Composite sample: _____

Sample Containers: _____
Analyses:

Appendix B
I&J Waterway PSDDA Sediment Characterization Sampling and Analysis Plan

I&J Waterway
Bellingham, Washington

Prepared by:

The RETEC Group, Inc.
1011 S.W. Klickitat Way, Suite #207
Seattle, Washington 98134

RETEC Project Number: PORTB-18449-100

Prepared for:

Port of Bellingham
1801 Roeder Avenue
Bellingham, Washington 98225

July 27, 2005

Appendix B
I&J Waterway PSDDA Sediment Characterization Sampling and Analysis Plan

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Prepared for:

Port of Bellingham
1801 Roeder Avenue
Bellingham, Washington 98225

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Daniel J. Berlin, Environmental Scientist

Reviewed by:

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July 27, 2005

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List of Acronyms

ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
BT	bioaccumulation trigger
COC	chemical of concern
DAIS	Dredged Analysis Information System
DGPS	Differential Global Positioning System
DMMP	Dredged Material Management Program
DMMU	Dredged Material Management Units
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
MDL	method detection limit
ML	maximum level
MLLW	mean lower low water
MS/MSD	matrix spike/matrix spike duplicate
Port	Port of Bellingham
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Protocol
QA/QC	quality assurance/quality control
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SL	screening level
SMARM	Sediment Management Annual Review Meeting
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SVOC	semivolatile organic compound
TDL	target detection limit
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
VCP	Voluntary Cleanup Program

1 Introduction

1.1 Project Description

This Sampling and Analysis Plan (SAP) provides the scope and methods to evaluate the suitability for open-water disposal of sediments at the I&J Waterway Site (Site) in Bellingham Bay in Bellingham, Washington under the Puget Sound Dredged Disposal Analysis Program (PSDDA) (See site map, Figure 1-1). This testing is being performed in support of the Sediments Remedial Investigation and Feasibility Study (RI/FS) occurring at the Site under the oversight of the Department of Ecology (Ecology). The need for disposal is driven by the cleanup at the site, but the design of the remedial activities will be influenced by navigation needs within the waterway and adjacent areas.

Based on areas identified for remediation in the Phase 2 Sampling (ThermoRetec, 2001), the area of the site within which dredging may occur is shown in Figure 1-2. This area has been divided into six (6) surface dredged material management units (DMMUs) and one (1) subsurface DMMU. Three (3) of the surface DMMUs and one (1) subsurface DMMU are contingent on the results of additional testing being performed as part of the RI/FS. These units may not be included in testing for open-water disposal if surface sediments do not exceed SMS criteria. The final orientation of DMMUs may change based upon results of surface sediment sampling conducted prior to coring. This SAP covers the characterization procedures for all seven DMMUs (6 surface, 1 subsurface).

These DMMUs are currently being investigated under an Agreed Order between Ecology and the Port of Bellingham to delineate sediment contamination at the site during preparation of the final RI/FS. All or some of the DMMUs will be evaluated depending on determinations from the Department of Ecology about the need for remediation in these areas based on the supplemental surface sediment chemical and biological data collected as part of a separate investigation. The SAP describing the surface testing is contained in Appendix A of the RI/FS Work Plan. Only those DMMUs in which the supplemental data from that area suggests remediation is necessary will be evaluated for open-water disposal under the PSDDA program.

An investigation of surface sediment contamination was conducted in 2000 by RETEC (formerly ThermoRetec, 2001). Elevated concentrations of bis(2-ethylhexyl)phthalate, phenol, polynuclear aromatic hydrocarbons (PAHs), and nickel are present in surface sediments. Historical sampling data collected by Hart Crowser in 1996 (1997) and Anchor Environmental (1998) indicate that mercury contamination is present in subsurface sediments. The coring prescribed in this plan will define which sediments may be unsuitable for unconfined, open-water disposal.

The total dredged volume of sediment of the three (3) non-contingent surface sediment DMMUs is approximately 9,910 cyds, including overdredge allowances. The total potential dredged material volume of all six (6) surface sediment DMMUs and the single subsurface sediment DMMU is approximately 22,030 cyds, including overdredge allowances.

1.2 Sediment Description

PSDDA guidance identifies Bellingham Bay as an area of high concern for sediment contamination. The waterway site has many known chemical sources and high concentrations of chemicals of concern (see Attachment A for historical analytical data results). Therefore, as an area of high concern, PSDDA guidance specifies that the maximum surface sediment volume represented by each surface DMMU is 4,000 cyds. Maximum subsurface sediment volume contained in each DMMU is 12,000 cyds.

Data collected as part of the Phase 2 investigation indicate that sediment in the waterway ranges from clayey silt to sand (ThermoRetec, 2001). Areas identified for remediation have been divided into 6 surface DMMUs and one subsurface DMMU based on similar contaminant levels (see Section 3 and Attachment A). Mudline elevations of sediments in the DMMUs range from approximately 0 to -17.0 feet MLLW.

RETEC proposes to characterize sediment by collecting and analyzing representative core samples in accordance with PSDDA requirements for each of the DMMUs. Dredged materials that pass chemical and biological guidelines may be disposed of at the Rosario Straits dispersive site if determined suitable, or to the Bellingham Bay non-dispersive open-water disposal site as part of the proposed project.

The field activities will be performed by The RETEC Group, Inc. (RETEC) on behalf of the Port of Bellingham (Port). Field sampling activities are currently scheduled for the summer of 2005.

1.3 Site History

The Site is located between Hilton Avenue and Bellwether Way on the Bellingham waterfront and was formerly called the “Olivine-Hilton sediment Site” (Figure 1-1). The Site includes areas of contaminated marine sediments in both the I & J Waterway and nearby berthing areas. The Waterway is located primarily on a state-owned aquatic land. The Port owns the berthing areas on the south side of the waterway and the surrounding uplands. The Waterway includes a federally authorized navigation channel with a current authorized channel depth of 18 feet below Mean Lower Low Water (MLLW). The U.S. Coast Guard owns the property north of the Site and berths vessels within the waterway and northern berth areas.

The upland areas near the Site include the former Olivine Corporation lease area and a property to its southwest that is currently leased to Bornstein Seafoods.

The ownership and history for the Site and adjacent upland properties were defined in the Phase 2 Sediment Sampling Report (ThermoRetec, 2001). The Whatcom Falls Mill Company owned and operated a lumber mill in the vicinity of the Site between the early 1900's and 1940. In 1944, these properties were acquired by the Port and leased to tenants, including Bayshore Lumber, who operated a lumber company (1947-1962) and H&H Products, who managed the same lumber mill (1963-1972) at the head of the waterway. The Olivine Corporation operated a rock crushing plant for the mineral olivine between 1963 and 1992. During that period, dust and wastewater were periodically released to the waterway. North Pacific Frozen Products managed a food processing plant between 1946 and 1959 in the location of the current Bornstein lease. Bornstein Seafoods has operated a seafood processing plant from 1959 to present in that location. Bornstein Seafoods provided diesel fuel to boats at its dock between 1960 and the early 1980s. A fire destroyed the main Bornstein Seafoods building in July of 1985. Fire suppression efforts lasted for two days, during which time fire control water was discharged directly to the Site.

Environmental impacts to the Site as documented by previous studies include contaminated surface sediments containing elevated concentrations of bis(2-ethylhexyl)phthalate. The elevated phthalate concentrations are located around the Bornstein Seafoods lease area in the vicinity of the 1985 fire. Surface sediments are also contaminated with nickel in the southeastern portion of the waterway adjacent to the former Olivine Corporation lease area. Nickel is a constituent within olivine ore. Additional contaminants present in subsurface sediments include mercury, phenols, and polynuclear aromatic hydrocarbon (PAH) compounds (ThermoRetec, 2001).

Dredging of approximately 68,000 cubic yards of sediments was conducted during maintenance dredging of the I&J Waterway by the Army Corps of Engineers in 1992 (West Central Environmental and ThermoRetec, 2000). Approximately 25,000 cyds were found to be unsuitable for unconfined, open-water disposal.

1.4 Program Objectives

The primary objective of the characterization is to collect the necessary chemical, physical, and biological testing data to evaluate the suitability of open-water disposal for site sediments that may be dredged as part of the proposed project.

The sediment characterization program objectives and constraints are summarized below:

- To characterize sediments for dredging in conformance with PSDDA requirements to enable the PSDDA agencies to designate approved disposal option(s);

- To collect, handle, and analyze representative sediment core samples that characterize the full dredging prism in accordance with protocols, timing, and QA/QC requirements outlined in the PSDDA Evaluation Procedures Technical Appendix (June 1988), the updated procedures documented in Chapter 5 and Appendix A of the PSDDA Phase II Management Plan Report (September, 1989), modifications made through the PSDDA and Sediment Management Annual Review Meeting (SMARM) process, and procedures presented in PSEP Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.

- Sediment cores will be composited and analyzed in a timely manner to meet the remediation schedule and PSDDA requirements for sample holding times, including those related to possible biological analysis, if needed.

- Chemical and biological testing results will be compared to chemical guidelines or biological performance criteria presented in the Evaluation Procedures Technical Appendix – Phase I (PSDDA, 1988), the PSDDA Management Plan Report – Phase II (PSDDA, 1989), as well as any revisions to guidelines or performance criteria that have been incorporated as part of the SMARM process.

2 Project Team and Responsibilities

The sediment characterization program will include: (1) project planning and agency coordination, (2) field sample collection, (3) laboratory preparation and analysis, (4) QA/QC management, and (5) final data reporting. Staffing and responsibilities are outlined below.

2.1 Project Planning and Coordination

Dan Berlin, RETEC, will be the overall Project Manager responsible for developing and completing the sampling program, and the primary contact for technical issues related to this SAP and the sediment characterization report. Following plan approval by the USACE, Mr. Berlin will be responsible for timely and successful completion of the project. Mr. Berlin will provide a copy of the approved SAP to all sampling and testing subcontractors, and coordinate any significant deviations from the approved sampling plan with the appropriate PSDDA agencies.

2.2 Field Sample Collection

Nick Bacher, RETEC, will provide overall direction to the field sampling and laboratory analysis programs in terms of logistics, personnel assignments, field observations, and analytical laboratory selection. Mr. Bacher will also supervise field collection of the sediment core samples. Mr. Bacher will be responsible for ensuring accurate sample positioning, recording sample locations, depths, and identification, ensuring conformance to sampling and handling requirements, including field decontamination procedures, photographing, physical evaluation, and logging of the samples, and for chain of custody of the sample cores until they are delivered to the analytical laboratory.

2.3 Laboratory Preparation and Analysis

Leslie McKee, RETEC, will be responsible for documenting sample preparation, observations, and chain of custody until the time she delivers the samples to the appropriate laboratory. Ms. McKee will also instruct the analytical laboratory on the need to maintain required handling and analytical protocols including detection limit requirements for dredge material characterization. Ms. McKee will ensure that archived sediments are stored under proper conditions. Analytical Resources, Inc. (ARI) will handle and analyze the submitted samples in accordance with PSDDA analytical testing protocols and QA/QC requirements. ARI will perform sediment grain size analysis. Vizon Scitec (Vancouver, BC) will conduct biological testing.

2.4 QA/QC Management

Jennifer Fetting will serve as Quality Assurance Representative for the sediment characterization project. She will perform quality assurance

oversight for both the field sampling and laboratory programs. She will remain fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation. She will record and correct any activities that vary from the written sampling and analysis plans. She will also review the laboratory analytical and QA/QC data to ensure that data are valid and procedures meet the required analytical quality control limits. Upon completion of the sampling and analytical program she will incorporate findings into a QA/QC report.

2.5 Final Data Report

Nick Bacher will be responsible for preparation of a PSDDA Data Evaluation Report, including descriptions of sample locations and depths, sampling, handling and analytical methods, QA/QC, and compilation and interpretation of data. Dan Berlin will provide technical oversight and review of the document. The report will include the following elements:

- Type of sampling equipment used;
- Protocols and procedures used during sampling and testing and an explanation of any deviations from the sampling plan protocols;
- Descriptions and core logs of each sample, including penetration and recovery depths, compositing intervals, mudline elevation, grain size, and geologic contacts;
- Methods used to locate the sampling positions within an accuracy of ±2 m;
- Maps and tables identifying locations where the sediment samples were collected, reported in State Plane Coordinates to the nearest foot;
- A plan view of the project site showing the waterway, bathymetry, and actual sampling locations;
- Chain of custody procedures used, and explanation of any deviations from the sampling plan procedures;
- Tabular summary of chemical testing results in DAIS (Dredged Analysis Information System) format, with comparisons to USACE guideline chemistry values; and
- Final QA Report, which will identify any field and laboratory activities that deviated from the approved sampling plan and the referenced protocols. The QA Report will assess the overall validity of the collected data.

3 Sample Collection and Handling Procedures

This SAP provides details of specific data collection and analysis activities designed to support the objectives of the project. Preparation of the SAP follows the USACE guidance manual titled *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 1994), the components and strategy of which are provided in the following subsections.

3.1 Definitions

The following definitions apply to this sampling program:

- **Dredging Prism:** the entire volume of sediments to be dredged, including a 1-foot overdredge allowance.

- **Sampling Depth (Penetration Depth):** the entire cumulative depth of penetration of the coring device from the sediment/water interface.

- **Sediment Core:** the entire cumulative length of sediment extracted by the coring device. Typically, the recovered sediment length is less than the total penetration depth due to compaction during coring.

- **Core Section:** each core section is 4 feet long except where the total sediment depth leaves a core section less than 4 feet at the bottom of the dredging prism. Core sections for each sediment core are designated alphabetically, beginning with "A" for the 4-foot surface layer and proceeding downward from the top in 4-foot increments…A, B, C, etc., to the bottom core section. Core sections are composited within Dredge Material Management Units for laboratory analyses. Slightly longer or shorter core sections may be composited if stratigraphic contacts in the sediment sequence are observed during core processing. One-foot core sections will be collected from below the dredge prism for archiving (z-sample). Core sections are composited within Dredge Material Management Units for laboratory analyses.

- **Dredged Material Management Unit (DMMU):** the volume of dredged material for which a separate decision on suitability for unconfined open-water disposal can be made. DMMUs are typically represented by chemical and biological testing of a single sample and composited from one or more core sections within the DMMU.

- **Surface Sediments:** sediments located within a 4-foot-thick surface layer. Surface sediment samples are repsresented by core sections designated by the capital letter "A"

- **Subsurface Sediments:** sediments located beneath the 4 foot layer of surface sediments. Subsurface sediment samples are represented by core sections designated by the capital letters "B", "C", etc.

- **"Z" Samples:** sediments below the dredge prism which will be exposed by dredging and represent the surface that will remain when dredging is completed.

3.2 Number of Cores and Samples Required Based on Site Ranking

The dredge materials at the site are ranked by PSDDA classification scheme as an area of high concern for sediment contamination. High concentrations of chemicals of concern are found in site surface sediments, and acute toxicity in sediment bioassays may be present (see Attachment A). In accordance with PSDDA requirements, full sediment characterization requirements for a dredging area ranked high concern are outlined below:

- **Surface Sediments (0 to 4 feet):** One core section and one laboratory analysis for each 4,000 cubic yards.

- **Subsurface Sediments (> 4 feet):** One core section for each 4,000 cubic yards, and one laboratory analysis for each 12,000 cubic yards.

Four cores will be collected from each DMMU in order to achieve sufficient volume for full chemical, bioassay, and bioaccumulation analyses. These cores will be composited into one surface sample within each DMMU to characterize more recently deposited sediments and one composite for the subsurface DMMU. A z-sample representing the top one-foot of the new surface following dredging will be collected and archived to verify compliance with Washington State's antidegradation policy. If the DMMP and/or the SMS programs require their analysis, testing will consist of conventional and chemistry analysis.

As shown in the historical data in Attachment A, much of the surface sediment is impacted with bis(2-ethylhexyl)phthalate, nickel, of PAHs. Mercury contamination and phenols are present in subsurface sediment and are not expected to extend beyond the depth to which the federal channel is maintained (-18 feet MLLW). Table A-1 summarizes surface chemical concentrations from studies in 1997 and 1999 and Table A-2 shows coring data from 1997 to a depth of 7.1 feet below mudline. Table A-3 provides results of the Phase 2 surface sediment sampling. Figure A-1 provides exceedances of SQS or MCUL criteria from Phase 2 and other historic surface sediment investigations.

The estimated total dredged volume of sediment in the three non-contingent DMMUs in the remediation area (DMMU-3, 5, and 6) is approximately 9,950 cyds, including overdredge allowances. Dredge cuts are meant to remove sediment to -18 feet MLLW in the federal waterway with a 2 foot overdredge depth. Volumes include slope volume, and assume a 3:1 slope from the federal channel boundary. The total potential dredged volume of sediment of the additional three (3) contingent units is approximately 12,080 cyds, including overdredge allowances. One sample will be collected from each DMMU, which will be composited from four cores in each DMMU.

3.3 Conceptual Dredging Plan, Sampling and Compositing Scheme

The SAP is developed with consideration of site-specific project and environmental factors. A key requirement is ensuring that if an individual DMMU (represented by one or more core sections) is found unsuitable for unconfined open-water disposal, then that unit can be feasibly dredged independently from surrounding clean sediments so that the contaminated material can be disposed of at an alternate approved site. The sampling program for the waterway dredging project was developed as follows:

- **Prepare Conceptual Dredging Plan.** Criteria for a dredging plan were established for this site based on the depth and similar chemical and physical characteristics of the sediments, the dredge layout plan including side slopes, appropriate dredging methods and equipment, and conventional construction practices at similar dredging projects in Puget Sound.

- **Prepare Sampling Scheme.** Basic criteria for selecting sampling locations and compositing for analysis are contained in PSDDA guidance documents relative to sediment volumes to be characterized. The approach is to delineate sediment sampling grid units as basic building blocks for identifying DMMUs capable of being dredged independently.

- **Integrate the Dredging Plan with the Sampling and Compositing Scheme.** This step consisted of using professional judgment to relate the operational aspects of dredging to the compositing scheme to ensure that specific sediment volumes, represented by sampling, and analytical results can be feasibly dredged independently from adjacent volumes. A primary consideration was to provide common lateral boundaries between the surface DMMUs as much as practicable to enable full depth dredging with each dredge setup where sampling results allow use of the same disposal site.

3.3.1 Conceptual Dredging Plan

Criteria for dredging are as follows:

- Dredge by clamshell and bottom-dump barge in open-water areas, or by backhoe with extended arm under docks with diver-guided hydraulic dredging to remove remaining sediments.

- Most practicable dredge cut widths are in the range of 50 to 90 feet.

- Full box-cutting of the dredge slopes will not be allowed along the Bornstein dock (southeastern portion of waterway) and Coast Guard dock (northwestern portion of waterway) in order to protect the piling from potential slope failure due to overcutting, i.e., the pier side slope will be excavated as close to the 1V-on-3H design slope as practicable (estimated dredge volumes assume vertical dredge cuts along the pilings). Adjusting dredge volume estimates to accommodate appropriate side slope requirements will decrease the total dredge volume of each DMMU, and will be performed prior to dredging as part of the engineering design.

- Dredged removal of the dock side slopes will be conducted by advancing the dredge cut longitudinally along the pier length. This will take advantage of increased bucket control by side swing (compared to more difficult control by raising and lowering the boom as would be required by advancing into the side slope perpendicular to the pier). Advancing parallel to the pier will also enhance operator control by creating a pattern of repetitive excavation along the slope cut in reference to the pier face.

- Underpier dredge cuts will be conducted with a backhoe with an extended arm on a barge pulling sediment from underneath the pier along gaps between piles. Due to the presence of braces preventing dredge cuts in the direction perpendicular to the first cuts, a diver-guided hydraulic dredge will remove remaining sediments. Total dredge area of sediments under the two docks is less than 900 yd^2, the majority of which will be removed by mechanical dredge.

- Remaining dredge cuts will also be oriented longitudinally along the pier, i.e., parallel to the pier face and the pier side slope cut. However, it is also practicable to orient selected dredge cuts perpendicular to the pier; however, this would require more dredge positioning to initiate the additional cuts and alignments.

- Except for the dock side slope cut (which may require successive passes), the full allowable depth of removal, based on testing results, will be accomplished as the dredge advances into the cut.

3.3.2 Sampling and Compositing Scheme

The basic approach for establishing the sampling array and compositing scheme include the following criteria:

- Design sediment grid unit borders perpendicular to the federal channel boundary consistent with the maintenance dredging requirements of the waterway such that units are composed of similar sediment quality.

- Arrange grid unit borders beyond the federal channel boundary to allow for appropriate side-slope cuts (3H:1V) along the channel boundary

- Design contingent sediment grid unit borders (DMMUs 1, 2, and 4) along the perimeter of the remediation area.

- Arrange sediment grid units to provide testing of surface sediments in both shallower and deeper water.

Sediment DMMUs have been designed based on historically similar concentrations of contaminants in surface sediments. Attachment A contains a tabular summary of surface sediment data (Tables A-1 and A-3) and subsurface data (Table A-2) and one figure summarizing sample locations and contaminant exceeding SMS criteria.

The waterway sediment surface contains a distinct footprint of bis(2-ethylhexyl)phthalate with areas of PAH and phenol contamination. Nickel is elevated in sediments on the eastern portion of the inner waterway. DMMU units have been designed to minimize the chemical heterogeneity within a single unit based on historic data. DMMUs 5 and 6 contain surface sediment that exceed MCUL concentrations, and DMMU-3 contains surface sediment with SQS or MCUL exceedances.

3.3.3 Sampling Locations

Sampling locations have been designed to capture sediment that is representative of chemical and physical makeup of each DMMU. Twenty-four (24) sediment cores will be collected at approximately 60 to 150-foot intervals, depending on the shape of the DMMU. Sampling locations are established as shown on Figure 3-1. Table 3-1 lists sediment core sampling locations, core and sample nomenclature, and estimated sediment volumes of each DMMU. Each of the four sampling locations for remediation area

DMMUs is positioned in a manner to maximize the distance between sampling locations without being too close to any borders of the DMMU. Sampling locations are spaced in order to sample both more and less contaminated areas within the DMMU.

Surface Sampling Units

The surface interval from each of four sediment cores of each DMMU will be composited together into one analytical sample and designated with an "S1" extension. Table 3-1 identifies length of sediment cores for each DMMU. Surface unit depths vary according to proximity to the waterway. Depths of surface units vary in each DMMU. Maximum depths in DMMUs 1, 2, 3, 5, and 6 do not exceed 4 feet. Maximum depth of the surface interval in DMMU-4 is 3 feet. Additional sediment will be sampled from the subsurface unit below the surface interval in DMMU-4. Cores in the waterway will be sampled to -20 feet MLLW (-18 feet MLLW plus 2 feet of overdredge depth). Cuts away from the waterway are meant to provide a final slope of 3H-on-1V.

Actual sample composite depths may vary depending on observed stratigraphy in each core. Historical maintenance dredging has shown a native clay layer present at approximately -20 feet MLLW throughout much of the waterway. If a well-defined contact between recent sediments and native sediments exist and is slightly deeper or shallower than the targeted dredge cut, then the surface sample will be sampled to the contact composed of recent sediments. Z-samples will be designated with an "S2" extension and collected from composites collected from the 1 foot layer beneath the surface intervals in DMMUs 1, 2, 3, 5, and 6.

Subsurface Sampling Units

The subsurface interval from the four cores in DMMU-4 will be composited together into one analytical sample and designated with an "S-2" extension. No other subsurface units will be characterized. Table 3-1 identifies the length of sediment core sections in the subsurface intervals. Subsurface sampling intervals range from one to three feet below the surface interval. Subsurface cuts are meant to remove sediment to the depth of -20 feet MLLW within the federal channel boundary and with a 3H-on-1V slope to the edges of the DMMU.

Actual sample composite depths may vary depending on observed stratigraphy in each core. Historical maintenance dredging has shown a native clay layer present at approximately -20 feet MLLW throughout much of the waterway. If a well-defined contact between recent sediments and native sediments exist and is slightly deeper or shallower than the targeted dredge cut, then the surface sample will be sampled to the contact composed of recent sediments. Z-samples will be designated with an "S2" extension and collected

from composites collected from the 1 foot layer beneath the subsurface intervals in DMMU-4B.

Reference Samples

Sediment samples collected for sediment bioassay testing will be compared to one or two reference samples collected in the field with similar grain size and total organic carbon (TOC) characteristics. Reference samples are ambient surface samples collected from areas not likely impacted by site activities. They will be collected from Samish Bay or a similar reference site in Washington and rapid field-sieved in the field to best match grain size distributions. Reference sediment samples will be submitted for grain size analysis, as well as total solids, total volatile solids, total organic carbon, grain size, ammonia, and sulfides.

3.4 Field Sampling Schedule

The field sampling schedule is constrained by the shortest sample holding time (7 days). To safely meet the holding times for composited samples, the field samples will be composited and delivered for laboratory testing within 3 days of sampling the first core section within each composite. Sampling will generally proceed by completing each core for a DMMU before proceeding to core locations for the next DMMU. Based on a review of the limited available sediment data and expected logistic considerations, it is projected that up to 5 sediment cores can be completed per sampling day. The entire core-sampling program is expected to be completed within 5 working days.

Initiation of core sampling will be preceded by preparation of sample coring and handling equipment, acquisition of appropriate EPA-approved decontaminated sample containers from the analytical laboratories, on-site establishment of positioning references and tide gauge by the surveyor, and mobilization of the coring vessel to the site.

3.5 Field Operations and Equipment

The field crew and equipment will be mobilized from RETEC's Seattle and Bellingham Offices. The field crew will make sure all equipment is in good working order prior to collection of cores. Initiation of sediment sampling will be preceded by preparation and cleaning of sample coring and handling equipment, acquisition of decontaminated sample containers from the analytical laboratory, and establishment of sampling locations in the waterway. All field sampling and sediment handling will conform to the procedures outlined in the project Health and Safety Plan.

3.5.1 Sediment Sampling Equipment

The sampling vessel and operator to be employed for the coring program will be provided by Marine Sampling Systems of Seattle, Washington. The sampling vessel, *R/V Nancy Anne*, is an aluminum, flat-deck, 36-foot-long, and 14-foot-wide catamaran vessel with twin 120-horsepower engines. The *R/V Nancy Anne* is equipped with a 14-foot-high hydraulically-operated A-frame with boom with variable speed, 3,000-pound capacity, hydraulic winch (1 to 3 ft/s), and 270 square feet of deck space. The vessel is equipped with a pilot house, freshwater and seawater pumps; and vessel draft ranges from 18 inches forward to 42 inches aft.

Sediment cores will be collected using a vibracore. A vibracoring system collects a continuous profile of sediments below mudline. The system utilizes a high frequency vibrating coring device, which penetrates into the underlying sediments with minimal distortion. This method is ideal for collecting long, relatively undisturbed cores from a variety of sediment types. The vibratory head assembly and core barrels will be deployed from the A-frame of the *R/V Nancy Anne*. If debris is encountered, alternative sampling gear will be considered, including the mud-mole or diver operated core sampling prior to moving the location.

The field representative will log each sample on a chain of custody form, noting the location, date, and time of collection. Subsequent chain of custody forms will be used to track the submittal of specific samples to the laboratory, and will be signed by any individual handling the coolers. Coolers, in which samples are kept on ice, will be in possession of project personnel or secured at all times. A complete record of drilling and sampling operations will be maintained on the appropriate sediment sampling forms.

3.5.2 Positioning and Navigation

The objective of the positioning procedure is to accurately (±2 m) determine and record the positions of all sampling locations. This determination will be achieved by documenting the following parameters at each sampling location:

- Horizontal location in state plane coordinates and latitude/longitude (NAD 83) recorded electronically when sampler is on the bottom and cable is taut and perpendicular to the water surface;
- Vertical elevation in feet (USACE MLLW) recorded from lead-line water depth measurements and tide height; and
- Time and date.

These parameters will be measured using combinations of a Differential Global Positioning System (DGPS), local tide gauges, tide programs, acoustic and lead-line water depth instruments, and back-up methods (i.e., triangulation or taping to survey control points and/or terminal landmarks or structures).

Positioning while sampling will be performed using a DGPS, which will provide positions every second with submeter accuracy for precise positioning of sample locations. The navigation system onboard the vessel will provide the vessel pilot with a navigation display to enable piloting to sample locations and recording the exact location of the sediment core. Each day, the sampling vessel will be positioned at a land-surveyed quality control point to verify the accuracy of the DGPS system, and recorded in the field notes.

As a back up, horizontal triangulation is proposed for recording station positions. If necessary, sampling locations will be identified by measuring the horizontal distance from the actual sampling location to a known survey control point and/or permanent structure to the nearest foot using an incremental tape measure. These horizontal measurements can be translated into state plane coordinates using project base maps.

3.6 Sample Collection Techniques

Sediment samples will be collected in the following manner:

- Vessel will maneuver to the proposed sample location;
- A decontaminated core tube the length of the desired penetration depth will be secured to the vibratory assembly and deployed from the vessel;
- The cable umbilical to the vibrator assembly will be drawn taut and perpendicular, as the core rests on the bottom sediment;
- Location of the umbilical hoist will be measured and recorded by the location control personnel, depth to sediment will be measured with a survey tape attached to the head assembly;
- A 4-inch-diameter, thin-walled, aluminum tube will be vibratory-driven into the sediment using two counter-rotating vibrating heads;
- A continuous core sample will be collected to the designated coring depth or until refusal;
- The depth of core penetration will be measured and recorded;

- The vibrator will be turned off and the core barrel will be extracted from the sediment using the winch;

- While suspended from the A-frame, the assembly and core barrel will be sprayed off and then placed on the vessel deck; and

- The core sample will be evaluated at the visible ends of the core tube, the length of recovered sediment will be recorded and, if accepted, the core tube will be sectioned into 4-foot lengths.

Sample recovery will be inspected relative to the following RETEC acceptance criteria:

- Overlying water is present and the surface is intact;
- The core tube appears intact without obstruction or blocking; and
- Recovery is greater than 75 percent of drive length.

If sample acceptance criteria are not achieved, the sample will be rejected. If repeated deployments (2) within a 15.2-meter (50-foot) radius within the DMMU of the proposed location do not meet acceptance criteria, then selection of an alternate sample location will be considered within the DMMU. Prior to selection of an alternative sample location, the Dredged Material Management Office (206-764-3768) should be contacted for discussion/approval.

Once the core samples are deemed acceptable, the cutterhead will be removed and a cap will be placed over the end of the tube and secured firmly in place with duct tape. The core tube will then be removed from the sampler and the other end of the core will be capped and taped. A label identifying the core will be securely attached to the outside of the core and wrapped with transparent table to prevent loss or damage of the label. The core sections will be stored upright in an insulated core storage box filled with blue ice. The cores will be sealed tightly enough to prevent leakage or disturbance during transport.

As samples are collected, logs and field notes of all sediment samples will be maintained on field forms and in a project notebook. Field forms are contained in Attachment B. Included on the forms and in this log will be the following:

- Calculated elevation of each sediment sample;
- Date and time of sampling;
- Initials of person supervising the sampling operation;
- Weather conditions;
- Sample location number and core section identification;

- Physical description of sediment; and
- Chronological occurrence of events during sampling operations.

3.7 Sample Compositing and Subsampling

3.7.1 Extrusion

Core sections will have their sealed caps removed for extrusion. The sediment from each sample tube will be extruded onto a stainless steel tray using vibratory/pushing techniques or cutting the core longitudinally using a circular saw if push-extruding the sediment is difficult. The sample will be disturbed as little as possible when extruding. Upon extrusion, the core will be split with decontaminated stainless steel wire core splitters or spatulas.

A color photograph will be taken and the sediment description of each core sample will be recorded on the sediment-sampling log for the following parameters as appropriate and present:

- Sample recovery;
- Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, color);
- Odor (e.g., hydrogen sulfide, petroleum);
- Visual stratification, structure, and texture;
- Vegetation;
- Debris (e.g. woodchips or fibers, paint chips, concrete, sand blast grit, metal debris;
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms);
- Presence of oil sheen; and
- Any other distinguishing characteristics or features.

3.7.2 Compositing

To reduce cross-contamination due to smear, the smeared sediments found along the sidewalls of the core tube will be removed prior to compositing. Only sediment that is not touching the sidewalls or ends will be collected for chemical analysis. Samples will be composited under the direction of an

experienced RETEC geologist per the compositing plan presented in Table 3-1 and in accordance with USACE guidance. For sediment composite samples, equal volumes of sediment will be removed from each core section comprising a composite.

Immediately upon extrusion of cores, a subsample volume will be collected from a selected core section for volatiles and sulfide analysis without mixing by randomly selecting a sample that has not had contact with the core lining from one core representing each composite. Tables 3-1 and 3-2 indicate the stations randomly selected for volatile and sulfide subsampling. For sulfides, 5 ml of 2N zinc acetate will be added to every 30 grams of sediment using a pipette creating a thin film across the top of sediment in the jar. Separate containers will be completely filled with sample sediment for volatiles. No headspace will be allowed to remain in either container.

Sediments representing each composite sample will be placed in a decontaminated stainless steel bowl and mixed using decontaminated stainless steel mixing spoons or paddles. The composited sediment in the stainless steel bowl will be mixed until homogenous in color and texture.

Field sample recovery will be taken into account when vertically compositing the sample material. For example, a core sample with 3 feet of penetration but only 2.5 feet of recovery (retained) will have 83 percent sample recovery. Therefore, a 2.5-foot sample interval will be reduced by 17 percent from 2.5 feet to 2.08 feet to account for compaction during driving.

3.7.3 Sample Volume

Approximately 27 liters of homogenized sample will be prepared for each composite. Table 3-3 contains sediment collection requirements for each composite sample or core. Two liters of sample are required to provide adequate volume for physical and chemical laboratory analyses. An additional 25 liters of sample will be collected and archived (refrigerated), pending chemical testing results, which will indicate if subsequent biological (5 liters) testing and/or bioaccumulation (20 liters) testing is deemed necessary to determine suitability for open-water disposal. Portions of each composite sample will be placed in appropriate containers obtained from the analytical chemistry laboratories.

Each sample container will be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book. Samples will be stored at approximately 4 °C until withdrawn for analysis.

3.8 Equipment Decontamination Procedures

Sampling and sediment compositing equipment will be thoroughly cleaned prior to use and after each sample collection event. Sampling equipment will be decontaminated according to the following procedure:

- Initial rinse with site water to dislodge residual particles;
- Wash with brush and Alconox soap;
- Rinse with tap water;
- Rinse with methanol, nitric acid, or other cleaning solvent, if necessary; and
- Rinse with deionized water.

After cleaning, all sampling equipment not immediately used will be wrapped in foil to limit the risk of contamination. Cleaning solvents, such as hexane and/or nitric acid may be considered if heavy sheens/free product are present in the sample material. In general, core tubes will not be reused for sampling.

Hand processing work (e.g., using stainless steel spoons for extracting the sample from the split cores, mixing the samples and filling sample containers) will be conducted with disposable gloves, which will be rinsed with distilled water before and after handling each individual sample, as appropriate, to prevent sample contamination. Gloves will be disposed of between composites to prevent cross-contamination between the DMMUs.

3.9 QA/QC Samples

Additional matrix spike/matrix spike duplicate (MS/MSD) samples will be collected for laboratory QA purposes. Samples will be collected from one station with sufficient sediment volume for analysis of volatiles, SVOCs, PCBs/pesticides, metals, and tributyl tin. Section 4.1.5 contains additional information on laboratory QA procedures.

3.10 Sample Transport and Chain of Custody Procedures

Containerized sediment samples will be transported to the laboratories after compositing is completed. Specific sample shipping procedures will be as follows:

- Individual sample containers will be packed to prevent breakage and transported in a sealed ice chest or other suitable container; glass jars

will be separated in the shipping container by shock-absorbent material (e.g., bubble wrap) to prevent breakage;

- Coolers will be packed with ice packs or crushed ice (sealed in plastic bags) to keep the samples at 4 °C ± 2 ºC;

- Cooler trip blanks will be included with volatile samples at a frequency of one per cooler;

- Each cooler or container containing the sediment samples for chemical analysis will be delivered to the laboratory within 24 hours of being sealed;

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification;

- A sealed envelope containing chain of custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler; and

- Signed and dated custody seals will be placed on all coolers prior to shipping.

Upon transfer to sample possession to the analytical laboratory, the custody form will be signed by the persons transferring custody of the sample container. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the receiver will record the condition of the samples. Custody forms will be used internally in the lab to track sample handling and final disposition.

3.11 Health and Safety

Prior to the initiation of any field activities, all parties with review, become familiar with, and sign off in acknowledgement of the Site-Specific Health and Safety Plan, provided under separate cover. Issues related to health and safety, including emergency plans and potentially dangerous situations, will be discussed at the start of each day of sampling, and potential corrective actions will be considered.

4 Chemical and Physical Testing

This section provides an overview of the chemical and physical testing program. Samples will be analyzed in accordance with PSDDA guidelines by an Ecology-accredited laboratory using accredited methods. Table 4-1 presents the proposed analyte list, methods, and the target detection limits (TDLs).

4.1 Chemical Analyses Protocols

Laboratory testing procedures will be conducted in accordance with the procedures specified in the PSDDA Evaluation Procedures Technical Appendix, June 1988; the PSDDA Phase II Management Plan Report, September 1989; and with the PSEP Recommended Protocols. These procedures are discussed below.

4.1.1 Chain of Custody

A chain of custody record for each set of samples will be maintained throughout all sampling activities and will accompany samples during shipment to the laboratory. Information tracked by the chain of custody records include sample identification number, date and time of sample receipt, analytical parameters required, location and conditions of storage, signature of person relinquishing and receiving custody, and final disposition of the sample.

4.1.2 Chemical Analyte List and Methods

A maximum of eight composited sediment samples will be analyzed for the full suite of PSDDA analytes listed in Table 4-1. Volatiles and sulfide subsamples will be collected from a randomly selected core section immediately upon extrusion of cores to avoid volatilization of potential contaminants and (for sulfides) to add necessary preservative. Samples will be submitted to ARI laboratory for chemical analysis.

4.1.3 Physical Analysis

Grain size distribution of sediment samples will be determined using PSDDA-specified protocol (ASTM D-422 modified). Wet sieve analysis will be used to determine the size distribution greater than the U.S. No. 230 mesh sieve (sand and gravel fraction). The silt and clay fraction will be determined by the hydrometer method. One triplicate analysis of one sample will be performed for QA purposes. Sediment samples will be submitted to ARI laboratory for physical analysis.

4.1.4 Limits of Detection

The sediment composite samples identified in Table 3-1 will be analyzed for each of the parameters listed in Table 4-1. The analytical test methods and

reporting limits to be achieved by the analytical laboratory are also identified in Table 4-1. The testing laboratories are aware of the PSDDA detection limit requirements and will employ all reasonable means, including additional cleanup steps and method modifications, to reach these detection limits. Failure to reach PSDDA detection limits may result in a requirement to reanalyze or perform bioassays. All reasonable means, including additional cleanup steps and method modifications will be used to bring all limits-of-detection below PSDDA screening levels. Additionally, an aliquot (8-oz) of each sediment sample for analysis will be archived and preserved at –18 °C for additional analysis if necessary.

The following scenarios are possible and will be handled appropriately:

1) One or more chemicals-of-concern (COC) have limits of detection exceeding screening levels while all other COCs are quantitated or have limits of detection at or below the screening levels: the requirement to conduct biological testing would be triggered solely by limits of detection. In this case the chemical testing subcontractor will do everything possible to bring limits of detection down to or below the screening levels, including additional cleanup steps, re-extraction, etc. This is the only way to prevent unnecessary biological testing. If problems or questions arise, the chemical testing subcontractor will be directed to contact the Dredged Material Management Office.

2) One of more COCs have limits of detection exceeding screening levels for a lab sample, but below respective bioaccumulation triggers (BT) and maximum levels (ML), and other COCs have quantitated concentrations above screening levels: the need to do bioassays is based on the detected exceedances of SLs and the limits of detection above SL become irrelevant. No further action is necessary.

3) One or more COCs have limits of detection exceeding SL and exceeding BT or ML, and other COCs have quantitated concentrations above screening levels: the need to do bioassays is based on the detected exceedances of SLs but all other limits of detection must be brought below BTs and MLs to avoid the requirement to do bioaccumulation testing or special biological testing. As in case 1), everything possible will be done to lower the limits of detection.

4) One COC is quantitated at a level that exceeds ML by more than 100%, or more than one COC concentration exceeds ML: although there is reason to believe that the test sediment is unsuited for open-water disposal without additional chronic sublethal testing data, the standard suite of bioassay tests must be completed, and no additional testing is required by the program. However, the DMMP agencies

retain the authority to require "additional, specialized" testing of any dredged material based on "reason-to-believe" whenever the disposal of that material is subject to 404 authority.

In all cases, to avoid potential problems and leave open the option for retesting, sediments or extracts will be kept under proper storage conditions until the chemistry data is deemed acceptable by the PSDDA agencies.

4.1.5 Quality Assurance/Quality Control

The analyst will review results of the quality control samples from each sample group immediately after a sample group has been analyzed. The quality control sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the Project QA Coordinator will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples. A summary of the types of quality control procedures to be performed by the laboratories is presented in Table 4-2.

All samples for physical and chemical testing will be maintained at the testing laboratory in accordance with the sample holding limitations and storage temperature requirements listed in Table 3-3.

4.2 Laboratory Written Report

A written report will be prepared by the analytical laboratories documenting the activities associated with sample analyses. Because of the possibility of additional bioassay testing, to the maximum extent practicable, all chemical results will be provided within 28 days of sampling to allow a timely decision for tiered biological testing. At a minimum, the following will be included in the report:

- Results of the laboratory analyses and QA/QC results;
- Protocols used during analyses;
- Chain of custody procedures, including explanation of any deviation from those identified herein;
- Any protocol deviations from the approved sampling plan; and
- Location and availability of data.

The final report will include QA2 deliverables, surrogate recoveries where appropriate, and sample custody information. QA2 deliverables are required for submission of the data into the SEDQUAL database maintained by the

Department of Ecology. A list of QA2 deliverables is summarized in Attachment C. All data will be submitted to the Corps in the pre-tested DAIS format. The Corps will convert the DAIS data to SEDQUAL format and transfer to Ecology. Any QA problems (i.e., calibrations, internal standards) must be noted in the laboratory report narrative. Chemical data will be qualified in accordance with PSEP guidelines. The "J" qualifier will be applied to all concentrations that fall between the limit of detection and the laboratory's method detection limit (MDL). Dilution volumes, sample sizes, percent moisture, and surrogate recoveries will be presented on each summary sheet with the analytical results in the data packages. Similar information will also be assembled for each QC sample (method blanks, matrix spikes, etc.).

4.3 Data Validation

Within 14 days of receipt of the analytical results, the contractor will review all raw data to verify the laboratory has supplied the required QA/QC deliverables. The data will then be validated against QA1 and project criteria for inclusion into the sediment characterization reports.

All analytical results will be validated in accordance with PSDDA QA1 review (PTI, 1989). The QA1 review will evaluate the data for completeness, format, holding conditions, and laboratory QA sample results (e.g., blanks, matrix spikes). The data validation will also include a review of surrogate recovery values for each of the organic samples. Data validation checklists will be followed.

Where data fail criteria provided in the QA1 manual, the laboratory will be contacted, and the data will be: (1) reanalyzed, (2) qualified, or (3) discarded. Data quality issues will be summarized in a data validation report.

5 Biological Testing

Bioassays will be conducted to determine whether chemicals of concern (COCs) outlined by PSDDA are present and bioavailable at concentrations that are toxic to biota. A tiered testing approach will be used. Bioassay procedures used in this program will be conducted in accordance with protocols recommended by PSEP (PSEP, 1995), in addition to standard laboratory procedures. Analyses will be required to conform to accepted standard methods and rigorous internal QA/QC checks prior to final approval. Vizon Scitec, an Ecology-accredited laboratory in Vancouver, B.C., will conduct the biological testing.

5.1 Bioassay Testing Approach

Biological testing will be undertaken on any composite sample which has one or more chemicals of concern above the PSDDA screening level (SL) but below the PSDDA maximum level (ML), although a sample with a single ML exceedance which is less than or equal to two times the ML still qualifies for biological testing. If any COC exceeds a bioaccumulation trigger (BT), a decision will be made as to whether or not to pursue biological testing, which would include the standard suite of PSDDA bioassays plus bioaccumulation testing with Macoma and an adult polychaete (*Nereis virens*, *Arenicola marina*, or *Nepthys caecoides*). If bioaccumulation testing is performed, the organisms and exposure durations will be coordinated with the DMMP.

Adequate sample volume will be collected in the field for chemical, physical, and bioassay/bioaccumulation testing. To the extent practicable, chemical results will be provided for bioassay decisions within 28 days of the first sample collection.

5.2 Sample Handling

Bioassay samples will be composited, placed in appropriate glass or plastic jars with minimal headspace, labeled, and stored on ice in insulated coolers while in the field; all under proper chain of custody procedures. Samples retained for biological analysis will be split from the same composited sample designated for chemical analysis. Table 3-3 specifies the sample jars and maximum allowable holding times for bioassay samples. Following the completion of each day's sample collection, chain of custody forms will be completed for each set of samples.

Sediment samples collected for bioassay analyses will be delivered to the biological laboratory at the end of the sampling period. All samples delivered to the laboratory will be properly packed in coolers and maintained at 4 ºC. Original chain of custody forms and analysis request forms will accompany the samples to the laboratory. All bioassay analyses, including retests, will commence within 56 days after collection of the first core section of the

sediment composite to be analyzed. No field duplicates will be submitted for biological testing.

5.3 Sediment Toxicity Tests

The suite of biological tests is summarized in Table 5-1 and will consist of the following tests:

- Acute 10-day Amphipod Mortality (*Eohaustorius estuarius*, *Rhepoxynius abronius* or *Ampelisca abdita*);
- Acute 48-hour Larval Mortality/Abnormality (*Dendraster excentricus*, or *Mytilus* (*edulis*) *galloprovincialis*); and
- Chronic 20-day Juvenile Polychaete (*Neanthes arenoceodentata*).

The final selection of bioassay species will be approved by the PSDDA agencies. Some of the bioassay species show a sensitivity to high percentages of fine grained sediments. Some of the historic sediment samples located near the proposed coring locations contain large proportions of fines. It is possible some samples will contain more than 30% clay. Bioassay tests performed on sediment collected from cores with high clay content must use bioassay organisms that are insensitive to high fines content.

Other historical data collected from stations contained in the site DMMUs tend to be silty sand. If sediment conditions have not changed, bioassay tests performed on sediment collected from cores containing silty sand may use bioassay organisms that are not sensitive to sediments with high percentages of fines.

5.3.1 Species Selection

Amphipod Test

The amphipod *Rhepoxynius abronius* has demonstrated sensitivity to high percent fines in sediments, particularly high clay content sediments, and has exhibited mortalities greater than 20 percent in clean, reference area sediments (DeWitt et al., 1988; Fox, 1993). *Eohaustorius estuaries* has also exhibited sensitivity to high clay content (>30%) despite being relatively insensitive to salinity changes and other effects of grain size. *E. estuarius* will be the preferred amphipod species unless clays are greater than 30 percent clay. *A. abdita* is relatively insensitive to grain size up to concentrations of fines greater than 60 percent (USACE, 2000). If clay is greater than 30% and fines are greater than 60 percent, *A. abdita* will be the preferred amphipod test species. If clay is more than 30% and fines are less than 60%, *R. abronius*

will be used for testing. Table 5-1 summarizes the preferred bioassay test organisms for each DMMU composite sample.

Larval Test

For the sediment larval test, adults must be collected in spawning condition or must be induced to spawn in the laboratory. Therefore, seasonality plays a role in selecting a test organism. The preferred species for larval testing is the sand dollar *Dendraster excentricus*. According to the Users Manual for the PSDDA program, *D. excentricus* spawns naturally in Puget Sound from April through December. Larvae of *D. excentricus* do not show an adverse response to increasing silt and clay fractions, and under conditions of expected high silts and clay, the sand dollar test is preferable (EPA, 1993). The bioassay laboratory has had success inducing spawning in *D. excentricus*, however, if spawning is unable to be induced, another species deemed acceptable for test sediments containing at least 60% fines is *Mytilus* (*edulis*) *galloprovincialis*. Although they spawn naturally in Puget Sound between March and July, (USACE, 2000), AMEC bioassay laboratory has had success inducing spawning in *M. galloprovincialis*. Table 5-1 indicates preferred larval bioassay test organism for each DMMU sample.

Prior to initiating bioassay testing, sediment grain size and interstitial salinity will be determined to confirm selection of the appropriate test species. If there is headspace in the jars, nitrogen will be added prior to storage (PSEP, 1995).

5.3.2 Procedures

Amphipod Bioassay

This test involves exposing the amphipod *Rhepoxynius abronius* to test sediment for ten (10) days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. Amphipod mortality must meet the performance requirements defined in Table 5-2.

Sediment Larval Bioassay

This test monitors larval development of a suitable echinoderm or bivalve species in the presence of test sediment. The test is run until the appropriate stage of development is achieved in a sacrificial seawater control (PSDDA MPR-Phase II, pp. 5-20). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality.

Performance standards of the larval test are defined in Table 5-2. Initial counts will be made for a minimum of five 10-ml aliquots. Final counts for seawater control, reference sediment and test sediment will be made on 10-ml

aliquots. The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) that is determined by the developmental stage of organisms in a sacrificial seawater control (PSDDA MPR Phase II, page 5-20).

Ammonia and sulfides toxicity may interfere with test results for this bioassay. Aeration will be conducted throughout the test to minimize these effects.

Neanthes Growth Test

This test utilizes the polychaete *Neanthes arenaceodentata*, in a 20-day growth test. The growth rate of organisms exposed to test sediments is compared to the growth rate of organisms exposed to a reference sediment. Performance requirements for this test are defined in Table 5-2.

5.3.3 Negative Controls

Negative control sediments are used in the amphipod and Neanthes bioassays to check laboratory performance. Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low mortality. The sediment larval test utilizes a negative seawater control rather than a control sediment. The negative control to be used for the sediment toxicity test will be a clean control (i.e., inert material with site seawater) or native sediment where the organisms reside. Bioassay performance standards for negative controls are identified on Table 5-2.

5.3.4 Reference Sediment

Reference sediments will also be included with each bioassay. Reference sediments provide toxicity data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size and total organic carbon. Bioassay testing requires that test sediments be matched and tested simultaneously with an appropriate PSDDA-approved reference sediment to factor out sediment grain size effects on bioassay organisms.

One or two reference samples will be collected from Samish Bay or a similar reference site in Washington if substantially different grain sizes are encountered in the DMMU composite samples. Reference sediments will be collected using a 0.1-square-meter stainless van Veen grab sampler deployed by boat. Upon reaching the designated reference sediment location, a test grab sample will be collected and a subsample will be wet-sieved to determine grain size. If the grain size is not appropriate, the vessel position will be adjusted and another test grab will be collected. This procedure will be conducted until sediments with the proper grain size have been located. Multiple grab samples will then be taken until enough reference sediment is

collected. A subsample of the final composite will be wet-sieved to verify the appropriate grain size.

Locations of reference station coordinates will be reported, with an accuracy of ± 3 meters. Reference sediment samples will also be tested for total solids, total volatile solids, total organic carbon, grain size, ammonia, and sulfides. Performance standards for bioassay testing with reference sediment are listed in Table 5-2.

5.3.5 Replication

Five laboratory replicates of test sediments, reference sediments, and negative controls will be run for each bioassay.

5.3.6 Positive Controls

A positive control will be run for each bioassay. The positive control to be used for the sediment toxicity test will be a toxic control in which a reference toxicant is used to establish the relative sensitivity of the test organism. Cadmium chloride will be the positive control reference toxicant used for the amphipod and juvenile polychaete bioassays. Copper sulfate will be the positive control reference toxicant used for the bivalve larvae bioassay. In addition, a water-only ammonia reference toxicant using measured ammonia concentrations will be used for the bivalve larvae bioassay, and a 10-day ammonia-spiked sediment test will be used as a positive control for the amphipod bioassay.

5.3.7 Water Quality Monitoring

Bioassays require that proper water quality conditions be maintained to ensure survival of the organisms, and to ensure that undue stress is not exerted on the organisms unrelated to test sediments. Daily water quality measurements include salinity, temperature, pH, and dissolved oxygen for the amphipod and sediment larval tests. These measurements will be made every three days for the *Neanthes* bioassay. Ammonia and total sulfide concentrations in both porewater and overlying water will be measured at test initiation and termination for all three tests. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls).

For the amphipod test, according to DMMP guidance implemented in the 2002 clarification paper (EPA, 2002), coordination with the DMMO should occur prior to testing regarding the need for purging if interstitial ammonia concentrations approach 30 mg/L total ammonia for *A. abdita* or *R. abronius* testing. If a value of one half of the threshold value for purging (15 mg/L total ammonia) for either amphipod species test is exceeded, an ammonia reference toxicant test (LC50) test must be performed to assist with test interpretation. Purging methods will follow that listed in the DMMP

clarification paper (EPA, 2002), and ammonia will be reported for initial bulk sediment interstitial ammonia, total and unionized ammonia at test initiation (day 0) and day 10, overlying water ammonia should be reported as part of the regular daily water quality measurements, and LC50 water only experiment data should be reported.

Parameter measurements must be within the limits specified for each bioassay. Interstitial salinity will be documented at test initiation for the amphipod bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

5.4 Interpretation

Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. Test interpretation will follow the guidelines established in the PSDDA Management Plan Report — Phase II and the minutes of the dredging year 1991 annual review meeting for the *Neanthes* bioassay, as modified by subsequent annual review proceedings and workshops. Current endpoints are those provided in the PSDDA Users Manual (February, 2000), which are reproduced in Table 5-2 as they pertain to the non-dispersive disposal sites.

5.5 Bioaccumulation Testing

Bioaccumulation testing will be performed if any COC exceeds a bioaccumulation trigger (BT). An adult bivalve (*Macoma nasuta*) and an adult polychaete (*Nereis virens*, *Arenicola marina*, or *Nephtys caecoides*) will be used for bioaccumulation testing. Test organisms and exposure periods will be coordinated with the DMMP prior to testing.

5.6 Laboratory Reporting Requirements

A written report will be prepared by the biological laboratory documenting the activities associated with the samples. The laboratory will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. Bioassay laboratories must meet the DMMP QA2 deliverable requirements so that data may be incorporated into the SEDQUAL database. A list of QA2 deliverables is summarized in Attachment C. Elements of the report will include:

- A discussion of any deviations from methodology or problems with the process and procedures of analyses;
- Test methods used for bioassay testing and statistical analyses;

- Sources and collection locations of all bioassay organisms;
- Results for survival, growth, reburial, abnormalities, water quality parameters, reference toxicant, and statistical analyses;
- Original data sheets for water quality, survival, growth, reburial, abnormalities, reference toxicant, and statistics;
- Original quality control checklists;
- Custody records; and
- Results of the laboratory bioassay analyses and QA/QC results, reported both in hard copy and in the USACE Dredged Analysis Information System (DAIS) data format. Raw data will be legibly written or typed. If data are unintelligible and cannot be interpreted by the DMMP agencies, a retest may be required.

6 Reporting and Deliverables

RETEC will document all activities associated with collection, compositing, transportation, and analysis of samples. Data summary results will be presented in tabular form using maps and figures as appropriate. Laboratory analytical results/reports will be included as appendices along with the data validation reports. Results will be presented in a final report and discussed relative to the objectives of this sediment sampling effort. The results section will include, at a minimum, a discussion of the following issues:

- **Sample Collection and General Observations**
  - Type of sampling equipment used;
  - Protocols and procedures used during sampling and testing and an explanation of any deviations from the sampling plan protocols;
  - Descriptions and core logs of each sample, including penetration and recovery depths, compositing intervals, mudline elevation, grain size, and geologic contacts;
  - Methods used to locate the sampling positions (within an accuracy of ±2 m);
  - Maps and tables identifying locations where the sediment samples were collected, reported in latitude and longitude to the nearest tenth of a second, and in State Plane Coordinates; and
  - A plan view of the project site showing the shoreline, bathymetry, and actual sampling locations.
- **Analytical Testing Results**
  - Chain of custody procedures used, and explanation of any deviations from the sampling plan procedures.
- **Tabular Summary**
  - Tabular summary of chemical (dry weight) and physical data with comparison to SMS and PSDDA criteria. Any PSDDA chemical exceedances will be highlighted and discussed. Trends in contaminant levels will be discussed, if apparent;
  - Biological testing results, with comparisons to PSDDA biological testing criteria. Any failures of PSDDA toxicity and/or bioaccumulation criteria will be highlighted and discussed; and
  - Final QA Report, which will identify any field and laboratory activities that deviated from the approved sampling plan and the referenced protocols. The QA Report will assess the overall validity of the collected data.

7 References

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Tables

Table 3-1 I&J Waterway Dredging Coring Plan

DMMU [1]	Dredge Prism: Approximate Dredge Volume (cy)	Dredge Prism: Approximate Dredge Surface Area (sq. yd)	Proposed Sediment Core ID	Core Section Designations and Depths	Length of Sediment Cores [1]	WGS [3]: Latitude	WGS [3]: Longitude	NAD 83 [4]: Easting	NAD 83 [4]: Northing	Compositing Scheme [5]: Surface Sediment Composite ID	Compositing Scheme [5]: Subsurface Sediment Composite	Compositing Scheme [5]: z-sample ID
1	3,140	3,010	IJ-10*	A -16.0 to -20.0	5	48.76606909	121.0027696	1599551	644281.8	IJ-C1-S1	-	IJ-C8-Z
				Z -20.0 to -21.0							-	
			IJ-11	A -17.0 to -20.0	4	48.76597492	121.0026361	1599583	644247.4		-	
				Z -20.0 to -21.0							-	
			IJ-12	A -17.0 to -20.0	4	48.76641596	121.002231	1599681	644408.1		-	
				Z -20.0 to -21.0							-	
			IJ-13	A -17.5 to -20.0	3.5	48.76632611	121.0021027	1599712	644375.2		-	
				Z -20.0 to -21.0							-	
2	3,120	3,120	IJ-14	A -17.0 to -20.0	4	48.76591002	121.0025185	1599611	644223.6	IJ-C2-S1	-	IJ-C9-Z
				Z -20.0 to -21.0							-	
			IJ-15	A -15.0 to -18.0	4	48.76592568	121.002187	1599691	644229.2		-	
				Z -18.0 to -19.0							-	
			IJ-16*	A -15.0 to -18.0	4	48.76573708	121.0022297	1599681	644160.4		-	
				Z -18.0 to -19.0							-	
			IJ-17	A -10.0 to -13.0	4	48.76573695	121.00249	1599618	644160.5		-	
				Z -13.0 to -14.0							-	
3	3,650	3,020	IJ-18	A -17.0 to -20.0	4	48.76652813	121.0019054	1599759	644448.8	IJ-C3-S1	-	IJ-C10-Z
				Z -20.0 to -21.0							-	
			IJ-19*	A -15.0 to -19.0	5	48.76682052	121.0016769	1599815	644555.4		-	
				Z -19.0 to -20.0							-	
			IJ-20	A -16.0 to -20.0	5	48.7669563	121.0012282	1599923	644604.7		-	
				Z -20.0 to -21.0							-	
			IJ-21	A -16.5 to -20.0	4.5	48.76670102	121.0014853	1599861	644511.7		-	
				Z -20.0 to -21.0							-	
4 [2]	3580 (surface) 2240 (subsurface)	3,580	IJ-30	A -15.0 to -18.0	6	48.76712529	121.0009695	1599986	644666.2	IJ-C4-S1	IJ-C5-S2 [6]	IJ-C11-Z
				B -18.0 to -20.0								
				Z -20.0 to -21.0								
			IJ-31	A -16.0 to -19.0	5	48.76726796	121.0007749	1600033	644718.2			
				B -19.0 to -20.0								
				Z -20.0 to -21.0								
			IJ-32*	A -1.5 to -4.5	5.5	48.76729717	121.0004748	1600105	644728.7			
				B -4.5 to -6.0								
				Z -6.0 to -7.0								
			IJ-33	A -9.0 to -12.0	7	48.76709502	121.0005005	1600099	644654.9			
				B -12.0 to -15.0								
				Z -15.0 to -16.0								
5	3,760	3,010	IJ-22*	A -16.5 to -20.0	4.5	48.76611901	121.0020832	1599716	644299.7	IJ-C6-S1	-	IJ-C12-Z
				Z -20.0 to -21.0							-	
			IJ-23	A -16.5 to -20.0	4.5	48.76639898	121.0016394	1599824	644401.6		-	
				Z -20.0 to -21.0							-	
			IJ-24	A -16.0 to -20.0	5	48.76668249	121.0013756	1599887	644504.9		-	
				Z -20.0 to -21.0							-	
			IJ-25*	A -16 to -20.0	5	48.76689979	121.0010149	1599975	644584		-	
				Z -20.0 to -21.0							-	
6	2,540	2,540	IJ-26*	A -14.0 to -18.0	5	48.76605603	121.0019873	1599739	644276.6	IJ-C7-S1	-	IJ-C13-Z
				Z -18.0 to -19.0							-	
			IJ-27	A -15.0 to -19.0	5	48.7663514	121.0016007	1599833	644384.2		-	
				Z -19.0 to -20.0							-	
			IJ-28	A -7.0 to -9.0	3	48.7665834	121.0011115	1599951	644468.6		-	
				Z -9.0 to -10.0							-	
			IJ-29	A -10.0 to -12.0	3	48.7668507	121.0008110	1600024	644566		-	
				Z -12.0 to -13.0							-	
Total	**22,030**	**18,280**										

Notes:

[1] DMMUs 1, 2, and 4 are contingent on surface sediment sampling results conducted as part of the I&J Waterway RI/FS.

[2] DMMU 4 is composed of a surface unit and a subsurface unit. DMMU-4A is the surface unit composited from cores IJ-30A, IJ-31A, IJ-32A, and IJ-33A. DMMU-4B is the subsurface unit composited from cores IJ-30B, IJ-31B, IJ-32B, and IJ-33B.

[3] World Geodetic System, 1984 (datum NAD 83)

[4] North American Datum of 1983, Washington State Plane North

[5] Surface cores (labelled A) will be composited into the S-1 sample. Subsurface cores (labelled B) will be composited into the S-2 sample. Z-samples will be archived for chemistry analysis

[6] Cores IJ-30B, IJ-31B, IJ-32B, and IJ-33B will be composited into sample IJ-C5-S2.

* Randomly selected for sulfide and volatile subsampling

Table 3-2 Sample Collection Requirements

DMMU	Sediment Composite ID [1]	Analysis											
		Total Sulfide[2]	Volatile Organics[2]	Total Solids, Total Volatile Solids, Total Organic Carbon, Ammonia	SVOCs	Pesticides/ PCBs	Metals	Bulk Butyl tin	Butyl tin porewater	Grain size	Archived Chemistry Sample	Bioassay	Bioac-cumulation
1	IJ-C1-S1	IJ-10	IJ-10	X	X	X	X	X	X	X	X	X	X
2	IJ-C2-S1	IJ-16	IJ-16	X	X	X	X	X	X	X	X	X	X
3	IJ-C3-S1	IJ-19	IJ-19	X	X	X	X	X	X	X	X	X	X
4A	IJ-C4-S1	IJ-32	IJ-32	X	X	X	X	X	X	X	X	X	X
4B	IJ-C5-S2	IJ-32	IJ-32	X	X	X	X	X	X	X	X	X	X
5	IJ-C6-S1	IJ-25	IJ-25	X	X	X	X	X	X	X	X	X	X
6	IJ-C7-S1	IJ-26	IJ-26	X	X	X	X	X	X	X	X	X	X
Samish Bay													
	REF-1	X		X						X		X	X
	REF-2	X		X						X		X	X

[1] Z samples will be archived with the potential for analysis of volatiles, SVOCs, pesticides/PCBs, and metals.

[2] Volatiles and sulfides are sampled prior to compositing from randomly selected cores.

Note: One MS/MSD sample will be collected for analysis of volatiles, SVOCs, pesticides/PCBs, and metals.

Table 3-3 PSDDA Sample Holding Times and Bottle Requirements

Analytical Parameter	Holding Time 4 ℃	Holding Time -18 ℃	Sample Bottle Size and Preservation
Total Solids, Total Volatile Solids, Total Organic Carbon	14 days [4]	6 months	4-oz. glass
Ammonia	7 days	NA [1]	
Total Sulfide	7 days dark	NA [1]	4-oz. glass w/ zinc acetate
Volatile Organics	14 days [4]	NA [1]	4-oz. glass w/ septa top
Semivolatile Organics	14 days [2, 4]	1 year [2]	16-oz. glass
Pesticides/PCBs	14 days [4]	NA [1]	8-oz. glass
Metals	6 months	2 years	4-oz. glass
Mercury	—	28 days	
Grain Size	6 months	not recommended [3]	16-oz. glass
Archive Sample (Chemistry)	—	1 year	8-oz. glass
Bioassay	8 weeks	NA	(2) - 2-liter plastic headspace free
Bioaccumulation	8 weeks	NA	20 1-L glass jars

Notes:

[1] Freezing samples will cause breakage of sample jar, which are completely filled with no headspace for these analyses.

[2] Holding time until extraction; extracts must be processed within 40 days.

[3] Samples must not be frozen or dried before analysis.

[4] Allen *et al.* (1991) recommended 14-day holding time at 4 ℃.

Table 4-1 Sediment Chemical Analysis Methods, Target Detection Limits, and Criteria

Parameter	Preparation Method	Analysis Method	Target MDL [1]	SMS Criteria [2]		PSDDA Criteria [14]		
				SQS	MCUL	SL	BT	ML
Conventionals								
Total Solids (%)	--	PSEP [4a]	0.1	nv	nv	nv	nv	nv
Total Volatile Solids(%)	--	PSEP [4a]	0.1	nv	nv	nv	nv	nv
Total Organic Carbon (%)	--	PSEP [4b]	0.1	nv	nv	nv	nv	nv
Ammonia (mg/kg)	--	EPA 350.1 [5]	1	nv	nv	nv	nv	nv
Total Sulfides (mg/kg)	--	PSEP [4a]	10	nv	nv	nv	nv	nv
Grain Size (%)	--	PSEP [4a]	1	nv	nv	nv	nv	nv
Metals								
Antimony	Appendix D [4]	GFAA [6]	5	nv	nv	150	nv	200
Arsenic	Appendix D [4]	ICP [7]	5	57	93	57	507.1	700
Cadmium	Appendix D [4]	ICP [7]	0.2	5.1	6.7	5.1	11.3	14
Chromium	Appendix D [4]	ICP [7]	0.5	260	270	nv	267	nv
Copper	Appendix D [4]	ICP [7]	0.2	390	390	390	1,027	1,300
Lead	Appendix D [4]	ICP [7]	2	450	530	450	975	1,200
Mercury	MER [8]	7471 [8]	0.05	0.41	0.59	0.41	1.5	2.3
Nickel	Appendix D [4]	ICP [7]	0.01	nv	nv	140	370	370
Silver	Appendix D [4]	ICP [7]	0.3	6.1	6.1	6.1	6.1	8.4
Zinc	Appendix D [4]	ICP [7]	1.0	410	960	410	2,783	3,800
LPAH								
Naphthalene	3550 [9]	8270 [10]	0.02	99	170	2.1	nv	2.4
Acenaphthylene	3550 [9]	8270 [10]	0.02	66	66	0.56	nv	1.3
Acenaphthene	3550 [9]	8270 [10]	0.02	16	57	0.5	nv	2
Fluorene	3550 [9]	8270 [10]	0.02	23	79	0.54	nv	3.6
Phenanthrene	3550 [9]	8270 [10]	0.02	100	480	1.5	nv	21
Anthracene	3550 [9]	8270 [10]	0.02	220	1200	0.96	nv	13
2-Methylnaphthalene	3550 [9]	8270 [10]	0.02	38	64	0.67	nv	1.9
Total LPAH				370	780	5.2	nv	29
HPAH								
Fluoranthene	3550 [9]	8270 [10]	0.02	160	1200	1.7	4.6	30
Pyrene	3550 [9]	8270 [10]	0.02	1000	1400	2.6	11.98	16
Benzo(a)anthracene	3550 [9]	8270 [10]	0.02	110	270	1.3	nv	5.1
Chrysene	3550 [9]	8270 [10]	0.02	110	460	1.4	nv	21
Benzofluoranthenes	3550 [9]	8270 [10]	0.02	230	450	3.2	nv	9.9
Benzo(a)pyrene	3550 [9]	8270 [10]	0.02	99	210	1.6	nv	3.6
Indeno(1,2,3-cd)pyrene	3550 [9]	8270 [10]	0.02	34	34	0.6	nv	4.4
Dibenzo(a,h)anthracene	3550 [9]	8270 [10]	0.02	12	33	0.23	nv	1.9
Benzo(g,h,i)perylene	3550 [9]	8270 [10]	0.02	31	78	0.67	nv	3.2
Total HPAH				960	5300	12	nv	69
Chlorinated Hydrocarbons								
1,3-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	nv	nv	0.17	1.241	nv
1,4-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	3.1	9	0.11	nv	0.12
1,2-Dichlorobenzene	P&T [11]	8240 [11]	0.0032	2.3	2.3	0.035	nv	0.11
1,2,4-Trichlorobenzene	3550 [9]	8270 [10]	0.006	0.81	1.8	0.031	nv	0.064
Hexachlorobenzene	3550 [9]	8270 [10]	0.012	0.38	2.3	0.022	0.168	0.23
Phthalates								
Dimethyl phthalate	3550 [9]	8270 [10]	0.02	53	53	0.1	nv	1.4
Diethyl phthalate	3550 [9]	8270 [10]	0.02	61	110	0.2	nv	1.2
Di-n-butyl phthalate	3550 [9]	8270 [10]	0.02	220	1700	1.4	nv	5.1
Butyl benzyl phthalate	3550 [9]	8270 [10]	0.02	4.9	64	0.06	nv	0.97
Bis(2-ethylhexyl)phthalate	3550 [9]	8270 [10]	0.02	47	78	1.3	nv	8.3
Di-n-octyl phthalate	3550 [9]	8270 [10]	0.02	58	4500	6.2	nv	6.2
Phenols								
Phenol	3550 [9]	8270 [10]	0.020	0.42	1	0.42	nv	1.2
2-Methylphenol	3550 [9]	8270 [10]	0.020	0.063	0.063	0.063	nv	0.077
4-Methylphenol	3550 [9]	8270 [10]	0.020	0.67	0.67	0.67	nv	3.6
2,4-Dimethylphenol	3550 [9]	8270 [10]	0.020	0.029	0.029	0.029	nv	0.21
Pentachlorophenol	3550 [9]	8270 [10]	0.100	0.36	0.69	0.4	0.504	0.69
Miscellaneous Extractables								
Benzyl alcohol	3550 [9]	8270 [10]	0.020	0.057	0.073	0.057	nv	0.87
Benzoic acid	3550 [9]	8270 [10]	0.200	0.65	0.65	0.65	nv	0.76
Miscellaneous Extractables								
Dibenzofuran	3550 [9]	8270 [10]	0.020	15	58	0.54	nv	1.7
Hexachloroethane	3550 [9]	8270 [10]	0.020	nv	nv	1.4	nv	14
Hexachlorobutadiene	3550 [9]	8270 [10]	0.020	3.9	6.2	0.029	nv	0.27
N-Nitrosodiphenylamine	3550 [9]	8270 [10]	0.020	11	11	0.028	nv	0.13
Volatile Organics								
Trichloroethene	P&T [11]	8260 [12]	0.0032	nv	nv	0.16	nv	1.6
Tetrachlorethene	P&T [11]	8260 [12]	0.001	nv	nv	0.057	nv	0.21
Ethylbenzene	P&T [11]	8260 [12]	0.001	nv	nv	0.01	nv	0.05
Total xylenes	P&T [11]	8260 [12]	0.001	nv	nv	0.04	nv	0.16
Pesticides								
DDT	3550 [9]	8081 [13]	0.003	nv	nv	0.0069	0.05	0.069
Aldrin	3550 [9]	8081 [13]	0.0017	nv	nv	0.01	nv	nv
alpha-chlordane	3550 [9]	8081 [13]	0.0017	nv	nv	0.01	0.037	nv
dieldrin	3550 [9]	8081 [13]	0.0023	nv	nv	0.01	nv	nv
heptachlor	3550 [9]	8081 [13]	0.0017	nv	nv	0.01	nv	nv
alpha-BHC	3550 [9]	8081 [13]	0.0017	nv	nv	nv	0.01	nv
gamma-BHC (Lindane)	3550 [9]	8081 [13]	0.0017	nv	nv	0.01	nv	nv
Total PCBs	3550 [9]	8081 [13]	0.160	12	65	0.13	38	3.1

Notes:

1 Method detection limit (MDL) values - from Analytical Resources, Inc. (ARI) laboratory - expressed on a dry weight

Note that some SMS criteria are expressed as the carbon-normalized value (ppm TOC) - see note 2 below - direct comparison to the detection limits cannot be made without a TOC conversion factor.

2 Sediment Management Standards (SMS), includes Sediment Quality Levels (SQL) [low screen] and Maximum Chemical Criteria (MCUL) [high screen] expressed as mg/kg dw; The following are TOC normalized: LPAH, HPAH, Chlorinated hydrocarbons, phthalates, misc.extractables, and PCBs.

3 Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Organic Compounds in Puget Sound, 1996. TBT extraction method is Krone, 1988.

4a Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound, 1986.

4b Puget Sound Estuary Program (PSEP), Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound, 1996.

5 Plumb, 1981. EPA/U.S. Army Corps of Engineers procedures for measuring ammonia.

6 Graphite Furnace Atomic Absorption (GFAA) Spectrometry. SW-846. EPA, 1986.

7 Inductively Coupled Plasma (ICP) Emission Spectrometry. SW-846. EPA, 1986.

8 Mercury Digestion and Cold Vapor Atomic Absorption (CVAA) Spectrometry, Method 7471. SW-846. EPA 1986.

9 Sonication Extraction of Sample Solids, Method 3550 (Modified). SW-846. EPA, 1986. Method is modified to add matrix spikes before, rather than after, the dehydration step.

10 GCMS Capillary Column, Method 8270. SW-846. EPA, 1986.

11 Purge and Trap Extraction and GCMS Analysis, Method 8240. EPA, 1986.

12 Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique, Method 8260A. EPA, 1994.

13 Organochlorine Pesticides and PCBs as Arochlors by Gas Chromatography and Capillary Column Technique, Method 8081. EPA, 1994.

14 Puget Sound Dredged Disposal Analysis (PSDDA) criteria, includes Screening Level (SL), Bioaccumulation Trigger

Table 4-2 Minimum Laboratory QA/QC Requirements

Analysis Type	Total Possible Samples	Laboratory QA/QC				
		Method Blanks[1]	Repli-cates[2]	CRM[3]	Matrix Spike[1]	Surro-gates[4]
Volatile Organics[5, 6]	16	✓	✓[2]		✓	✓
Semivolatiles[5, 6]	16	✓	✓[2]	✓[7]	✓	✓
Pesticides/PCBs[5, 6]	16	✓	✓[2]	✓[7]	✓	✓
Metals	16	✓	✓	✓	✓	
Ammonia	16	✓	✓			
Total Sulfides	16	✓	✓			
Total Organic Carbon	16	✓	✓	✓		
Total Solids	16		✓			
Total Volatile Solids	16		✓			
Grain Size	16		✓			

Notes:

[1] Frequency of Analysis (FOA) = 5% or one per batch, whichever is more frequent

[2] Matrix spike duplicate will be run

[3] Certified Reference Material

[4] Surrogate spikes required for every sample, including matrix spiked samples, blanks, and reference materials

[5] Initial calibration required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria.

[6] Ongoing calibration required at the beginning of each work shift, every 10-12 samples, or every 12 hours (whichever is more frequent), and at the end of each shift.

[7] Sequim Bay Reference (one replicate)

Table 5-1 Proposed Bioassay Test Organisms for PSDDA Testing

DMMU	Surface Sediment Composite ID	Anticipated Grain Size [1]	Amphipod [2]	Larval Test		*Neanthes arenaceodentata*
			Eohaustorius estuarius	*Dendraster excentricus*	*Mytilus galloprovincialis*	
1	IJ-C1-S1	Silty sand	X	X [2]	(X) [3]	X
2	IJ-C2-S1	Silty sand	X	X [2]	(X) [3]	X
3	IJ-C3-S1	Clayey silt	X	X [2]	(X) [3]	X
4A	IJ-C4-S1	Silty sand	X	X [2]	(X) [3]	X
4B	IJ-C5-S2	Silty sand	X	X [2]	(X) [3]	X
5	IJ-C6-S1	Clayey silt	X	X [2]	(X) [3]	X
6	IJ-C7-S1	Sandy silt	X	X [2]	(X) [3]	X
Samish Bay						
	REF-1	Silty sand	X	X [2]	(X) [3]	X
	REF-2	Clayey silt	X	X [2]	(X) [3]	X

1 Grain size estimated from historical samples collected near the proposed coring locations.

2 If clays are greater than 30% and fines are greater than 60%, *Ampelisca abdita* will be used for the amphipod test. If clays are greater than 30% and fines are less than 60%, *Rhepoxynius abronius* will be used.

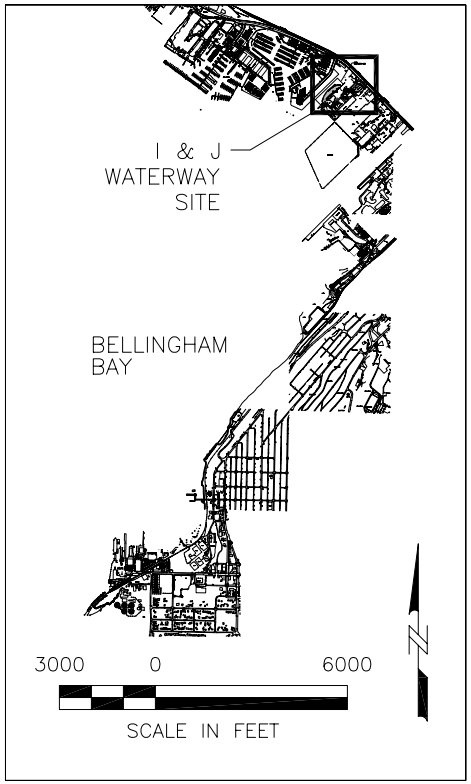
3 *Mytilus galloprovincialis* is the preferred species, but if spawning is unable to be induced, *Dendraster excentricus* will be used.

Table 5-2 PSDDA Bioassay Evaluation Guidelines

Bioassay	Negative Control Performance Standard	Reference Sediment Performance Standard	Dispersive Disposal Site Interpretation Guidelines		Nondispersive Disposal Site Interpretation Guidelines	
			1-hit Rule	2-hit Rule	1-hit Rule	2-hit Rule
Amphipod	$M_C \leq 10\%$	$M_R - M_C \leq 20\%$	$M_T - M_C > 20\%$ and M_T vs M_R SD ($p = 0.05$) and		$M_T - M_C > 20\%$ and M_T vs M_R SD ($p = 0.05$) and	
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Larval	$N_C \div I \geq 0.70$	$N_R \div N_C \geq 0.65$	$N_T \div N_C < 0.80$ and N_T/N_C vs N_R/N_C SD ($p = 0.10$) and		$N_T \div N_C < 0.80$ and N_T/N_C vs N_R/N_C SD ($p = 0.10$) and	
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
Neanthes growth	$M_C \leq 10\%$ and MIGC ≥ 0.38	$M_R \leq 20\%$ and 'MIGR ÷ MIGC ≥ 0.80	$MIG_T \div MIG_C < 0.80$ and MIG_T vs MIG_R SD ($p = 0.05$) and		$MIG_T \div MIG_C < 0.80$ and MIG_T vs MIG_R SD ($p = 0.05$) and	
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

Notes:
I - Initial count
M - Mortality
MIG - Mean individual growth rate
N - Normals
NOCN - No other conditions necessary
SD - Statistically different
Subscripts:
C - Negative control
R - Reference sediment
T - Test sediment

Figures



RI/FS
INVESTIGATION AREA

CURRENT EXTENT OF
SMS CHEMICAL AND
BIOLOGICAL EXCEEDANCES

I & J WATERWAY

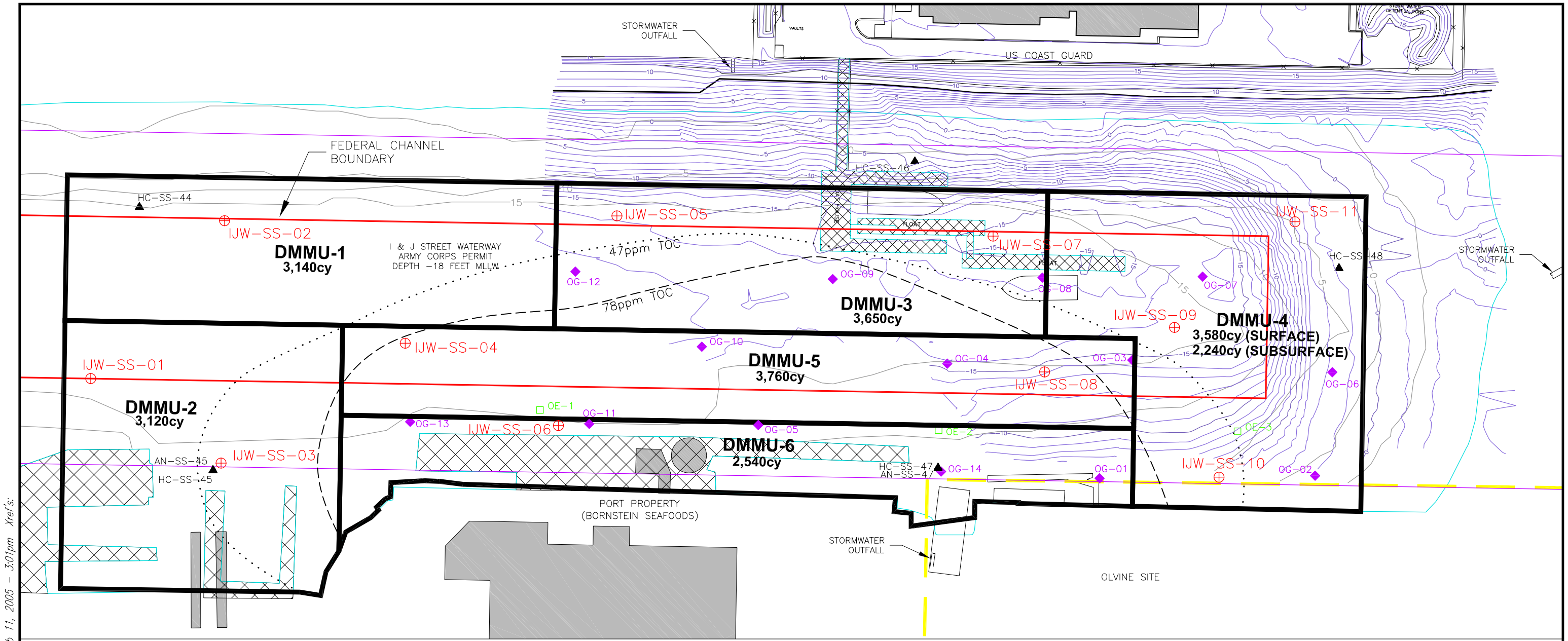
Pipe
Paved
Conc
FH
Rails Obscured
Dock
Unpaved Parking
Storage
Boat Storage
Stack
RTV

N
100
0
200
SCALE IN FEET

NOTE:
THE INVESTIGATION AREA MAY BE EXPANDED IF CONTAMINATION APPEARS TO EXTEND BEYOND THE CURRENT INVESTIGATION AREA.

RETEC

I&J WATERWAY RI/FS WORK PLAN PORTB-18449-100	**SITE LOCATION MAP**
DATE: 06/15/05 DRWN: A.S./SEA	**FIGURE 1-1**



LEGEND

- DOCKS OR PIERS
- EXISTING STRUCTURES
- EXISTING SHORELINE
- BATHYMETRY (25)
- CURRENT OLIVINE UPLAND SITE BOUNDARY
- I & J WATERWAY BOUNDARY

- ▲ HC-SS-47 — WHATCOM WATERWAY STATION SEDIMENT GRAB SAMPLE (HART CROWSER, 1997)
- ◆ OG-10 — 2001 RETEC STATION SURFACE SEDIMENT GRAB SAMPLE
- □ OE-1 — PRE-REMEDIAL DESIGN TESTING STATION (COMPOSITE FOR LEACHING TESTS 2002) (SAMPLE TO BE COLLECTED 0-3FT BELOW MUDLINE)
- ▲ AN-SS-47 — ANCHOR BIOASSAY SAMPLE LOCATION
- ⊕ IJW-SS-04 — PROPOSED RI/FS SAMPLE LOCATION

- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL SQS CRITERIA (47ppm TOC)
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL MCUL CRITERIA (78ppm TOC)

NOTE:

EXCEEDENCES OF SQS BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-45. EXCEEDENCES OF MCUL BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-47.

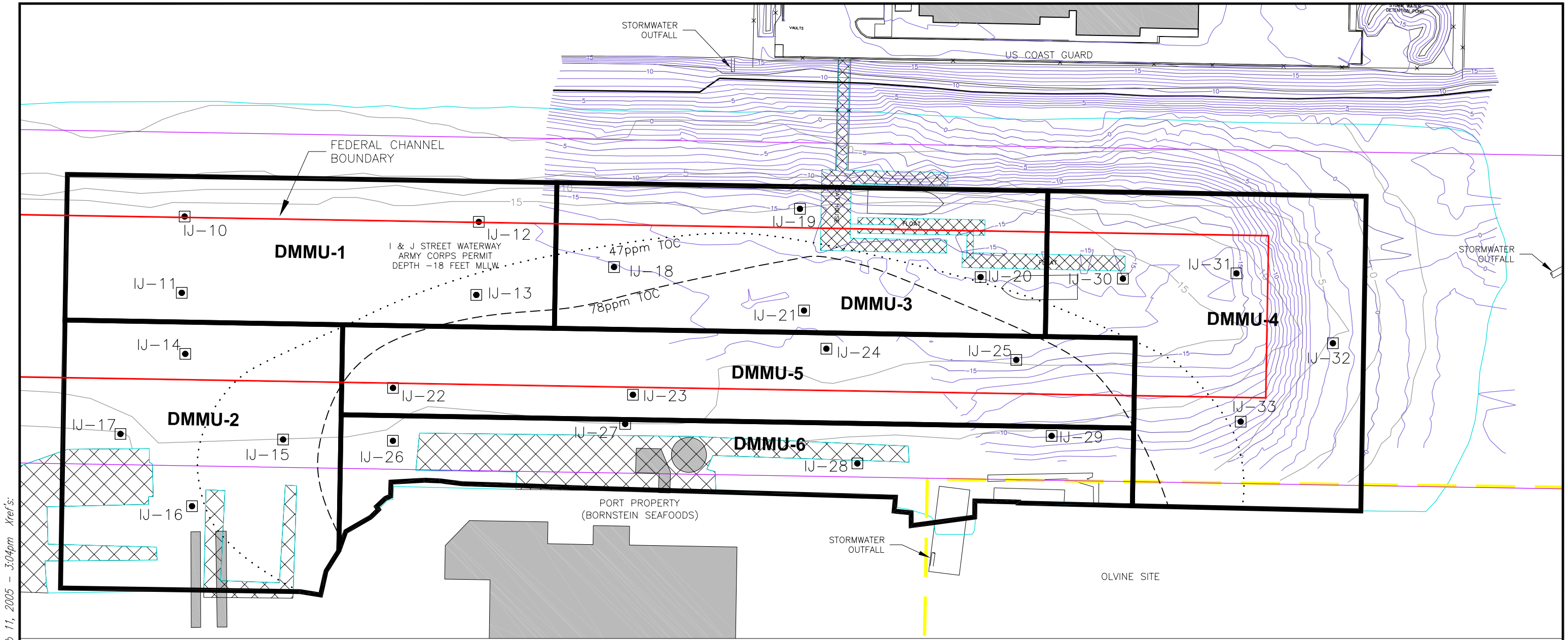
30 0 60

SCALE IN FEET

RETEC

I & J WATERWAY PSDDA SAMPLING AND ANALYSIS PLAN PORTB-18449-100			PROPOSED I & J WATERWAY DREDGING AREAS
DATE: 02/11/05	DRWN: A.S./SEA		FIGURE 1-2

File: H:\18449\18449S006.dwg Layout: Layout1 User: astenberg Plotted: Feb 11, 2005 - 3:01pm Xref's:



LEGEND

- DOCKS OR PIERS
- EXISTING STRUCTURES
- EXISTING SHORELINE
- BATHYMETRY (25)
- CURRENT OLIVINE UPLAND SITE BOUNDARY
- I & J WATERWAY BOUNDARY
- IJ-27 SUBSURFACE CORE LOCATIONS
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL SQS CRITERIA (47ppm TOC)
- bis(2-Ethylhexyl)phthalate EXCEEDS CHEMICAL MCUL CRITERIA (78ppm TOC)

NOTE:

EXCEEDENCES OF SQS BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-45. EXCEEDENCES OF MCUL BIOLOGICAL EFFECTS CRITERIA WERE PREVIOUSLY DETECTED AT STATION AN-SS-47.

30 0 60

SCALE IN FEET

RETEC

I & J WATERWAY PSDDA SAMPLING AND ANALYSIS PLAN PORTB-18449-100			PROPOSED I & J WATERWAY DMMU SAMPLING LOCATIONS
DATE: 02/11/05	DRWN: A.S./SEA		FIGURE 3-1

File: H:\18449\184495005.dwg Layout: Layout1 User: astenberg Plotted: Feb 11, 2005 - 3:04pm Xref's:

Attachment A

Summary of Historical Analytical Data

Table A-1 Summary of Valid Historical Analytical Data for Surface Sediments

Station			HC-SS-45	HC-SS-46	HC-SS-47	HC-SS-48	HC-SC-85	AN-SS-84	AN-SS-45	AN-SS-47
Sampling Date			9/4/1996	9/5/1996	9/4/1996	9/5/1996	9/9/1996	10/27/1998	10/27/1998	10/27/1998
Datum			NAD-83	NAD-83	NAD-83	NAD-83	NAD-83	Corresponds approximately to HC-SC-84	Corresponds approximately to HC-SS-45	Corresponds approximately to HC-SS-47
Easting			1239793	1239963	1240107	1240194	1240186	Surface Grab	Surface Grab	Surface Grab
Northing			644131	644572	644449	644711	644711	NT	NT	NT
Sample Type			Surface Grab	Surface Grab	Surface Grab	Surface Grab	Surface Grab	0-10 cm	0-10 cm	0-10 cm
Reported elevation			-13.1 ft.	-7.0 ft.	-7.1 ft.	-2.3 ft.	-2.3 ft.	Anchor	Anchor	Anchor
Sampling Interval			0-10 cm	0-10 cm	0-10 cm	0-10 cm	0-10 cm	Anchor, 1999	Anchor, 1999	Anchor, 1999
Consultant	SMS Criteria		Hart Crowser	Hart Crowser	Hart Crowser	Hart Crowser	Hart Crowser			
Reference	SQS	MCUL	HC May 1997	HC May 1997	HC May 1997	HC May 1997	HC May 1997			
Conventionals										
Total Solids (%)	NV	NV	**40**	**45**	**50**	**50**	**35**	**43.3**	**39.2**	**62.2**
Total Organic Carbon (%)	NV	NV	**3.4**	**2.6**	**4**	**0.82**	**3.1**	**2.6**	**2.8**	**4.2**
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg dry)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Antimony	NV	NV	NT	NT	NT	NT	NT	NT	NT	NT
Arsenic	57	93	**11 E**	NT	**9.2 E**	**3.2 E**	**9.6 E**	NT	NT	NT
Cadmium	5.1	6.7	**1.6**	NT	**1.3**	< 0.59	**1.3**	**1 U**	**1**	**0.7 J**
Chromium	260	270	**71**	NT	**49**	**17**	**66**	NT	NT	NT
Copper	390	390	**73**	NT	**51**	**16**	**61**	NT	NT	NT
Lead	450	530	**19**	NT	**24**	**11**	**20**	NT	NT	NT
Mercury	0.41	0.59	**0.36**	**0.36**	**0.29**	< 0.13	**0.45**	**0.45**	**0.41**	**0.17 J**
Nickel	NV	NV	NT	NT	NT	NT	NT	NT	NT	NT
Silver	6.1	6.1	< 1.2	NT	< 1.0	< 0.59	< 1.3	NT	NT	NT
Zinc	410	960	**130**	NT	**190**	**51**	**120**	**106**	**138**	**137**
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.94 E**	NT	**4.00**	**6.83**	**0.68 E**	**1.4**	**3**	3.3 U
Acenaphthene	16	57	**0.47 E**	NT	**40.00**	**2.07 E**	**0.84 E**	0.77 U	**1.1**	3.3 U
Acenaphthylene	66	66	< 1.12	NT	**2.15**	**1.16 E**	< 1.42	0.77 U	**0.75**	3.3 U
Anthracene	220	1,200	**1.56**	NT	**35.00**	**5.98**	**1.16 E**	**1.6**	**6.1**	**4.3**
Fluorene	23	79	**0.94 E**	NT	**7.50**	**4.02**	**1.26 E**	**0.96**	**2.5**	3.3 U
Naphthalene	99	170	**1.53**	NT	**3.75**	**7.44**	**1.13 E**	**2**	**3.6**	3.3 U
Phenanthrene	100	480	**4.41**	NT	**30.00**	**24.39**	**7.74**	**3.8**	**10**	**11**
Total LPAHs	562	780	**8.91**	NT	**118.40**	**45.06**	**12.13**	**11**	**27**	**32**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**5.29**	NT	**42.50**	**18.29**	**4.52**	**2.4**	**13**	**12**
Benzo(a)pyrene	99	210	**3.24**	NT	**13.50**	**20.73**	**3.13**	**1.9**	**8.2**	**10**
Benzo(b)fluoranthene	230	450	**8.53 C**	NT	**35.0 C**	**20.73**	**4.52**	**2.5**	**14**	**17**
Benzo(g,h,i)perylene	31	78	**2.24 E**	NT	**5.75**	**19.51**	**2.26 E**	**1.3**	**3.1**	**4**
Benzo(k)fluoranthene	230	450	**8.53 C**	NT	**35.0 C**	**19.51**	**3.87**	**3**	**12**	**24**
Chrysene	110	460	**8.82**	NT	**47.50**	**29.27**	**8.06**	**3.8**	**19**	**31**
Dibenz(a,h)anthracene	12	33	**1.32 E**	NT	**3.75**	**9.27**	**1.0 E**	0.77 U	**1.8**	3.3 U
Fluoranthene	160	1,200	**10.29**	NT	**125.00**	**47.56**	**12.58**	**8.5**	**24**	**74**
Indeno(1,2,3-cd)pyrene	34	88	**2.24**	NT	**5.75**	**18.29**	**2.16 E**	**1.1**	**3.9**	**5.5**
Pyrene	1,000	1,400	**10.00**	NT	**117.50**	**47.56**	**12.58**	**9.2**	**54**	**100**
Total HPAHs	2,016	5,300	**51.97**	NT	**396.25**	**250.73**	**54.7**	**35.0**	**152.0**	**280.0**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**13.24**	NT	**700.00**	**25.61**	**7.1**	**4.6**	**50**	**476**
Butylbenzylphthalate	4.9	64	**0.59 E**	NT	< 1.53	**1.83 E**	< 2.81	**0.88**	**1.3**	3.3 U
Diethylphthalate	61	110	< 2.94	NT	< 2.00	< 6.34	< 3.87	0.77 U	0.71 U	3.3 U
Dimethylphthalate	53	53	< 2.53	NT	**0.73 E**	< 5.37	< 3.16	0.77 U	**0.82**	3.3 U
Di-n-Butylphthalate	220	1,700	< 1.74	NT	< 1.18	**1.34 E**	< 2.16	**1.3**	0.71 U	**18**
Di-n-Octyl phthalate	58	4,500	< 2.12	NT	< 1.43	< 4.51	**4.19**	0.77 U	**0.93 E**	3.3 U
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Phenol	0.42	1.2	**1.50**	NT	**0.46**	**0.07**	**0.026 E**	0.039 U	0.040 U	0.280 UG
2,4-Dimethylphenol	0.029	0.029	**0.014 E**	NT	**.016 E**	**0.010 E**	**0.0093 E**	0.059 U	0.060 U	0.410 UG
2-Methylphenol	0.063	0.063	**0.009 E**	NT	**0.011 E**	**0.0059 E**	**0.0068 E**	0.039 U	0.040 U	0.280 UG
4-Methylphenol	0.67	0.67	**0.22**	NT	**0.21**	**0.04**	**0.19**	**0.062**	**0.22**	0.140 UG
Pentachlorophenol	0.36	0.69	**0.015 E**	NT	**0.018 E**	**0.010 E**	**0.011 E**	0.099 U	0.099 U	0.410 UG
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Benzyl Alcohol	0.057	0.073	< 0.0057 E	NT	< 0.0077 E	< 0.034	**0.0064 E**	0.099 U	0.099 U	0.690 U
Benzoic Acid	0.65	0.65	< 0.23 E	NT	< 0.29	< 0.089 E	< 0.19 E	0.2 U	0.20 U	1.4 UG
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 1.15	NT	< 0.78	< 2.44	< 1.42	0.77 U	0.71 U	3.3 U
1,2-Dichlorobenzene	2.3	2.3	< 1.35	NT	< 0.90	< 2.93	< 1.68	0.77 U	0.71 U	3.3 U
1,3-Dichlorobenzene	NV	NV	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	3.1	9	< 1.21	NT	< 0.83	< 2.56	< 1.52	0.77 U	0.71 U	3.3 U
Dibenzofuran	15	58	**0.91 E**	NT	**4.50**	**4.88**	**0.94 E**	**1.4**	**3.6**	3.3 U
Hexachlorobenzene	0.38	2.3	< 0.12	NT	< 0.08	< 0.27	< 0.15	0.77 U	0.71 U	3.3 U
Hexachlorobutadiene	3.9	6.2	< 0.12	NT	< 0.08	< 0.27	< 0.15	1.5 U	1.4 U	6.7 U
N-Nitrosodiphenylamine	11	11	< 1.5	NT	< 1.03	< 3.29	< 1.90	0.77 U	0.71 U	3.3 U
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
Aroclor 1016	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1221	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1232	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1242	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1248	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1254	12	65	< 3.82	NT	< 2.5	< 7.93	< 4.52	NT	NT	NT
Aroclor 1260	12	65	< 3.82	NT	**3.25**	< 7.93	< 4.52	NT	NT	NT
Total PCBs	12	65	< 3.82	NT	**3.25**	< 7.93	< 4.52	NT	NT	NT

NOTES:

Single underlined values exceed the SQS value.
Double underlined values exceed the MCUL value.
NV - No Value.
NA - Not Analyzed.
D - Indicates value reported in diluted sample.
E - Value above linear range of detector
M - indicates estimated value of analyte found and confirmed by analyst but with low spectral match.

Table A-2 Summary of Valid Historical Core Sampling Data

Station			HC-VC-85-S1	HC-SC-85-S2
Sampling Date			9/11/1996	9/11/1996
Datum			NAD-83	NAD-83
Easting			1240186	1240186
Northing			644634	644634
Sample Type			Vibracore	Vibracore
Reported elevation			-16.6 ft.	-16.6 ft.
Sampling Interval			0 to 4.5 ft.	4.7 to 7.1 ft.
Consultant	SMS Criteria		Hart Crowser	Hart Crowser
Reference	SQS	MCUL	HC May 1997	HC May 1997
Conventionals				
Total Solids (%)	NV	NV	**43**	**59**
Total Organic Carbon (%)	NV	NV	**4.2**	**13**
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Antimony	NV	NV	NT	NT
Arsenic	57	93	**9.9**	**4.7**
Cadmium	5.1	6.7	**1.4**	< 0.86
Chromium	260	270	**69**	**24**
Copper	390	390	**66**	**28**
Lead	450	530	**33**	**15**
Mercury	0.41	0.59	**0.88**	< 0.16
Nickel	NV	NV	NT	NT
Silver	6.1	6.1	< 1.2	< 0.86
Zinc	410	960	**130**	**54**
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**5.0 E**	**7.69 E**
Acenaphthene	16	57	**1.88 E**	**1.85 E**
Acenaphthylene	66	66	**0.81 E**	**1.31 E**
Anthracene	220	1,200	**3.33 E**	**2.15 E**
Fluorene	23	79	**2.86 E**	**3.0 E**
Naphthalene	99	170	**6.43 E**	**9.23 E**
Phenanthrene	100	480	**8.10 E**	**7.62 E**
Total LPAHs	562	780	**23.4**	**25.15**
HPAH	*(ppm TOC)*	*(ppm TOC)*		
Benzo(a)anthracene	110	270	**6.67 E**	**1.69 E**
Benzo(a)pyrene	99	210	**5.0 E**	**1.23 E**
Benzo(b)fluoranthene	230	450	**6.43 E**	**1.92 E**
Benzo(g,h,i)perylene	31	78	**5.48 E**	**0.75 E**
Benzo(k)fluoranthene	230	450	**5.71 E**	**1.92 E**
Chrysene	110	460	**10.24 E**	**2.08 E**
Dibenz(a,h)anthracene	12	33	**1.93 E**	< 0.40 E
Fluoranthene	160	1,200	**13.10 E**	**5.85 E**
Indeno(1,2,3-cd)pyrene	34	88	**4.29 E**	**0.58 E**
Pyrene	1,000	1,400	**20.48 E**	**3.31 E**
Total HPAHs	2,016	5,300	**79.3**	**17.42**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**50.0 E**	**< 1.23 E**
Butylbenzylphthalate	4.9	64	**1.71 E**	< 0.40 E
Diethylphthalate	61	110	< 2.21 E	**0.23 E**
Dimethylphthalate	53	53	**0.50 E**	**0.42 E**
Di-n-Butylphthalate	220	1,700	**0.86 E**	**0.15 E**
Di-n-Octyl phthalate	58	4,500	**2.62 E**	< 0.37 E
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Phenol	0.42	1.2	**0.28 E**	**0.37 E**
2,4-Dimethylphenol	0.029	0.029	**0.038 E**	**0.61 E**
2-Methylphenol	0.063	0.063	**0.023 E**	**0.40 E**
4-Methylphenol	0.67	0.67	**0.200 E**	**1.5 E**
Pentachlorophenol	0.36	0.69	**0.0098 E**	**0.028 E**
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
Benzyl Alcohol	0.057	0.073	**0.0048 E**	**0.0044 E**
Benzoic Acid	0.65	0.65	< 0.20 E	< 0.047 E
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.86 E	< 0.20 E
1,2-Dichlorobenzene	2.3	2.3	< 1.00 E	**0.05 E**
1,3-Dichlorobenzene	NV	NV	NA	NA
1,4-Dichlorobenzene	3.1	9	< 0.90 E	**0.08 E**
Dibenzofuran	15	58	**3.81 E**	**4.69 E**
Hexachlorobenzene	0.38	2.3	**0.17**	< 0.02
Hexachlorobutadiene	3.9	6.2	< 0.09	< 0.02
N-Nitrosodiphenylamine	11	11	**0.55 E**	**0.92 E**
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*	*(ppm TOC)*
Aroclor 1016	12	65	< 2.86	< 0.65
Aroclor 1221	12	65	< 2.86	< 0.65
Aroclor 1232	12	65	< 2.86	< 0.65
Aroclor 1242	12	65	< 2.86	< 0.65
Aroclor 1248	12	65	< 2.86	< 0.65
Aroclor 1254	12	65	< 2.86	< 0.65
Aroclor 1260	12	65	< 2.86	< 0.65
Total PCBs	12	65	< 2.86	< 0.65

NOTES:

Single underlined values exceed the SQS value.
Double underlined values exceed the MCUL value.
NV - No Value.
NA - Not Analyzed.
D - Indicates value reported in diluted sample.
E - Value above linear range of detector
M - indicates estimated value of analyte found and confirmed by analyst but with low spectral match.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-1 8/25/2000		OG-2 8/24/2000	
Conventionals						
Total Solids (%)	NV	NV	**64.4**		**76.2**	
Total Organic Carbon (%)	NV	NV	**2.0**		**1.6**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	**11.0**		**16.0**	
Arsenic	57	93	< 7.0		< 6.0	
Cadmium	5.1	6.7	**0.60**		**0.40**	
Chromium	260	270	**31.2**		**26.8**	
Copper	390	390	**28.7**		**14.5**	
Lead	450	530	**17.0**		**13.0**	
Mercury	0.41	0.59	**0.14**		**0.090**	
Nickel	NV	NV	**523**		**731**	
Silver	6.1	6.1	< 0.4		< 0.40	
Zinc	410	960	**84.5**		**50.8**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.086**	**4.3**	< 0.019	< 1.2
Acenaphthene	16	57	**0.22**	**11.0**	**0.030**	**1.9**
Acenaphthylene	66	66	**0.38**	**19.0**	**0.041**	**2.6**
Anthracene	220	1,200	**0.55**	**27.5**	**0.072**	**4.5**
Fluorene	23	79	**0.23**	**11.5**	**0.045**	**2.8**
Naphthalene	99	170	**0.25**	**12.5**	**0.023**	**1.4**
Phenanthrene	100	480	**2.5 D**	**125 D**	**0.35**	**21.9**
Total LPAHs	562	780	**4.2**	**211**	**0.56**	**35.1**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**1.7 D**	**85.0 D**	**0.22**	**13.8**
Benzo(a)pyrene	99	210	**1.1**	**55.0**	**0.15**	**9.4**
Benzo(b)fluoranthene	230	450	**2.2 D**	**110 D**	**0.16**	**10.0**
Benzo(g,h,i)perylene	31	78	**0.25**	**12.5**	**0.042**	**2.6**
Benzo(k)fluoranthene	230	450	**1.4 D**	**70.0 D**	**0.25**	**15.6**
Chrysene	110	460	**5.1 D**	**255 D**	**0.27**	**16.9**
Dibenz(a,h)anthracene	12	33	**0.066**	**3.3**	< 0.019	< 1.2
Fluoranthene	160	1,200	**8.3 D**	**415 D**	**0.66**	**41.3**
Indeno(1,2,3-cd)pyrene	34	88	**0.33**	**16.5**	**0.069**	**4.3**
Pyrene	1,000	1,400	**9.6 D**	**480 D**	**0.66**	**41.3**
Total HPAHs	2,016	5,300	**30.0**	**1502**	**2.5**	**155**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**2.6 D**	**130 D**	**0.14**	**8.8**
Butylbenzylphthalate	4.9	64	< 0.019	< 0.95	< 0.019	< 1.2
Diethylphthalate	61	110	< 0.019	< 0.95	< 0.019	< 1.2
Dimethylphthalate	53	53	**0.022**	**1.1**	< 0.019	< 1.2
Di-n-Butylphthalate	220	1,700	< 0.019	< 0.95	< 0.019	< 1.2
Di-n-Octyl phthalate	58	4,500	< 0.019	< 0.95	< 0.019	< 1.2
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	**0.030**		< 0.019	
2,4-Dimethylphenol	0.029	0.029	< 0.019		< 0.019	
2-Methylphenol	0.063	0.063	< 0.019		< 0.019	
4-Methylphenol	0.67	0.67	**0.035**		**0.026**	
Pentachlorophenol	0.36	0.69	< 0.097		< 0.097	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.019		< 0.019	
Benzoic Acid	0.65	0.65	< 0.19		< 0.19	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.019	< 0.95	< 0.019	< 1.2
1,2-Dichlorobenzene	2.3	2.3	< 0.019	< 0.95	< 0.019	< 1.2
1,3-Dichlorobenzene	NV	NV	< 0.019	< 0.95	< 0.019	< 1.2
1,4-Dichlorobenzene	3.1	9	< 0.019	< 0.95	< 0.019	< 1.2
Dibenzofuran	15	58	**0.28**	**14.0**	**0.032**	**2.0**
Hexachlorobenzene	0.38	2.3	< 0.019	< 0.95	< 0.019	< 1.2
Hexachlorobutadiene	3.9	6.2	< 0.019	< 0.95	< 0.019	< 1.2
N-Nitrosodiphenylamine	11	11	< 0.019	< 0.95	< 0.019	< 1.2
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	< 0.018	< 0.90	< 0.018	< 1.1
Aroclor 1221	12	65	< 0.036	< 1.8	< 0.036	< 2.3
Aroclor 1232	12	65	< 0.018	< 0.90	< 0.018	< 1.1
Aroclor 1242	12	65	< 0.018	< 0.90	< 0.018	< 1.1
Aroclor 1248	12	65	< 0.018	< 0.90	< 0.018	< 1.1
Aroclor 1254	12	65	**0.018**	**0.90**	< 0.018	< 1.1
Aroclor 1260	12	65	< 0.018	< 0.90	< 0.018	< 1.1
Total PCBs	12	65	**0.018**	**0.90**	< 0.036	< 2.3

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-3 8/25/2000		OG-4 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**35.5**		**32.2**	
Total Organic Carbon (%)	NV	NV	**2.7**		**2.8**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	**20.0**		**20.00**	
Arsenic	57	93	< 10.0		< 10.00	
Cadmium	5.1	6.7	**0.70**		**0.60**	
Chromium	260	270	**75.0**		**76.0**	
Copper	390	390	**57.0**		**61.6**	
Lead	450	530	**22.0**		**17.0**	
Mercury	0.41	0.59	**0.30**		**0.30**	
Nickel	NV	NV	**133**		**122**	
Silver	6.1	6.1	< 0.80		< 0.80	
Zinc	410	960	**130**		**132**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.055**	**2.0**	**0.27**	**9.6**
Acenaphthene	16	57	**0.062**	**2.3**	**0.053**	**1.9**
Acenaphthylene	66	66	**0.049**	**1.8**	**0.053**	**1.9**
Anthracene	220	1,200	**0.15**	**5.6**	**3.3 D**	**118 D**
Fluorene	23	79	**0.062**	**2.3**	**0.82**	**<u>29.3</u>**
Naphthalene	99	170	**0.075**	**2.8**	**0.11**	**3.9**
Phenanthrene	100	480	**0.39**	**14.4**	**2.7 D**	**96.4 D**
Total LPAHs	562	780	**0.84**	**31.2**	**7.3**	**261**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.36**	**13.3**	**0.75**	**26.8**
Benzo(a)pyrene	99	210	**0.20**	**7.4**	**0.23**	**8.2**
Benzo(b)fluoranthene	230	450	**0.32**	**11.9**	**0.52**	**18.6**
Benzo(g,h,i)perylene	31	78	**0.064**	**2.4**	**0.081**	**2.9**
Benzo(k)fluoranthene	230	450	**0.33**	**12.2**	**0.40**	**14.3**
Chrysene	110	460	**0.74**	**27.4**	**0.94**	**33.6**
Dibenz(a,h)anthracene	12	33	< 0.020	< 0.74	< 0.020	< 0.71
Fluoranthene	160	1,200	**0.94**	**34.8**	**3.0 D**	**107 D**
Indeno(1,2,3-cd)pyrene	34	88	**0.087**	**3.2**	**0.087**	**3.1**
Pyrene	1,000	1,400	**0.92**	**34.1**	**1.4 D**	**50.0 D**
Total HPAHs	2,016	5,300	**4.0**	**147**	**7.4**	**265**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**1.4**	**<u>51.9</u>**	**14.0 D**	**<u>500</u> D**
Butylbenzylphthalate	4.9	64	**0.045**	**1.7**	**0.030**	**1.1**
Diethylphthalate	61	110	< 0.020	< 0.74	< 0.020	< 0.71
Dimethylphthalate	53	53	< 0.020	< 0.74	< 0.020	< 0.71
Di-n-Butylphthalate	220	1,700	< 0.020	< 0.74	< 0.020	< 0.71
Di-n-Octyl phthalate	58	4,500	< 0.020	< 0.74	< 0.020	< 0.71
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	< 0.020		< 0.020	
2,4-Dimethylphenol	0.029	0.029	< 0.020		< 0.020	
2-Methylphenol	0.063	0.063	< 0.020		< 0.020	
4-Methylphenol	0.67	0.67	**0.094**		**0.076**	
Pentachlorophenol	0.36	0.69	< 0.099		< 0.099	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.020		< 0.020	
Benzoic Acid	0.65	0.65	< 0.20		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.020	< 0.74	< 0.020	< 0.71
1,2-Dichlorobenzene	2.3	2.3	< 0.020	< 0.74	< 0.020	< 0.71
1,3-Dichlorobenzene	NV	NV	< 0.020	< 0.74	< 0.020	< 0.71
1,4-Dichlorobenzene	3.1	9	< 0.020	< 0.74	< 0.020	< 0.71
Dibenzofuran	15	58	**0.094**	**3.5**	**0.29**	**10.4**
Hexachlorobenzene	0.38	2.3	< 0.020	< 0.74	< 0.020	< 0.71
Hexachlorobutadiene	3.9	6.2	< 0.020	< 0.74	< 0.020	< 0.71
N-Nitrosodiphenylamine	11	11	< 0.020	< 0.74	< 0.020	< 0.71
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	< 0.020	< 0.74	< 0.019	< 0.68
Aroclor 1221	12	65	< 0.039	< 1.4	< 0.038	< 1.36
Aroclor 1232	12	65	< 0.020	< 0.74	< 0.019	< 0.68
Aroclor 1242	12	65	< 0.020	< 0.74	< 0.019	< 0.68
Aroclor 1248	12	65	< 0.020	< 0.74	< 0.019	< 0.68
Aroclor 1254	12	65	< 0.020	< 0.74	**0.031**	**1.1**
Aroclor 1260	12	65	< 0.020	< 0.74	< 0.019	< 0.68
Total PCBs	12	65	< 0.039	< 1.4	**0.031**	**1.1**

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-100 (Duplicate of OG-04) 8/25/2000		OG-5 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**37.8**		**46.1**	
Total Organic Carbon (%)	NV	NV	**2.8**		**3.4**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	**20.0**		< 10.0	
Arsenic	57	93	< 10.0		< 10.0	
Cadmium	5.1	6.7	**0.60**		**0.70**	
Chromium	260	270	**77.0**		**47.0**	
Copper	390	390	**58.1**		**345**	
Lead	450	530	**19.0**		**25.0**	
Mercury	0.41	0.59	**0.30**		**0.21**	
Nickel	NV	NV	**126**		**80.0**	
Silver	6.1	6.1	< 0.80		< 0.70	
Zinc	410	960	**130**		**271**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.043**	**1.5**	**0.30**	**8.8**
Acenaphthene	16	57	**0.058**	**2.1**	**3.8 D**	**<u>112</u> D**
Acenaphthylene	66	66	**0.034**	**1.2**	**0.19**	**5.6**
Anthracene	220	1,200	**0.11**	**3.9**	**9.2 D**	**<u>271</u> D**
Fluorene	23	79	**0.066**	**2.4**	**1.5**	**<u>44.1</u>**
Naphthalene	99	170	**0.056**	**2.0**	**0.58**	**17.1**
Phenanthrene	100	480	**0.38**	**13.6**	**9.9 D**	**<u>291</u> D**
Total LPAHs	562	780	**0.75**	**26.7**	**25.5**	**<u>749</u>**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.26**	**9.3**	**5.7 D**	**<u>168</u> D**
Benzo(a)pyrene	99	210	**0.14**	**5.0**	**2.6 D**	**76.5 D**
Benzo(b)fluoranthene	230	450	**0.18**	**6.4**	**3.1 D**	**91.2 D**
Benzo(g,h,i)perylene	31	78	**0.044**	**1.6**	**0.37**	**10.9**
Benzo(k)fluoranthene	230	450	**0.24**	**8.6**	**2.9 D**	**85.3 D**
Chrysene	110	460	**0.33**	**11.8**	**7.7 D**	**<u>226</u> D**
Dibenz(a,h)anthracene	12	33	< 0.020	< 0.71	**0.16**	**4.7**
Fluoranthene	160	1,200	**0.77**	**27.5**	**31.0 D**	**<u>912</u> D**
Indeno(1,2,3-cd)pyrene	34	88	**0.054**	**1.9**	**0.58**	**17.1**
Pyrene	1,000	1,400	**0.84**	**30.0**	**22.0 D**	**647 D**
Total HPAHs	2,016	5,300	**2.9**	**102**	**76.1**	**<u>2239</u>**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**68.0 D**	**<u>2429</u> D**	**19.0 D**	**<u>559</u> D**
Butylbenzylphthalate	4.9	64	**0.027**	**0.96**	**0.089**	**2.6**
Diethylphthalate	61	110	< 0.020	< 0.71	< 0.020	< 0.59
Dimethylphthalate	53	53	< 0.020	< 0.71	**0.15**	**4.4**
Di-n-Butylphthalate	220	1,700	< 0.020	< 0.71	< 0.020	< 0.59
Di-n-Octyl phthalate	58	4,500	< 0.020	< 0.71	< 0.020	< 0.59
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	< 0.020		< 0.020	
2,4-Dimethylphenol	0.029	0.029	< 0.020		< 0.020	
2-Methylphenol	0.063	0.063	< 0.020		< 0.020	
4-Methylphenol	0.67	0.67	**0.054**		**0.091**	
Pentachlorophenol	0.36	0.69	< 0.098		< 0.098	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.020		< 0.020	
Benzoic Acid	0.65	0.65	< 0.20		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.020	< 0.71	< 0.020	< 0.59
1,2-Dichlorobenzene	2.3	2.3	< 0.020	< 0.71	< 0.020	< 0.59
1,3-Dichlorobenzene	NV	NV	< 0.020	< 0.71	< 0.020	< 0.59
1,4-Dichlorobenzene	3.1	9	< 0.020	< 0.71	< 0.020	< 0.59
Dibenzofuran	15	58	**0.099**	**3.5**	**0.94**	**<u>27.6</u>**
Hexachlorobenzene	0.38	2.3	< 0.020	< 0.71	< 0.020	< 0.59
Hexachlorobutadiene	3.9	6.2	< 0.020	< 0.71	< 0.020	< 0.59
N-Nitrosodiphenylamine	11	11	< 0.020	< 0.71	< 0.020	< 0.59
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	< 0.019	< 0.68	< 0.019	< 0.56
Aroclor 1221	12	65	< 0.038	< 1.4	< 0.044	< 1.3
Aroclor 1232	12	65	< 0.019	< 0.68	< 0.019	< 0.56
Aroclor 1242	12	65	< 0.019	< 0.68	< 0.019	< 0.56
Aroclor 1248	12	65	< 0.019	< 0.68	< 0.019	< 0.56
Aroclor 1254	12	65	< 0.019	< 0.68	**0.025**	**0.74**
Aroclor 1260	12	65	< 0.019	< 0.68	< 0.019	< 0.56
Total PCBs	12	65	< 0.038	< 1.4	**0.025**	**0.74**

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-6 8/24/2000		OG-7 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**72.4**		**45.5**	
Total Organic Carbon (%)	NV	NV	**1.0**		**2.6**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	**20.0**		< 10	
Arsenic	57	93	< 20.0		< 10	
Cadmium	5.1	6.7	< 0.70		**0.50**	
Chromium	260	270	**28.0**		**73.0**	
Copper	390	390	**17.9**		**59.2**	
Lead	450	530	**20.0**		**18.0**	
Mercury	0.41	0.59	**0.090**		**0.40**	**J**
Nickel	NV	NV	**1,120**		**129**	
Silver	6.1	6.1	< 1.0		< 0.6	
Zinc	410	960	**73.0**		**120**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.029**	**2.9**	**0.038**	**1.5**
Acenaphthene	16	57	**0.030**	**3.0**	**0.029**	**1.1**
Acenaphthylene	66	66	**0.028**	**2.8**	**0.029**	**1.1**
Anthracene	220	1,200	**0.074**	**7.4**	**0.160**	**6.2**
Fluorene	23	79	**0.032**	**3.2**	**0.049**	**1.9**
Naphthalene	99	170	**0.035**	**3.5**	**0.048**	**1.8**
Phenanthrene	100	480	**0.30**	**30.0**	**0.220**	**8.5**
Total LPAHs	562	780	**0.53**	**52.8**	**0.573**	**22.0**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.25**	**25.0**	**0.200**	**7.7**
Benzo(a)pyrene	99	210	**0.24**	**24.0**	**0.150**	**5.8**
Benzo(b)fluoranthene	230	450	**0.30**	**30.0**	**0.210**	**8.1**
Benzo(g,h,i)perylene	31	78	**0.079**	**7.9**	**0.066**	**2.5**
Benzo(k)fluoranthene	230	450	**0.30**	**30.0**	**0.210**	**8.1**
Chrysene	110	460	**0.46**	**46.0**	**0.360**	**13.8**
Dibenz(a,h)anthracene	12	33	< 0.020	< 2.0	**0.023**	**M** **0.88** **M**
Fluoranthene	160	1,200	**0.73**	**73.0**	**0.550**	**21.2**
Indeno(1,2,3-cd)pyrene	34	88	**0.085**	**8.5**	**0.850**	**32.7**
Pyrene	1,000	1,400	**0.94**	**94.0**	**0.540**	**20.8**
Total HPAHs	2,016	5,300	**3.4**	**338**	**3.16**	**121.5**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**0.40**	**40.0**	**0.67**	**25.8**
Butylbenzylphthalate	4.9	64	< 0.020	< 2.0	**0.025**	**1.0**
Diethylphthalate	61	110	< 0.020	< 2.0	< 0.020	< 0.77
Dimethylphthalate	53	53	< 0.020	< 2.0	< 0.020	< 0.77
Di-n-Butylphthalate	220	1,700	< 0.020	< 2.0	< 0.020	< 0.77
Di-n-Octyl phthalate	58	4,500	< 0.020	< 2.0	< 0.020	< 0.77
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	< 0.02		**0.046**	**M**
2,4-Dimethylphenol	0.029	0.029	< 0.02		< 0.02	
2-Methylphenol	0.063	0.063	< 0.02		< 0.02	
4-Methylphenol	0.67	0.67	< 0.02		**0.051**	
Pentachlorophenol	0.36	0.69	< 0.10		< 0.10	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.020		< 0.020	
Benzoic Acid	0.65	0.65	< 0.20		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.02	< 2	< 0.02	< 0.77
1,2-Dichlorobenzene	2.3	2.3	< 0.02	< 2	< 0.02	< 0.77
1,3-Dichlorobenzene	NV	NV	< 0.02	< 2	< 0.02	< 0.77
1,4-Dichlorobenzene	3.1	9	< 0.02	< 2	< 0.02	< 0.77
Dibenzofuran	15	58	**0.037**	**3.7**	**0.051**	**2.0**
Hexachlorobenzene	0.38	2.3	< 0.02	< 2	< 0.02	< 0.77
Hexachlorobutadiene	3.9	6.2	< 0.02	< 2	< 0.02	< 0.77
N-Nitrosodiphenylamine	11	11	< 0.02	< 2	< 0.02	< 0.77
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	< 0.018	< 1.8	NA	NA
Aroclor 1221	12	65	< 0.037	< 3.7	NA	NA
Aroclor 1232	12	65	< 0.018	< 1.8	NA	NA
Aroclor 1242	12	65	< 0.018	< 1.8	NA	NA
Aroclor 1248	12	65	< 0.018	< 1.8	NA	NA
Aroclor 1254	12	65	< 0.018	< 1.8	NA	NA
Aroclor 1260	12	65	< 0.018	< 1.8	NA	NA
Total PCBs	12	65	< 0.037	< 3.7	NA	NA

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-8 8/25/2000		OG-9 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**47.3**		**44.6**	
Total Organic Carbon (%)	NV	NV	**2.8**		**2.9**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	NA		NA	
Arsenic	57	93	NA		NA	
Cadmium	5.1	6.7	NA		NA	
Chromium	260	270	NA		NA	
Copper	390	390	NA		NA	
Lead	450	530	NA		NA	
Mercury	0.41	0.59	NA		NA	
Nickel	NV	NV	NA		NA	
Silver	6.1	6.1	NA		NA	
Zinc	410	960	NA		NA	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.039**	**1.4**	**0.049**	**1.7**
Acenaphthene	16	57	**0.029**	**1.0**	**0.043**	**1.5**
Acenaphthylene	66	66	**0.034**	**1.2**	**0.032**	**1.1**
Anthracene	220	1,200	**0.120**	**4.3**	**0.13**	**4.5**
Fluorene	23	79	**0.050**	**1.8**	**0.070**	**2.4**
Naphthalene	99	170	**0.047**	**1.7**	**0.056**	**1.9**
Phenanthrene	100	480	**0.220**	**7.9**	**0.27**	**9.3**
Total LPAHs	562	780	**0.539**	**19.2**	**0.650**	**22.4**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.230**	**8.2**	**0.24**	**8.3**
Benzo(a)pyrene	99	210	**0.170**	**6.1**	**0.15**	**5.2**
Benzo(b)fluoranthene	230	450	**0.250**	**8.9**	**0.29**	**10.0**
Benzo(g,h,i)perylene	31	78	**0.056**	**2.0**	**0.014 J**	**0.48**
Benzo(k)fluoranthene	230	450	**0.250**	**8.9**	**0.23**	**7.9**
Chrysene	110	460	**0.380**	**13.6**	**0.38**	**13.1**
Dibenz(a,h)anthracene	12	33	**0.021 M**	**0.7 M**	< 0.020	< 0.69
Fluoranthene	160	1,200	**0.560**	**20.0**	**0.67**	**23.1**
Indeno(1,2,3-cd)pyrene	34	88	**0.074**	**2.6**	**0.021**	**0.72**
Pyrene	1,000	1,400	**0.540**	**19.3**	**0.61**	**21.0**
Total HPAHs	2,016	5,300	**2.53**	**90.4**	**2.61**	**89.8**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**0.37**	**13.2**	**3.2 D**	**<u>110.3</u> D**
Butylbenzylphthalate	4.9	64	**0.026**	**0.9**	**0.035 M**	**1.2**
Diethylphthalate	61	110	< 0.020	< 0.71	< 0.020	< 0.69
Dimethylphthalate	53	53	**0.022**	**0.8**	< 0.020	< 0.69
Di-n-Butylphthalate	220	1,700	< 0.020	< 0.71	**0.042 M**	**1.4**
Di-n-Octyl phthalate	58	4,500	< 0.020	< 0.71	< 0.020	< 0.69
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	**0.086**	**M**	**0.05**	**M**
2,4-Dimethylphenol	0.029	0.029	< 0.02		**0.043**	
2-Methylphenol	0.063	0.063	< 0.02		< 0.020	
4-Methylphenol	0.67	0.67	**0.068**		**0.062**	
Pentachlorophenol	0.36	0.69	< 0.10		< 0.10	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.02		< 0.020	
Benzoic Acid	0.65	0.65	< 0.20		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.020	< 0.71	< 0.020	< 0.69
1,2-Dichlorobenzene	2.3	2.3	< 0.020	< 0.71	< 0.020	< 0.69
1,3-Dichlorobenzene	NV	NV	< 0.020	< 0.71	< 0.020	< 0.69
1,4-Dichlorobenzene	3.1	9	< 0.020	< 0.71	< 0.020	< 0.69
Dibenzofuran	15	58	**0.052**	**1.9**	**0.068**	**2.3**
Hexachlorobenzene	0.38	2.3	< 0.020	< 0.71	< 0.020	< 0.69
Hexachlorobutadiene	3.9	6.2	< 0.020	< 0.71	< 0.020	< 0.69
N-Nitrosodiphenylamine	11	11	< 0.020	< 0.71	< 0.020	< 0.69
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	NA	NA	NA	NA
Aroclor 1221	12	65	NA	NA	NA	NA
Aroclor 1232	12	65	NA	NA	NA	NA
Aroclor 1242	12	65	NA	NA	NA	NA
Aroclor 1248	12	65	NA	NA	NA	NA
Aroclor 1254	12	65	NA	NA	NA	NA
Aroclor 1260	12	65	NA	NA	NA	NA
Total PCBs	12	65	NA	NA	NA	NA

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-10 8/25/2000		OG-11 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**41.4**		**44.8**	
Total Organic Carbon (%)	NV	NV	**3.2**		**3.0**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	NA		< 10	
Arsenic	57	93	NA		< 10	
Cadmium	5.1	6.7	NA		**0.5**	
Chromium	260	270	NA		**62.0**	
Copper	390	390	NA		**61.0**	
Lead	450	530	NA		**136**	
Mercury	0.41	0.59	NA		< 0.10	**J**
Nickel	NV	NV	NA		**47.0**	
Silver	6.1	6.1	NA		< 0.7	
Zinc	410	960	NA		**170**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.059**	**1.8**	**0.032**	**1.1**
Acenaphthene	16	57	**0.072**	**2.3**	**0.24**	**8.0**
Acenaphthylene	66	66	**0.035**	**1.1**	**0.058**	**1.9**
Anthracene	220	1,200	**0.14**	**4.4**	**0.24**	**8.0**
Fluorene	23	79	**0.082**	**2.6**	**0.10**	**3.3**
Naphthalene	99	170	**0.063**	**2.0**	**0.046**	**1.5**
Phenanthrene	100	480	**0.38**	**11.9**	**0.73**	**24.3**
Total LPAHs	562	780	**0.83**	**26.0**	**1.4**	**48.2**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.26**	**8.1**	**0.60**	**20.0**
Benzo(a)pyrene	99	210	**0.15**	**4.7**	**0.36**	**12.0**
Benzo(b)fluoranthene	230	450	**0.24**	**7.5**	**0.68**	**22.7**
Benzo(g,h,i)perylene	31	78	**0.052**	**1.6**	**0.082**	**2.7**
Benzo(k)fluoranthene	230	450	**0.32**	**10.0**	**0.56**	**18.7**
Chrysene	110	460	**0.32**	**10.0**	**0.67**	**22.3**
Dibenz(a,h)anthracene	12	33	< 0.020	< 0.63	**0.031**	**1.0**
Fluoranthene	160	1,200	**0.87**	**27.2**	**2.5 D**	**83.3 D**
Indeno(1,2,3-cd)pyrene	34	88	**0.078**	**2.4**	**0.12**	**4.0**
Pyrene	1,000	1,400	**0.98**	**30.6**	**3.2 D**	**107 D**
Total HPAHs	2,016	5,300	**3.3**	**102**	**8.8**	**293**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**2.8 D**	**87.5 D**	**28.0 D**	**933 D**
Butylbenzylphthalate	4.9	64	< 0.020	< 0.63	**0.020**	**0.67**
Diethylphthalate	61	110	< 0.020	< 0.63	< 0.020	< 0.67
Dimethylphthalate	53	53	< 0.020	< 0.63	**0.68**	**22.7**
Di-n-Butylphthalate	220	1,700	< 0.020	< 0.63	**0.11**	**3.7**
Di-n-Octyl phthalate	58	4,500	< 0.020	< 0.63	< 0.020	< 0.67
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	< 0.020		< 0.020	
2,4-Dimethylphenol	0.029	0.029	< 0.020		< 0.020	
2-Methylphenol	0.063	0.063	< 0.020		< 0.020	
4-Methylphenol	0.67	0.67	**0.089**		**0.070**	
Pentachlorophenol	0.36	0.69	< 0.10		< 0.10	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.020		< 0.020	
Benzoic Acid	0.65	0.65	< 0.20		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.020	< 0.63	< 0.02	< 0.67
1,2-Dichlorobenzene	2.3	2.3	< 0.020	< 0.63	< 0.02	< 0.67
1,3-Dichlorobenzene	NV	NV	< 0.020	< 0.63	< 0.02	< 0.67
1,4-Dichlorobenzene	3.1	9	< 0.020	< 0.63	< 0.02	< 0.67
Dibenzofuran	15	58	**0.098**	**3.1**	**0.13**	**4.3**
Hexachlorobenzene	0.38	2.3	< 0.020	< 0.63	< 0.02	< 0.67
Hexachlorobutadiene	3.9	6.2	< 0.020	< 0.63	< 0.02	< 0.67
N-Nitrosodiphenylamine	11	11	< 0.020	< 0.63	< 0.02	< 0.67
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	NA	NA	NA	NA
Aroclor 1221	12	65	NA	NA	NA	NA
Aroclor 1232	12	65	NA	NA	NA	NA
Aroclor 1242	12	65	NA	NA	NA	NA
Aroclor 1248	12	65	NA	NA	NA	NA
Aroclor 1254	12	65	NA	NA	NA	NA
Aroclor 1260	12	65	NA	NA	NA	NA
Total PCBs	12	65	NA	NA	NA	NA

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Table A-3 Summary of Phase 2 Surface Sediment Analytical Data

Parameter	SMS Criteria SQS	SMS Criteria MCUL	OG-12 8/25/2000		OG-13 8/25/2000	
Conventionals						
Total Solids (%)	NV	NV	**43.6**		**41.9**	
Total Organic Carbon (%)	NV	NV	**2.6**		**3.8**	
Metals	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Antimony	NV	NV	NA		< 10	
Arsenic	57	93	NA		< 10	
Cadmium	5.1	6.7	NA		**0.6**	
Chromium	260	270	NA		**49**	
Copper	390	390	NA		**43**	
Lead	450	530	NA		**14**	
Mercury	0.41	0.59	NA		**0.3**	**J**
Nickel	NV	NV	NA		**71**	
Silver	6.1	6.1	NA		< 0.7	
Zinc	410	960	NA		**176**	
LPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
2-Methylnaphthalene	38	64	**0.044**	**1.7**	**0.14**	**3.7**
Acenaphthene	16	57	**0.039**	**1.5**	**0.30**	**7.9**
Acenaphthylene	66	66	**0.025**	**1.0**	**0.11**	**2.9**
Anthracene	220	1,200	**0.084**	**3.2**	**0.49**	**12.9**
Fluorene	23	79	**0.059**	**2.3**	**0.34**	**8.9**
Naphthalene	99	170	**0.048**	**1.8**	**0.12**	**3.2**
Phenanthrene	100	480	**0.20**	**7.7**	**1.7 D**	**44.7 D**
Total LPAHs	562	780	**0.499**	**19.2**	**3.2**	**84.2**
HPAH	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Benzo(a)anthracene	110	270	**0.16**	**6.2**	**1.2**	**31.6**
Benzo(a)pyrene	99	210	**0.11**	**4.2**	**0.56**	**14.7**
Benzo(b)fluoranthene	230	450	**0.22**	**8.5**	**0.8**	**21.1**
Benzo(g,h,i)perylene	31	78	< 0.019	< 0.73	**0.14**	**3.7**
Benzo(k)fluoranthene	230	450	**0.17**	**6.5**	**1.2**	**31.6**
Chrysene	110	460	**0.26**	**10.0**	**1.5**	**39.5**
Dibenz(a,h)anthracene	12	33	< 0.019	< 0.73	**0.038**	**1.0**
Fluoranthene	160	1,200	**0.50**	**19.2**	**5.6 D**	**147 D**
Indeno(1,2,3-cd)pyrene	34	88	**0.017 J**	**0.7**	**0.2**	**5.3**
Pyrene	1,000	1,400	**0.42**	**16.2**	**5.6 D**	**147 D**
Total HPAHs	2,016	5,300	**1.86**	**71.4**	**16.8**	**443**
Phthalates	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
bis(2-Ethylhexyl)phthalate	47	78	**1.4**	**<u>53.8</u>**	**16.0**	**<u>421</u>**
Butylbenzylphthalate	4.9	64	**0.014 JM**	**0.5**	< 0.020	< 0.53
Diethylphthalate	61	110	< 0.019	< 0.73	< 0.020	< 0.53
Dimethylphthalate	53	53	< 0.019	< 0.73	**0.046**	**1.2**
Di-n-Butylphthalate	220	1,700	< 0.019	< 0.73	< 0.020	< 0.53
Di-n-Octyl phthalate	58	4,500	< 0.019	< 0.73	< 0.020	< 0.53
Phenols	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Phenol	0.42	1.2	**0.052**	**M**	< 0.020	
2,4-Dimethylphenol	0.029	0.029	**0.019**	**J**	< 0.020	
2-Methylphenol	0.063	0.063	< 0.019		< 0.020	
4-Methylphenol	0.67	0.67	**0.056**		**0.11**	
Pentachlorophenol	0.36	0.69	**0.018**	**J**	< 0.099	
Misc. Extractables	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*		*(mg/kg)*	
Benzyl Alcohol	0.057	0.073	< 0.019		< 0.020	
Benzoic Acid	0.65	0.65	< 0.19		< 0.20	
Misc. Extractables	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
1,2,4-Trichlorobenzene	0.81	1.8	< 0.019	< 0.73	< 0.020	< 0.53
1,2-Dichlorobenzene	2.3	2.3	< 0.019	< 0.73	< 0.020	< 0.53
1,3-Dichlorobenzene	NV	NV	< 0.019	< 0.73	< 0.020	< 0.53
1,4-Dichlorobenzene	3.1	9	< 0.019	< 0.73	< 0.020	< 0.53
Dibenzofuran	15	58	**0.059**	**2.3**	**0.30**	**7.9**
Hexachlorobenzene	0.38	2.3	< 0.019	< 0.73	< 0.020	< 0.53
Hexachlorobutadiene	3.9	6.2	< 0.019	< 0.73	< 0.020	< 0.53
N-Nitrosodiphenylamine	11	11	< 0.019	< 0.73	< 0.020	< 0.53
PCBs	*(ppm TOC)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*	*(mg/kg)*	*(ppm TOC)*
Aroclor 1016	12	65	NA	NA	NA	NA
Aroclor 1221	12	65	NA	NA	NA	NA
Aroclor 1232	12	65	NA	NA	NA	NA
Aroclor 1242	12	65	NA	NA	NA	NA
Aroclor 1248	12	65	NA	NA	NA	NA
Aroclor 1254	12	65	NA	NA	NA	NA
Aroclor 1260	12	65	NA	NA	NA	NA
Total PCBs	12	65	NA	NA	NA	NA

NOTES:

Single underlined values exceed the SQS value
Double underlined values exceed the MCUL value
NV - No Value
NA - Not Analyzed
D - Indicates value reported in diluted sample.
J - Indicated value is an estimate.

Attachment B

Field Forms

Sediment Core Drive Log

Job: Core Location:

Job No: Date: Time:

Field Reps: Attempt #: Accept/Reject

Contractor: Sample Method:

Proposed Coordinates	Actual Coordinates
N: E:	N: E:
Mudline:	Mudline:
Core Drive:	Core Drive: Core Recovery:

DTS Boat: DTS Lead Line:

Mudline Elevation:

Tide Measurements (Datum:)

Time/Height:

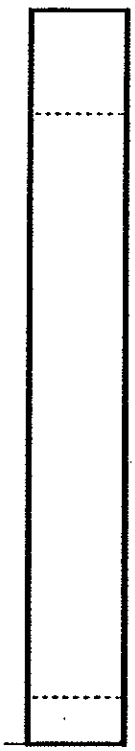
Time/Height:

Description:

(free fall, fingers inverted, vibration needed to drive/extract, estimation of density, debris encountered, slopes, refusal, mudline conditions, drive action, etc.)

Measurement (to nearest 0.1 foot):

Core Tube Length:



Avg. % Recovery:

Avg. % Compaction:

Section:	Length:	Description at Cuts:
A =		
B =		
C =		
D =		

Total Drive: Length Recovered:

Notes:

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Sediment Core Processing Log

Job:

Core Location/Sample Number:

Job Number:

Date/ Time:

No. of Sections:

Sample Logged by:

Sample Length (from log):

Type/Diameter of Sample:

Avg. % Compaction:

Sample Quality: good fair poor disturbed

Notes:

Recovered Length (ft)	% Compaction	Color	Size % - G	Size % - S	Size % - F	PID	Description (grain size, color, moisture, sheen/odor, biota, wood, other debris)	Insitu Actual Depth (ft)	Sample Depth	Subsample No.	Summary Sketch

DAILY FIELD REPORT

RETEC

Job: Arrival Time:

Location/Client: Departure Time:

Job Number: Weather:

Purpose of Observations:

RETEC Representative: RETEC Project Manager:

Contractor: Permit No.:

Contractor Rep: Job Phone:

ATTENDEES:

SCOPE:

ACTIVITIES:

ACTION ITEMS:

Attachment C

Reporting Requirements for Chemical Variables and Bioassays

1 Chemical Variables

1.1 ORGANIC COMPOUNDS

The following documentation is needed for organic compounds:

- A cover letter referencing or describing the procedure used and discussing any analytical problems;
- Reconstructed ion chromatograms for GC/MS analyses for each sample;
- Mass spectra of detected target compounds (GC/MS) for each sample and associated library spectra;
- GC/ECD and/or GC/flame ionization detection chromatograms for each sample;
- Raw data quantification reports for each sample;
- A calibration data summary reporting calibration range used [and decafluorotriphenylphosphine (DFTPP) and bromofluorobenzene (BFB) spectra and quantification report for GC/MS analyses];
- Final dilution volumes, sample size, wet-to-dry ratios, and instrument detection limit;
- Analyte concentrations with reporting units identified (to two significant figures unless otherwise justified);
- Quantification of all analytes in method blanks (ng/sample);
- Method blanks associated with each sample;
- Recovery assessments and a replicate sample summary (laboratories should report all surrogate spike recovery data for each sample; a statement of the range of recoveries should be included in reports using these data); and
- Data qualification codes and their definitions.

2 BIOASSAYS

2.1 Amphipod Mortality Test

The following data should be reported by all laboratories performing this bioassay:

- Daily water quality measurements during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination);
- Daily emergence for each beaker and the 10-day mean and standard deviation for each treatment;
- 10-day survival in each beaker and the mean and standard deviation for each treatment;
- Interstitial salinity values of test sediments;
- 96-hour LC50 values with reference toxicants; and
- Any problems that may have influenced data quality.

2.2 *Neanthes* Growth Test

The following data should be reported by all laboratories performing this bioassay:

- Water quality measurements at test initiation and termination and every three days during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination);
- 20-day survival in each beaker and the mean and standard deviation for each treatment;
- Initial biomass;
- Final biomass (20-day) for test, reference and control treatments;
- 96-hour LC50 values with reference toxicants; and
- Any problems that may have influenced data quality.