PRELIMINARY REVIEW DRAFT

APPENDIX B
SEDIMENT SAMPLING AND ANALYSIS PLAN FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY AND DRAFT CLEANUP ACTION PLAN

PORT OF EVERETT
BAY WOOD PRODUCTS SITE
EVERETT, WASHINGTON

Prepared for

Washington Department of Ecology
Olympia, Washington

Port of Everett
Everett, Washington

SLR International Corporation
West Linn, Oregon

Prepared by

Anchor Environmental, L.L.C.
Seattle, Washington

January 16, 2009

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%R	percent recovery
Anchor	Anchor Environmental, L.L.C.
ASTM	American Society of Testing and Materials
CAP	Cleanup Action Plan
cm	centimeter
COC	chain of custody
CSL	cleanup screening levels
DGPS	differential global positioning system
DMMP	Dredge Material Management Program
DO	dissolved oxygen
DQOs	data quality objectives
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high density polyethylene
MCUL	minimum cleanup levels
MDL	method detection limit
MLLW	mean lower low water
MS/MSDs	matrix spike/matrix spike duplicates
MTCA	Model Toxics Control Act
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PARCC	precision, accuracy, representativeness, comparability, and completeness
ppm	parts per million
PQLs	practical quantitation limits
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI	Analytical Resources Incorporated
RI/FS	Remedial Investigation/Feasibility Study
RLs	reporting limits
RPD	relative percent difference
SAIC	Science Applications International Corporation

SAP	Sediment Sampling and Analysis Plan
SAPA	Sediment Sampling and Analysis Plan Appendix
SDG	sample delivery group
Site	Bay Wood Products Site
SMARM	Sediment Management Annual Review Meeting
SMS	Sediment Management Standards
SOPs	standard operating procedures
SPI	Sediment profile imaging
SQS	sediment quality standards
SRMs	Standard Reference Materials
TOC	total organic carbon
TVS	total volatile solids
USCS	Unified Soil Classification System
WAC	Washington Administrative Code

1 INTRODUCTION

This Sediment Sampling and Analysis Plan (SAP) has been prepared to describe the proposed scope of work for sediment sampling to support the Remedial Investigation/Feasibility Study (RI/FS) and draft Cleanup Action Plan (CAP) being performed by the Port of Everett at the Bay Wood Products Site (Site) located at 200 West Marine View Drive, Everett, Washington, 98201. The Site may have received releases of hazardous and/or deleterious substances from former on-site tanks and from historical sawmill operations. As presented in the draft RI/FS Work Plan (December 18, 2008), to which this SAP is Appendix B, sawmill activities at the Site date back to the 1930s with operations including a sawmill, pre-fabrication shop, dry kilns, re-saw and planer shed, sorting shed, and numerous lumber storage and transfer sheds. This sediment SAP is being submitted separately from the December 18, 2008 draft RI/FS Work Plan to allow for the consideration of bay-wide sampling results collected throughout Port Gardner Bay, and as discussed with Ecology during the November 24, 2008 project meeting. The western portion of the upland Site was historically used primarily for lumber storage. A log way was located on the southern portion of the Site and large log rafts were located to the northwest and north of the Site. In 1979, Bay Wood Products, Inc., dismantled the sawmill and began using the Site as a log storage and processing yard.

This SAP identifies the purpose and objectives of the sediment data collection, and specifies field and quality assurance/quality control (QA/QC) procedures to be implemented during sampling activities and laboratory analyses to meet the requirements of Washington Administrative Code (WAC) 173-340, Model Toxics Control Act (MTCA) and WAC 173-204, Sediment Management Standards (SMS). The Site background and RI/FS objectives are described in the RI/FS Work Plan.

This SAP includes the following:

- Summary of existing data from previous investigations
- Identification of RI/FS data gaps
- Detailed sediment sampling and analysis plans to complete the RI/FS

2 SEDIMENT DATA COMPILATION AND WORK PLAN RATIONALE

Regulation of contaminated sediments in the marine environment of Washington State falls under the authority of the Washington State Department of Ecology (Ecology). In 1991, Ecology adopted the SMS (Chapter 173-204 WAC) for designating marine sediments that have acute or chronic adverse effects on aquatic organisms. Two sets of standards were established under the SMS: sediment quality standards (SQS) and cleanup screening levels (CSL).

The SQS criteria correspond to sediment quality that will result in no adverse effects, including acute or chronic adverse effects on biological resources and no significant health risk to humans. The SQS includes chemical concentration criteria for 47 chemicals or chemical groups (Table 1). If sediment chemical concentrations exceed SQS chemical concentration criteria, the sediments being evaluated are designated as having a potential adverse effect on biological resources. Sediments exceeding the SQS chemical criteria may be re-evaluated using biological tests described in WAC 173-204-315 and summarized in Table 2 to confirm or refute the original designation.

If sediments exceed SQS chemical or biological criteria, they are subject to sediment cleanup standards set forth in WAC 173-204-520, which establishes sediment chemical and/or biological screening concentrations that determine if contaminated sediments require cleanup. CSLs set the maximum degree of contamination at a site before cleanup is required. Similarly, minimum cleanup levels (MCUL) establish the maximum degree of contamination to be allowed at a site after cleanup and are used in the evaluation of cleanup alternatives as specified in the SMS. Minimum cleanup levels are set at the same concentration as CSLs (see Tables 1 and 2).

There is no promulgated SMS criterion for wood debris in sediment, and cleanup levels for wood debris are approved by Ecology on a case-by-case basis. At several other wood debris sites in Puget Sound, including at the head of the Hylebos Waterway in Tacoma and at the Former Scott Mill in Anacortes, a suite of confirmatory biological tests have been performed on synoptic surface sediment samples collected from locations representing a range of wood debris content with the potential for deleterious effects. These data were then used to develop site-specific sediment cleanup levels for wood debris. Based on Ecology's interpretation of these data, surface sediment total volatile solids (TVS) levels less than approximately 12 percent (dry

weight basis) and/or wood debris levels less than 25 percent (by volume) should not have the potential for site-specific deleterious effects exceeding SQS biological criteria.

There is also no promulgated SMS criterion for diesel and motor oil-range hydrocarbons. Based on Ecology's review of sediment bioassay data available from other similar sites with relatively weathered hydrocarbons, MTCA Method A soil cleanup level for diesel and motor oil-range hydrocarbons (2,000 parts per million [ppm]) is also likely to be protective of sediment and aquatic life exposures

The point of compliance for sediment cleanup is approved by Ecology on a case-by-case basis, but is typically the biologically active zone, which is operationally defined as surface sediments collected across the 0 to 10 centimeter (cm; 0 to 4 inch) interval below the mudline.

2.1 Existing Sediment Quality Data

From July to September 2008, Ecology and Science Applications International Corp. (SAIC) collected samples of sediments and biological tissue from numerous locations throughout Port Gardner Bay to help prioritize cleanup and restoration efforts in this area. Port Gardner Bay is one of seven Puget Sound areas receiving early-action, high-priority attention under the Puget Sound Initiative, a comprehensive effort by state governments and other stakeholders to restore and protect Puget Sound. The Ecology/SAIC sampling in Port Gardner Bay included:

- Sediment profile imaging (SPI), in which a camera penetrated the top 8 to 10 inches of sediments and photographed a cross section of the surface sediment layers
- Collection of fish, clam, and crab tissues for chemical analysis
- Collection of surface sediment grab samples from locations throughout Port Gardner Bay for chemical and biological analyses, with specific station locations selected based on the SPI data
- Video probe and sediment coring at targeted locations for chemical analyses, again based on the SPI data

A total of three surface grabs (Stations A2-23, A2-25, and A2-25B; samples collected 0 to 10 cm below mudline) and one core (Station A2-25; samples collected 1 to 3 feet and 3 to 5 feet below mudline) were obtained by Ecology/SAIC in the Site area, and the samples were

submitted for a wide suite of physical, chemical, and biological analyses. Station locations are depicted on Figure 1 (note that sediments collected from Station A2-24 were archived, and were not submitted for laboratory analysis).

Summaries of validated sediment sampling chemistry data (provided by Ecology on December 29, 2008), along with comparisons with area background concentrations observed at seven stations collected by Ecology/SAIC roughly 1 to 2 miles from the Site and likely removed from Site influence, are presented in Table 3. All surface and subsurface samples collected within the Site area contained chemical concentrations below SQS chemical criteria. Sediment TVS concentrations were also below preliminary (conservative) screening criteria developed from the lowest site-specific standards developed at other regional wood debris sites, including the Hylebos Waterway and the Former Scott Mill. Dioxin/furan concentrations in the Site area were similarly relatively low, and within regional background sediment concentrations previously established by the Dredge Material Management Program (DMMP) for Port Gardiner Bay. Sediment bioassay analyses of these samples are still pending.

2.2 Sediment Data Gaps

Based on a review of the available data, and consistent with the discussion in the draft RI/FS and draft CAP Work Plan (SLR, December 18, 2008), the following sediment data gaps have been identified to complete the RI/FS at the Site:

- Characterize the volume of significant wood debris accumulations at the Site, if any, particularly at locations close to the former log way on the southern portion of the Site that likely received the greatest log handling activity
- Assess Site sediments for diesel and motor oil-range hydrocarbons, particularly at locations closest to former oil storage tanks located in the southern portion of the Site
- Verify compliance with SMS using bioassays at locations affected by wood debris and/or petroleum hydrocarbons
- Collect data as necessary to refine comparative analyses of remedial alternatives, including:
    - Logging the vertical distribution of wood debris at the Site to refine prospective remedial actions in this area, as necessary

- Performing selected physical, chemical, and/or biological analyses to assess disposal options (e.g., potential open-water disposal at the DMMP site in Port Gardiner Bay) and to evaluate the effectiveness of possible cap designs, as appropriate

2.3 Sediment Sampling Work Plan Rationale

Based on the information summarized above, a phased sampling program will be performed, beginning with collection of approximately 10 surface sediment samples located throughout the Site area, and analysis of each sample for conventional parameters (grain size, wood debris percentage, TVS, total organic carbon [TOC], porewater ammonia and sulfide, and diesel and motor oil-range hydrocarbons). Following collaborative evaluation of the data with Ecology, stations with relatively high wood debris and/or hydrocarbon indicators (e.g., relative to cleanup levels developed for other similar sites) would receive follow-on sampling to refine the nature and extent of wood debris and diesel and motor oil-range hydrocarbons at the Site, including sediment borings to define vertical distributions and confirmatory biological determinations to assess potential sediment toxicity. Figure 1 presents proposed sediment sampling stations for the first phase effort. Additional details on the supplemental sediment investigations are provided in Sections 3 and 4.

3 SUPPLEMENTAL SEDIMENT SAMPLING AND ANALYSIS PLAN

This supplemental sediment SAP describes activities to complete the RI/FS and plan for possible future sediment cleanup actions at the Site. The methods and procedures described herein will be followed by Anchor Environmental, L.L.C. (Anchor), SLR, and their subcontractors during various data collection activities beginning in March 2009.

Specific sampling objectives addressed by this SAP are summarized as follows:

- Using a phased sampling program, complete characterization of the nature and extent of wood debris indicator parameters (grain size, percent solids, wood debris percentage, TVS, TOC, and porewater ammonia and sulfide) and diesel and motor oil-range hydrocarbons in surface sediments at the 10 stations depicted on Figure 1 (BW-1 to BW-10).
- Assess Site sediments for hazardous substances at concentrations exceeding SQS chemical criteria by performing analysis of the full suite of SMS chemicals (including dioxins/furans, but excluding tributyltin) on surface sediment samples collected from Stations BW-1 and BW-3 (Figure 1).
- Based on a collaborative review of these data with Ecology, supplemental sediment borings and confirmatory bioassays may need to be performed to complete characterization of the horizontal and vertical distribution of wood debris and diesel and motor oil-range hydrocarbons.
- If significant wood debris or diesel/motor oil-range hydrocarbons are identified at the Site based during sediment coring, 0 to 4-foot and/or 4 to 8-foot composite sediment samples within the primary accumulation area(s) may be collected analyzed for a wide range of physical, chemical, and biological parameters to further characterize chemicals of potential concern and to concurrently assess possible open-water disposal options for these materials. Each of these samples will be analyzed for the full suite of DMMP chemical parameters (including dioxins and furans), along with confirmatory sediment bioassays following DMMP protocols.

The supplemental data collection program described herein, when combined with the data currently available for the Site (summarized in Section 2), is expected to complete site characterization for the purpose of the RI/FS, and provide data to inform the subsequent CAP and remedial design, as necessary.

Sediment sampling activities described herein will be initiated following Ecology's approval. Initial surface sediment sampling is currently scheduled for March 2009. Follow-on sediment core and bioassay sampling is currently targeted for May/June 2009.

The methods and procedures for the collection of field samples, sampling schedule, rationale for the sampling design, and design assumptions for locating and selecting environmental samples are detailed in the sections below. In general, all sampling procedures will comply with Ecology protocols or other approved sample collection standards established for the study area.

3.1 Surface Sample Collection and Processing

This section describes the number and type of surface sediment samples to be collected, the sampling platform, equipment decontamination procedures, and sample collection and processing techniques.

A minimum of 10 surface grab (0 to 10 cm) samples will be collected for physical and chemical analysis, with sampling locations depicted in Figure 1.

3.1.1 Sampling Platform

Surface sediment samples will be collected with a modified van Veen sampler using a vessel equipped with differential global positioning system (DGPS) and a depth sounder.

3.1.2 Horizontal and Vertical Control

Proposed sediment sampling location coordinates are summarized on Table 4. Horizontal positioning at each sampling location will be determined using an on-board DGPS. Station positions will be recorded in latitude and longitude to the nearest 0.01 second. The accuracy of the horizontal coordinates will be within 3 meters. All position coordinates submitted for inclusion in the SEDQUAL and EIM database will be provided in the NAD 83, Washington State North Zone horizontal datum.

Mudline elevation of each sampling station will be determined relative to mean lower low water (MLLW) by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. Tidal elevations will be determined using predicted tide charts available through Tides and Currents® navigation software.

3.1.3 Station and Sample Identification

Each individual sediment sample will be assigned a unique alphanumeric identifier using the format described below:

- Each sample is identified by "BW" for Bay Wood sediment sampling
- Each sediment surface grab sample for bioassay analyses will be identified by "BIO-" for sediment bioassay analysis
- Individual surface station locations will be identified by a number (i.e., 1, 2, etc.)

3.1.4 Sample and Equipment Handling

All equipment and instruments in contact with the sediments will be made of glass, stainless steel, or high density polyethylene (HDPE), and will be cleaned prior to each day's use and between sampling or compositing events. Decontamination of all items will follow this protocol:

- Pre-wash rinse with site water
- Wash with solution of site water and Alconox soap
- Rinse with site water
- Rinse three times with distilled water
- Use immediately or cover (no contact) all decontaminated items with aluminum foil
- Store in clean, closed container for next use

The analytical lab will provide certified, pre-cleaned, Environmental Protection Agency (EPA) approved containers for all samples. Prior to shipping, the analytical laboratory will add preservative, where required, according to Puget Sound Estuary Program (PSEP) (PSEP 1997) and *Sediment Sampling and Analysis Plan Appendix* (SAPA; Ecology 2008) protocols.

Specific sample collection methods are described in the following sections.

3.1.5 Surface Sediment Collection and Processing

Surface sediment samples for laboratory analyses from the 0 to 10-cm biologically active zone will be collected for physical, chemical, and biological testing using a van Veen grab sampler in accordance with PSEP (1997) and SAPA (Ecology 2008) protocols. The sampler is used to collect large volume, surficial sediment samples. The sampler utilizes a modified hydraulic hinged jaw assembly for sample collection. Upon contact with sediments, the jaws are drawn shut to collect the sample. Samples will be collected in the following manner:

- Vessel will maneuver to proposed location.
- Jaw assembly will be decontaminated and deployed.
- The winch cable to the grab sampler will be drawn taut and vertical.
- Location of the cable hoist will be measured and recorded by the location control personnel.
- The jaw assembly will be closed to collect the sediment sample to a penetration depth of approximately 20 cm.
- The sediment sample will be retrieved aboard the vessel and evaluated against the following PSEP acceptability criteria:
  - Grab sampler is not overfilled (i.e., sediment surface is not against the top of sampler)
  - Sediment surface is relatively flat, indicating minimal disturbance or winnowing (For the wood debris characterization samples, acceptable grab samples will allow for minor surface disturbance)
  - Overlying water is present, indicating minimal leakage
  - Overlying water has low turbidity, indicating minimal sample disturbance
  - Desired penetration depth is achieved
- Overlying water will be siphoned off and a stainless steel trowel or similar device will be used to collect a 0 to 10 cm sediment layer from inside the sampler, taking care not to collect sediment in contact with the sides/surface of the sampler.
- The collected sediment will be placed in a stainless steel mixing container. When sufficient sample volume has been collected, the sediment will be homogenized using a stainless steel spoon.

- Homogenized sediment will be placed immediately into appropriate pre-labeled sample containers (pre-cleaned HDPE) and placed immediately on ice for transport to the appropriate laboratory.

3.2 Sediment Coring

Depending on the results of the sediment grab sampling discussed above and following collaborative evaluation of these data with Ecology, sediment cores may be advanced and sampled for physical, chemical, biological analyses.

3.2.1 Sampling Platform

Core sediment sample collection will be conducted off of a vessel operated under the direction of a qualified operator. The vessel will be equipped with a frame and winch, seawater pumps, DGPS, and a depth sounder. All cores will be processed on land and fully logged.

3.2.2 Horizontal and Vertical Control

Horizontal positioning at each sampling location will be determined using an on-board DGPS. Station positions will be recorded in latitude and longitude to the nearest 0.01 second. The accuracy of the horizontal coordinates will be within 3 meters. All position coordinates submitted for inclusion in the SEDQUAL and EIM database will be provided in the NAD 83, Washington State North Zone horizontal datum.

Mudline elevation of each sampling station will be determined relative to MLLW by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. Tidal elevations will be determined using predicted tide charts available through Tides and Currents® navigation software.

3.2.3 Station and Sample Identification

Each individual sediment sample will be assigned a unique alphanumeric identifier using the format described below:

- Each sample is identified by "BW" for Bay Wood Product site sediment sampling.

- Each sediment core sample will be identified by "SEDC-" for sediment core sample.
- Core sample intervals for conventional analyses are identified from the mudline by "A" for the top interval, "B," "C," etc., and the last interval will end 15 cm above the native interface.
- One core interval of the native material will be collected. This interval will be designated "Z" and, if possible, will be a 15-cm interval that starts 15 cm below the native interface.
- Surface bioassay samples, as needed, would be designated "BW-BIO-."

3.2.4 Sediment Core Collection

Sediment cores will be collected at each location using a diver operated impact coring device. The corer will use a decontaminated aluminum barrel for collecting the sediment. The corer will be deployed by winch and sent to the bottom, where the unit will then be energized and lowered to the target coring depth. When that depth is reached, the corer will be turned off and returned to the surface for sample processing. During the coring operation, the penetration of the core barrel will be continuously monitored. The following procedure will be used to decontaminate sample tubes prior to use:

- Rinse and pre-clean with potable water
- Wash and scrub the tubes in a solution of laboratory grade, non-phosphate based soap and potable water
- Rinse with potable water
- Rinse three times with distilled water
- Seal both ends of each core tube with aluminum foil

The core tube caps will be removed immediately prior to placement into the coring device. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used. Logs and field notes of all core samples will be maintained as samples are

collected and correlated to the sampling location map. The following information will be included in this log:

- Mudline elevation of each boring station sampled relative to MLLW
- Location of each boring station as determined by DGPS
- Date and time of collection of each sediment core sample
- Names of field supervisor and person(s) collecting and logging the sample
- Observations made during sample collection including: weather conditions, complications, ship traffic, and other details associated with the sampling effort
- The sample station number
- Length and depth intervals of each core section relative to MLLW and recovery for each sediment sample; acceptable core samples will achieve a minimum of 70 percent recovery
- Qualitative notation of apparent resistance of sediment column to coring
- Any deviation from the approved sampling plan

Core tubes will be capped and placed on a rack for processing.

3.2.5 Core Processing

The core tube will be cut length-wise with an electric saw. Care will be taken to prohibit contact of the saw blade with the sediment. Each core section will be logged throughout the full penetration depth. A sediment description of each core sample will be recorded on the core log for the following parameters as appropriate and present:

- Sample recovery (depth in feet of penetration and estimated sample compaction)
- Physical soil description in accordance with the Unified Soil Classification System (USCS; includes soil type, density/consistency of soil, color)
- A description of wood debris including size of debris and percent by volume in each core section
- Odor (e.g., hydrogen sulfide, petroleum)
- Vegetation
- Debris
- Any other distinguishing characteristics or features

The cores will be sectioned in representative intervals based on core lithology starting at the mudline, and up to four samples per core will be collected representing non-native material (i.e., wood debris). The last interval of non-native material will end 15 cm above the native interface.

One sample of the native material (Z-layer samples) will also be collected. If possible, the "Z" samples will be collected 15 cm below the native interface and will consist of a 15-cm interval.

The sediment retrieved from each core that will contribute to a given sample will be homogenized by thoroughly mixing with stainless steel utensils until the sediment appears uniform in color and texture, except that porewater samples will not be homogenized. For porewater, homogenization is not performed to minimize disruption of the sample.

The homogenized sample material will be placed into the appropriate sample jars and stored on ice until shipment to the appropriate laboratories. The homogenate will be mixed throughout the process of filling sample jars to ensure that each sample jar is representative of the homogenate mixture. After placement of sample material into sample containers, each container will be firmly sealed, clearly labeled with the name of the project, sample number, type of analysis, date, time, and initials of the person preparing the sample. This information will be recorded in the logbook and on the chain of custody (COC) forms. Following proper sealing and labeling, all sample containers will be placed on ice in a cooler or container and maintained at 4°C.

3.2.6 Equipment Decontamination Procedures

Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment sample material must meet high standards of cleanliness. All equipment and instruments used that are in direct contact with the sediment collected for analysis will be made of glass, stainless steel, or HDPE, and will be cleaned prior to each day's use and between sampling or compositing events. Decontamination of all items will follow PSEP protocols. The decontamination procedure follows:

- Pre-wash rinse with site water
- Wash with solution of laboratory grade non-phosphate based soap (brush)
- Rinse with site water
- Rinse three times with laboratory grade distilled water
- Cover (no contact) all decontaminated items with aluminum foil
- Store in clean, closed container for next use

3.3 Quality Assurance and Quality Control

Field and laboratory activities must be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for QA/QC is derived from the protocols developed for the PSEP (1997), EPA SW-846, the EPA Contract Laboratory Program, and the cited methods.

3.3.1 Field Quality Control

Sampling personnel will identify and label samples in a consistent manner to ensure that field samples are traceable and that labels provide all information necessary for the laboratory to conduct required analyses properly. Samples will be placed in appropriate containers and preserved for shipment to the laboratory.

3.3.2 Sample Containers

Sample containers and preservatives will be provided by the laboratory. The laboratory will maintain documentation certifying the cleanliness of bottles and the purity of preservatives provided.

3.3.3 Sample Identification and Labels

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label at the time of collection:

- Project name
- Sample identification
- Date and time of sample collection
- Preservative type (if applicable)

Samples will be uniquely identified with a sample identification that at a minimum specifies sample matrix, sample number, sample location, and type of sample.

3.3.4 Sample Custody and Shipping Requirements

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).

COC procedures will be followed for all samples throughout the collection, handling, and analysis process. Each sample will be represented on a COC form the day it is collected. All data entries will be made using indelible ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Blank lines/spaces on the COC form will be lined-out, dated, and initialed by the individual maintaining custody.

A COC form will accompany each cooler of samples to the analytical laboratories. Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. Copies of all COC forms will be retained in the project files.

All samples will be shipped or delivered to the analytical laboratory no later than the day after collection. Samples collected on Friday may be held until the following Monday for shipment/delivery provided that this does not jeopardize any hold time requirements. Specific sample shipping procedures follow. If samples are hand-delivered to the laboratory, samples will be placed on ice and accompanied by a COC, but other steps will not be required.

- Each cooler or container containing the samples for analysis will be shipped via overnight delivery to the appropriate analytical laboratory. In the event that Saturday delivery is required, the Field Operations Coordinator will contact the analytical laboratory before 3 p.m. on Friday to ensure that the laboratory is aware of the number of coolers shipped and the airbill tracking letters for those coolers. Following each shipment, the Field Operations Coordinator will call the

laboratory and verify the shipment from the day before has been received and is in good condition.

- Coolant ice will be sealed in separate double plastic bags and placed in the shipping containers.
- Individual sample containers will be placed in a sealable plastic bag, 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.
- 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.
- The shipping waybill number will be documented on all COC forms accompanying the samples.
- A sealed envelope containing COC forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- A minimum of two signed and dated COC seals will be placed on adjacent sides of each cooler prior to shipping.
- Each cooler will be wrapped securely with strapping tape, labeled "Glass – Fragile" and "This End Up," and will be clearly labeled with the laboratory's shipping address and the consultant's return address.

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

3.3.5 Field Quality Assurance Sampling

Field QA procedures will consist of following standard operating procedures (SOPs) for acceptable practices for collecting and handling of samples. Adherence to these procedures will be complemented by periodic and routine equipment inspection.

Field QA samples will be collected along with the environmental samples. Field QA samples are useful in identifying possible problems resulting from sample collection or sample processing in the field. The collection of field QA samples includes homogenized field duplicates and matrix spike/matrix spike duplicates (MS/MSDs) as described below. Field duplicates will be collected at a frequency of one per 10 samples collected. MS/MSD samples will be collected at a frequency of one per sampling event or one in 20 samples processed, whichever is more frequent.

Field duplicate samples for soil will be prepared by homogenizing sufficient soil volume for two sample sets: one field sample and one blind field duplicate. The blind field duplicate will be labeled with a fictitious sample location name and will be analyzed for the same constituent list as the original sample. The actual sample location will be recorded in the field notes but will not be identified to the analytical laboratory.

The MS/MSD samples will also include the collection of additional sample volume, to ensure that the laboratory has sufficient sample volume to run the program-required analytical QA/QC samples for analysis. MS/MSD samples will be identified as MS/MSD samples on sample labels and the COC, and will retain the same sample identifier as the original sample. All field QA samples will be documented in the field logbook and verified by the QA/QC Coordinator or designee.

3.4 Field Instruments/Equipment

In accordance with the QA program, field staff shall maintain an inventory of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The Field Operations Coordinators will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. The equipment maintenance information will be documented in the instrument's calibration log. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturer's instruction manuals.

All maintenance records will be verified prior to each sampling event. The Field Operations Coordinator will be responsible for verifying that required maintenance has been performed prior to using the equipment in the field.

The subcontractor responsible for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. No other field equipment requires testing or calibration. The winch line and grab sampler will be inspected daily for fraying, misalignment of jaws, loose connections, and any other applicable mechanical problems. Any problems will be noted in the field logbook and corrected prior to continuing sampling operations.

4 QUALITY ASSURANCE PROJECT PLAN

This quality assurance project plan (QAPP) establishes QA objectives and functional activities associated with supplemental sediment sampling to complete the RI/FS and plan for possible future sediment cleanup actions at the Site. The methods and QA procedures described herein will be followed during various data collection activities beginning in March 2009.

The goal of this QAPP is to ensure that data of sufficiently high quality are generated to support the project data quality objectives (DQOs). This section describes project management responsibilities, sampling and analytical procedures, assessment and oversight, and data reduction, validation, and reporting. This QAPP was prepared following Ecology *Guidance for Quality Assurance Project Plans* (Lombard and Kirchmer 2004) and Ecology's SAPA guidance (Ecology 2008). Analytical QA/QC procedures were also developed based on the analytical protocols and quality assurance guidance of the PSEP (PSEP 1986, 1997).

4.1 Project Management

This section identifies key project personnel, identifies the studies to be performed and their respective schedules, outlines project DQOs and criteria, lists training and certification requirements for sampling personnel, and describes documentation and record keeping procedures.

4.1.1 Project Team/Task Organization

Responsibilities of the team members, as well as laboratory project managers, are described in the following paragraphs and this supplements the primary contacts and roles listed in the Work Plan (Section 2.1). Since the individuals listed below may change over time, the SAP has been written to include "designee" as an alternate to the team members listed. The following paragraphs define their functional responsibilities.

Mr. Scott Miller is the Project Coordinator for the Port of Everett and is responsible for project communications with Ecology, the Port of Everett, and subcontractors.

Mr. Clay Patmont of Anchor will be the overall sediment assessment project manager responsible for this sediment assessment portion of this project. Mr. Patmont will be responsible for timely and successful completion of the sediment characterization.

The Field Sampling Supervisor will be responsible for implementation of this SAP. Following plan approval by Ecology, the Field Sampling Supervisor will provide copies of the approved sampling plan to all sampling and testing subcontractors, ensure that laboratory personnel use acceptable protocols for chemical and physical analysis, QA/QC, and reporting.

The Field Operations Coordinator will provide overall direction to the sediment sampling in logistics, personnel assignments, and field operations. The Field Operations Coordinator will supervise field collection of the sediment surface and core samples and will be responsible for ensuring accurate sample positioning; recording sample locations, depths, and identification; ensuring conformity to sampling and handling requirements, including field decontamination procedures; physical evaluation and logging the samples; and COC of the samples. The Field Operations Coordinator is responsible for notifying the laboratory of sample delivery, ensuring samples are packaged properly for transportation, and ensuring sample delivery to the laboratory or sample pickup by the laboratory.

The samples will be physically evaluated, homogenized, and placed in appropriate sample containers. Appropriate protocols for decontamination, sample compositing, sample preservation, and holding times will be observed. Field staff will be responsible for documenting sample preparation, observations, and COC up until the time the samples are delivered for analysis to the analytical laboratory. Field staff will be responsible for writing a report detailing field sampling activities. This report will include details of the sampling effort, sample preparation, sample storage/transport procedures, and field quality assurance.

Ms. Sue Dunnihoo of Analytical Resources Incorporated (ARI) will be responsible for physical and chemical analyses. Ms. Dunnihoo will coordinate handling and analysis of the submitted samples in accordance with Ecology-approved analytical testing protocols, QA/QC requirements, and requirements as specified in this or a subsequent revised QAPP. A written report of analytical results and QA/QC procedures will be

prepared by Ms. Dunnihoo and included as an appendix in the final report in hard copy and electronic format.

Mr. Bill Gardner of NewFields Northwest, Port Gamble, Washington, will be responsible for the sediment bioassays and associated data analyses. Mr. Gardner will also provide oversight during bioassay sample collection. NewFields Northwest will analyze the samples received in accordance with the analytical testing and QA/QC requirements specified by this QAPP. A written report of the bioassay results and QA/QC procedures will be prepared by NewFields Northwest and included as an appendix in the final sampling and analysis results report.

The analytical testing laboratories will be responsible for the following:

- Perform the methods outlined in the SAP, including those methods referenced for each analytical procedure
- Follow documentation, custody, and sample logbook procedures
- Implement QA/QC procedures required by PSEP (1986; 1997) and Ecology (2008)
- Meet all reporting and QA/QC requirements
- Deliver electronic data files as specified in the SAP
- Meet turnaround times for deliverables as described in the SAP
- Allow Ecology and the QA/QC contractor to perform laboratory and data audits

The Project QA Manager will perform QA oversight for both the field sampling and laboratory programs. The Project QA Manager will be kept fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation. The Project QA Manager will record and correct any activities that vary from the QAPP. Upon completion of the sampling and analytical program, the laboratory QA/QC results and incorporate findings into the final sampling and analysis report will be reviewed. Any QA/QC problems will be brought to the attention of Ecology as soon as possible to discuss issues related to the problem and to evaluate potential solutions. The Project QA Manager will ensure data quality by conducting data review, verification, and validation.

4.2 Data Quality Objectives and Criteria

The DQO for this project is to ensure that the data collected are of known and acceptable quality so that the project objectives described above can be achieved. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness (the "PARCC" parameters). Definitions of these parameters and the applicable QC procedures are given below. Applicable quantitative goals for these data quality parameters are listed or referenced below.

4.2.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling, and in laboratory analysis. The American Society of Testing and Materials (ASTM 2002) recognizes two levels of precision: repeatability—the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions; and reproducibility—the random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material.

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field precision will be evaluated by the collection of blind field duplicates for chemistry samples at a frequency of one in 20 samples. Field chemistry duplicate precision will be screened against a RPD of 50 percent for sediment samples and 35 percent for water samples. However, no data will be qualified based solely on field homogenization duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit (MDL), where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

4.2.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory-fortified blanks, standard reference materials, and standard solutions. In addition, laboratory-fortified (i.e., matrix-spiked) samples are also measured; this indicates the accuracy or bias in the actual sample matrix. Accuracy is expressed as percent recovery (%R) of the measured value, relative to the true or expected value. If a measurement process produces results whose mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis (e.g., extraction efficiencies) or caused by an artifact of the measurement system (e.g., contamination). Analytical laboratories utilize several QC measures to eliminate analytical bias, including systematic analysis of method blanks, laboratory control samples, and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a %R in those analyses

where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \times (S-U)/Csa$$

Where:

%R = percent recovery
S = measured concentration in the spiked aliquot
U = measured concentration in the unspiked aliquot
Csa = actual concentration of spike added

Field accuracy will be controlled by adherence to sample collection procedures outlined in this SAP.

4.2.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents an environmental condition. For the Bay Wood Products site, the list of analytes has been identified to provide a comprehensive assessment of the potential contaminants in potentially stemming from historical activities at the Site.

4.2.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats, and of common traceable calibration and reference materials.

4.2.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{\text{(Number of acceptable data points)} \times 100}{\text{(Total number of data points)}}$$

The DQO for completeness for all components of this project is 100 percent. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

4.2.6 Sensitivity

Analytical sensitivities must be consistent with or lower than the regulated criteria values in order to demonstrate compliance with this SAP. When they are achievable, target detection limits specified in this SAP will be at least a factor of 2 less than the analyte's corresponding regulated criteria value.

The MDL is defined as the minimum concentration at which a given target analyte can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Laboratory MDLs will be used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program. Laboratory reporting limits (RLs) are defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions for that particular method.

The sample practical quantitation limits (PQLs) will be reported by the laboratory and will take into account any factors relating to the sample analysis that might decrease or increase the reporting limit (e.g., dilution factor, percent moisture, sample volume, sparge volume). In the event that the RL and PQL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, causing the SMS criteria to be exceeded, the data will be evaluated by Anchor and the laboratory to determine if an alternative course of action is required or possible. If this situation cannot be resolved readily (i.e., detection limits less than criteria achieved), Ecology will be contacted to discuss an acceptable resolution.

4.2.7 Special Training Requirements/Certifications

For sample preparation tasks, it is important that field crews are trained in standardized data collection requirements, so that the data collected are consistent among the field

crew. All field crew are fully trained in the collection and processing of surface and subsurface sediment, decontamination protocols, visual inspections, and COC procedures.

In addition, the 29 CFR 1910.120 Occupational Safety and Health Administration (OSHA) regulations require training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the OSHA regulations.

4.3 Physical and Chemical Testing

ARI, an Ecology-certified laboratory located in Tukwila, Washington, will conduct all physical and chemical testing for sediments (Accreditation # C1235). Sediment samples for dioxin and furan analyses by EPA Method 1613 will be analyzed either by ARI or Test America Laboratories, located in West Sacramento, California. Both laboratories are Ecology-certified for dioxin/furan analysis by EPA Method 1613.

All chemical/physical testing will adhere to the most recent PSEP QA/QC procedures (PSEP 1997) and PSEP analysis protocols. Method 9060 (EPA 1986) will be used for the analysis of TOC because the analytical method for TOC in PSEP (1986) is now out of date.

Guidelines for sampling handling and storage are provided in Table 5. The overall chemistry DQOs for the sediment investigation are summarized in Table 6. The laboratory quality control sample analysis frequencies are provided in Table 7. Sediment chemistry analytical methods and target detection limits are presented in Table 8.

In addition to the field QA/QC procedures that will be implemented, one of the samples submitted for chemical analysis will be analyzed as a laboratory MS/MSD. Additional laboratory quality control will include method blanks, method blank spikes, surrogate compound analysis, and standard reference material analysis.

In completing chemical analyses for this project, the laboratory is expected to meet the following minimum requirements:

- Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure
- Provide a detailed discussion to any modifications made to approved analytical methods (e.g., SOPs)
- Deliver fax, hard copy, and electronic data as specified
- Meet reporting requirements for deliverables
- Meet turnaround times for deliverables
- Implement QA/QC procedures, including data quality requirements, laboratory QA requirements, and performance evaluation testing requirements
- Allow laboratory and data audits to be performed, if deemed necessary

4.3.1 Laboratory Instruments/Equipment

In accordance with the QA program, the laboratories shall maintain an inventory of instruments and equipment and the frequency of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The laboratory preventative maintenance program, as detailed in their QA Plan, is organized to maintain proper instrument and equipment performance, and to prevent instrument and equipment failure during use. The program considers instrumentation, equipment, and parts that are subject to wear, deterioration, or other changes in operational characteristics, the availability of spare parts, and the frequency at which maintenance is required. Any equipment that has been overloaded, mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The client will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data.

Laboratories will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. All maintenance records will be checked according to the schedule on an annual basis and recorded by the

responsible individual. The Laboratory QA Manager, or designee, shall be responsible for verifying compliance.

4.3.2 Instrument Calibration

Proper calibration of equipment and instrumentation is an integral part of the process that provides quality data. Instrumentation and equipment used to generate data must be calibrated at a frequency that ensures sufficient and consistent accuracy and reproducibility.

4.3.3 Laboratory Instrument/Equipment Calibration

As part of their QC program, laboratories perform two types of calibrations. A periodic calibration is performed at prescribed intervals (i.e., balances, drying ovens, refrigerators and thermometers), and operational calibrations are performed daily, at a specified frequency, or prior to analysis (i.e., initial calibrations) according to method requirements. Calibration procedures and frequency are discussed in the laboratory QA Plan. Calibrations are discussed in the laboratory SOPs for analyses.

The Laboratory QA/QC Coordinator will be responsible for assuring that the laboratory instrumentation is calibrated in accordance with specifications. Implementation of the calibration program shall be the responsibility of the respective Laboratory Group Supervisors. Recognized procedures (EPA, ASTM, or manufacturer's instruction) shall be used when available.

Physical standards (i.e., weights or certified thermometers) shall be traceable to nationally recognized standards such as the National Institute of Standards and Technology (NIST). Chemical reference standards shall be NIST Standard Reference Materials (SRMs) or vendor certified materials traceable to these standards.

The calibration requirements for each method and respective corrective actions shall be accessible, either in the laboratory SOPs or the laboratory's QA Plan for each instrument or analytical method in use. All calibrations shall be preserved on electronic media.

4.3.4 Laboratory Quality Control

Laboratory QC procedures, where applicable, include initial and continuing instrument calibrations, standard reference materials, laboratory control samples, matrix replicates, MS, surrogate spikes (for organic analyses), and method blanks. Results of the quality control samples from each sample group will be reviewed by the analyst 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 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.

4.3.5 Laboratory Instrument Calibration and Frequency

A calibration factor will be verified on each laboratory instrument to be used at the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria. Ongoing calibration will be performed daily prior to any sample analysis to track instrument performance.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to continuing calibration verification at the instrument for each type of applicable analysis. The frequency of continuing calibration will be one blank for every 10 samples analyzed, or daily, whichever is more frequent. If the ongoing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to meet control specifications. All project samples analyzed while instrument calibration was out of control will be reanalyzed.

4.3.6 Laboratory Replicates/Duplicates

Analytical replicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical replicates are subsamples of the original sample that are prepared and analyzed as a separate sample. Analytical duplicates are performed, for example, to confirm an analytical result. The analytical duplicates are therefore two separate tests of the sample run for comparison of results.

4.3.7 Matrix Spikes and Matrix Spike Duplicates

Analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate matrix spike analyses, information on the precision of the method is also provided for organic analyses.

4.3.8 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. The method blank for all analyses must contain less than five times the reporting limit of any single target analyte/compound. If a laboratory method blank exceeds this criterion for any analyte/compound, and the concentration of the analyte/compound in any of the samples is less than five times the concentration found in the blank, analyses must stop and the source of contamination must be eliminated or reduced.

4.3.9 Laboratory Control Samples

Laboratory control samples are analyzed to assess possible laboratory bias at all stages of sample preparation and analysis. The laboratory control sample is a matrix-dependent spiked sample prepared at the time of sample extraction along with the preparation of sample and MSs. The laboratory control sample will provide information on the precision of the analytical process, and when analyzed in duplicate, will provide accuracy information as well.

4.3.10 Laboratory Deliverables

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Data quality will be assessed based on PSEP (1997) protocols by considering the following:

- Holding times
- All compounds of interest reported
- Reporting limits
- Surrogate spike results
- MS/MSD results
- Blank spikes

- Laboratory control samples/laboratory control sample duplicates
- Standard reference material results
- Method blanks
- Detection limits

4.4 Biological Testing

NewFields Northwest, an Ecology-certified laboratory located in Port Gamble, Washington, will conduct the bioassay testing (Accreditation # C2021). Bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out background conditions and sediment grain size effects on bioassay organisms. Reference sediments from Carr Inlet will be collected concurrently with the Site samples.

All bioassay sediment samples will be stored at 4° C, with no headspace, or under a nitrogen atmosphere (i.e., nitrogen-purged headspace). All bioassays will commence within 14 days from collection of the first grab sample to be tested. If necessary, retests will commence within 56 days from collection of the first grab sample to be tested. The laboratory will maintain chain-of-custody procedures throughout biological testing.

Three bioassays, including amphipod mortality, larval development, and juvenile polychaete growth tests, will be conducted on samples identified for biological testing based on collaborative evaluation with Ecology of the initial grab sampling data (Figure 1). All biological testing will be in compliance with PSEP (1995) and the Sediment SAPA (Ecology 2003, revised 2008), with appropriate modifications as specified by the Sediment Management Annual Review Meeting (SMARM). Ammonia reference toxicant tests may be conducted if elevated ammonia concentrations are identified in porewater. General biological testing procedures and specific procedures for each sediment bioassay are summarized in the following sections.

4.4.1 Amphipod Mortality Bioassay

Because of variable porewater salinities anticipated at the Site, the test organism to be used for this SAP is *Ampelisca abdita.* The tests will be run for a 10-day exposure period, followed by counting of the surviving animals. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded.

4.4.2 Larval Development Bioassay

The blue mussel (*Mytilus galloprovincialis)* or similar seasonally appropriate species, such as the sand dollar, D*endraster excentricus*, will be used for the larval development test. 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 (PSEP 1995). At the end of the test, larvae from each test sediment replicate exposure are examined to quantify abnormality and mortality.

4.4.3 Juvenile Polychaete Growth Bioassay

The polychaete (*Neanthes* sp.) will be used for the chronic juvenile polychaete growth test. The sediment juvenile polychaete bioassay will be run for a 20-day exposure period, followed by counting and weighing of the surviving animals (PSEP 1995). At the end of the test, mean individual growth rate is calculated for each replicate exposure as the difference between final and initial weights divided by the exposure duration.

4.4.4 Confirmatory Biological Test Interpretation and QA/QC

Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. The SMS biological effects criteria are summarized in Table 2.

4.4.4.1 Test Quality Assurance/Quality Control

Sediment toxicity tests will incorporate standard QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls, reference sediment samples, lab replicates, and measurements of water quality during testing.

4.4.4.2 Negative Controls

The negative control to be used for both sediment toxicity tests will be a clean control, which consists of a clean, inert material and the same seawater used in testing sediment toxicity. For the tests to be used in this study, the negative control will be the amphipod collection site sediment, which will most likely be sand

collected from Yaquina Bay, Oregon. The negative control for the bivalve larval test will be a seawater control.

4.4.4.3 Positive Controls

A positive control will be run for each bioassay using the same batch of organisms used in the test. 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. The positive control for sediment tests is typically conducted with diluent seawater and without sediment. Cadmium chloride will be used as the reference toxicant for the amphipod and juvenile polychaete tests. Copper sulfate will be used as the reference toxicant for the bivalve larval test.

4.4.4.4 Reference Sediment

Reference sediment will also be included with each bioassay, tested concurrently with test sediments to provide data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size. Reference sediment samples will be collected from an area documented to be free from chemical contamination and will represent the range of important natural, physical, and chemical characteristics of the test sediments (e.g., sediment grain size and TOC). For this study, reference sediment samples will be collected from Carr Inlet, Washington (PSEP 1995). All bioassays have performance standards for reference sediments as mentioned above. Failure to meet these standards may result in the requirement to retest.

4.4.4.5 Replicates

Five replicate chambers for each test sediment, reference sediment, and negative controls treatment will be run for each bioassay. A water quality replicate will also be run for each treatment.

4.4.4.6 Water Quality Monitoring

Water quality monitoring will be conducted for the amphipod, larval, and juvenile polychaete bioassays and reference toxicant tests. This consists of daily measurements in each test replicate of salinity, temperature, pH, and dissolved

oxygen (DO) for the amphipod and larval tests. These measurements will be made every 3 days for the juvenile polychaete bioassay, with the exception of DO, which will be measured daily. Ammonia and sulfides in the overlying water will be determined 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).

4.4.4.7 Interpretation

Test interpretation consists of endpoint comparisons of test sediments to the measurements observed in the controls and in reference sediments on an absolute percentage basis, as well as statistical comparison between the test and reference endpoints, where appropriate. Test interpretation will follow the guidelines established through the DMMP/SMS review process.

4.4.4.8 Bioassay Retest

Any bioassay retests must be fully coordinated with, and approved by Ecology, who will be contacted to handle this coordination.

4.4.4.9 Data Deliverables

The laboratory conducting the bioassay tests will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. The bioassay laboratory for this study will be required to report results that include all information recommended by PSEP protocols for quality assurance review, as follows:

- A description of any deviations from the methodology or problems with the process and procedures of analyses.
- Test methods used for bioassay testing and statistical analyses.
- Results for survival, growth, reburial, abnormalities, water quality parameters, reference toxicant, and statistical analyses. A reference toxicant control chart will be submitted for each test organism showing the temporal changes in the mean and the 95 percent CI or positive and negative 2 STD and include the LC50s at each of 12 previous reference toxicant tests to be acceptable.

- Original data sheets for water quality, survival, growth, reburial, abnormalities, reference toxicant, and statistics.
- COC records.

Close contact with the laboratory will be maintained to resolve any QA/QC problems in a timely manner.

4.5 Data Management

Field data sheets will be checked for completeness and accuracy by the Field Operations Coordinator prior to delivery to the Project QA Manager. All data generated in the field will be documented on hard copy and provided to the Project QA Manager, who is responsible for the data's entry into the database. All manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete.

Laboratory data will be provided to the Project QA Manager in the EQuIS electronic format. Laboratory data that is electronically provided and loaded into the database will undergo a 10 percent check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers, if assigned, will be entered manually. The accuracy of all manually entered data will be verified by a second party. Data tables and reports will be exported from EQuIS to MS Excel tables.

4.6 Assessments and Response Actions

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

A full data quality review will be performed in accordance with *EPA National Functional Guidelines* (EPA 1999 and 2004). The data will be evaluated in accordance with this QAPP. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis:

- COC documentation
- Holding times

- Instrument calibration
- Method blanks
- Detection limits
- Reporting limits
- Surrogate recoveries
- MS/MSD recoveries
- Laboratory control sample recoveries
- Laboratory and field duplicate RPDs

The results of the data quality review, including text assigning qualifiers in accordance with the Ecology EIM and SEDQUAL and a tabular summary of qualifiers, will be generated by the Project QA Manager and assessed for confirmation of the validity of the data. A copy of the validation report will be submitted by the Project QA Manager and will be presented as an appendix to the final sampling and analysis results report.

4.6.1 Compliance Assessments

Laboratory and field performance audits consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study; however, all laboratory audit reports will be made available to the Project QA Manager upon request. The laboratory is required to have written procedures addressing internal QA/QC; these procedures have been submitted and will be reviewed by the Project QA Manager to ensure compliance with this SAP. The laboratory must ensure that personnel engaged in sampling and analysis tasks have appropriate training. The laboratory will, as part of the audit process, provide for consultant's review written details of any and all method modifications planned.

The laboratory is required to comply with their SOPs. The Laboratory QA Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Laboratory QA Manager will be notified immediately if any QC sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before

continuing with the sample analysis. The Laboratory QA Manager will document the corrective action taken in a memorandum submitted to the Project QA Manager within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package in the form of a cover letter.

4.6.2 Reports to Management

Quality assurance reports to management include verbal status reports, written reports on field sampling activities and laboratory processes, data validation reports, and final project reports. These reports shall be the responsibility of the Project QA Manager.

Progress reports will be prepared by the Field Operation Coordinator following each sampling event. The Project QA Manager will also prepare progress reports after the sampling is completed and samples have been submitted for analysis, when information is received from the laboratory, and when analysis is complete. The status of the samples and analysis will be indicated with emphasis on any deviations from this QAPP. A data report will be written after validated data are available for each sampling event. These reports will be delivered electronically to the SLR Project Coordinator and the Anchor Project Manager.

4.7 Data Validation and Usability

This section describes the processes that will be used to review project data quality.

4.7.1 Data Review, Validation, and Verification

During the validation process, analytical data will be evaluated for method quality control and laboratory quality control compliance, and its validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers will be entered into the project database, thus enabling this information to be retained or retrieved, as needed.

4.7.2 Validation and Verification Methods

Data validation includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the Field Operations Coordinator and Laboratory QA Manager; review by the Project QA Manager for outliers and omissions; and the use of QC criteria to accept or reject specific data. All data will be entered into the EQuIS database and a raw data file printed. One hundred percent verification of the database raw data file will be performed by a second data manager or designee. Any errors found will be corrected on the raw data printout sheet. After the raw data is checked, the top sheet will be marked with the date the checking is completed and the initials of the person doing the checking. Any errors in the raw data file will be corrected, and the database established.

All laboratory data will be reviewed and verified to determine whether all DQOs have been met, and that appropriate corrective actions have been taken, when necessary. The Project QA Manager or designee will be responsible for the final review of all data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during generation of data. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

The analysts and/or laboratory department manager will prepare a preliminary QC checklist for each parameter and for each sample delivery group (SDG) as soon as analysis of an SDG has been completed. Any deviations from the DQOs listed on the checklist will be brought to the attention of the Laboratory QA Manager to determine whether corrective action is needed and to determine the impact on the reporting schedule.

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Data

quality will be assessed by a reviewer using current Functional Guidelines data validation requirements (EPA 1999 and 2004) by considering the following:

1. Holding times
2. Initial calibrations
3. Continuing calibrations
4. Method blanks
5. Surrogate recoveries
6. Detection limits
7. Reporting limits
8. Laboratory control samples
9. MS/MSD samples
10. Standard reference material results

The data will be validated in accordance with the project specific DQOs described above, analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

4.7.3 Reconciliation with User Requirements

The Project QA Manager will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the Project QA Manager will review the errors and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors. They will suggest corrective action. It is expected that the problem would be able to be corrected by retraining, revision of techniques, or replacement of supplies/equipment; if not, the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the Project QA Manager will recommend appropriate modifications. Any revisions will require approval by Ecology.

4.8 Documentation and Records

This project will require central project files to be maintained at SLR and Anchor. Project records will be stored and maintained in a secure manner. Each project team member is responsible for filing all necessary project information or providing it to the person responsible for the filing system. Individual team members may maintain files for individual tasks but must provide such files to the central project files upon completion of

each task. A project-specific index of file contents is to be kept with the project files. Hard copy documents will be kept on file at SLR and Anchor throughout the duration of the project.

4.8.1 Field Records

All documents generated during the field effort are controlled documents that become part of the project file.

4.8.2 Field Logs

Field team members will keep a daily record of significant events, observations, and measurements in a field log. All field activities will be recorded in a bound, paginated field logbook maintained by the Field Operations Coordinator or a designee for each activity. Field logbooks will be the main source of field documentation for all field activities. The on-site field representative will record in the field logbook information pertinent to the investigation program. The sampling documentation will contain information on each sample collected, and will include at a minimum the following information:

- Project name
- Field personnel on site
- Facility visitors
- Weather conditions
- Field observations and any deviations from the SAP
- Maps and/or drawings
- Date and time samples collected
- Sampling method and description of activities
- Identification or serial numbers of instruments or equipment used
- Deviations from the SAP

Entries for each day will begin on a new page. The person recording information must enter the date and time and initial each entry. Additional specific field reporting requirements and checklists for each study are defined in the SAP. In general, sufficient information will be recorded during sampling to permit reconstruction of the event without relying on the memory of the field personnel.

The field logbooks will be permanently bound and durable for adverse field conditions. All pages will be numbered consecutively. All pages will remain intact, and no page will be removed for any reason. Notes will be taken in indelible, waterproof blue or black ink. Errors will be corrected by crossing out with a single line, dating, and initialing. The front and inside of each field logbook will be marked with the project name, number, and logbook number. The field logbooks will be stored in the project files when not in use and upon completion of each sampling event.

Sample collection checklists will be prepared prior to each sampling program. The checklist will include location designations, types of samples to be collected, and whether any QC samples are to be collected.

4.8.3 Analytical and Chemistry Records

Analytical data records will be retained by the laboratory and in the Anchor central project files. For all analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of all raw data. The analytical laboratory will be required, where applicable, to report the following:

- Project Narrative. This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, QC, sample shipment, sample storage, and analytical difficulties. Any actual or perceived problems encountered, and their resolutions, will be documented in as much detail as appropriate.
- Chain of Custody Records. Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented on a sample receipt form. The form must include all cooler temperatures measured at the time of sample receipt.
- Sample Results. The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code

  - Sample matrix
  - Date of sample extraction
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Identification of the instrument used for analysis
  - Method detection limits
  - Method reporting limits accounting for sample-specific factors (e.g., dilution, total solids)
  - Analytical results with reporting units identified
  - Data qualifiers and their definitions
  - A computer disk with the data in a format specified in advance by Anchor

- QA/QC Summaries. This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
- Calibration Data Summary. This summary will report the concentrations of the initial calibration and daily calibration standards, and the date and time of analysis. The response factor, percent relative standard deviation, percent difference, and retention time for each analyte will be listed, as appropriate. Results for standards to indicate instrument sensitivity will be documented.
- Internal Standard Area Summary. The stability of internal standard areas will be reported.
- Method Blank Analysis. The method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks will be reported.
- Surrogate Spike Recovery. This will include all surrogate spike recovery data for organic compounds. The name and concentration of all compounds added, percent recoveries, and range of recoveries will be listed.
  - Matrix Spike Recovery. This will report all MS recovery data for organic and metal compounds. The name and concentration of all compounds added,

%R, and range of recoveries will be listed. The RPD for all duplicate analyses will be included.

- Matrix Duplicate. This will include the %R and associated RPD for all matrix duplicate analyses.
- Laboratory Control Sample. All laboratory control sample recovery data for organic and metal compounds will be reported. The name and concentration of all compounds added, %R, and range of recoveries will be listed. The RPD for all duplicate analyses will be included.
- Relative Retention Time. This will include a report of the relative retention time of each analyte detected in the samples for both primary and conformational analyses.

- Original Data. Legible copies of the original data generated by the laboratory will include:
  - Sample extraction, preparation, identification of extraction method used, and cleanup logs
  - Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
  - Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample
  - Printouts of chromatograms and quantitation reports for each instrument used, including reports for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials
  - Original data quantification reports for each sample
  - Original data for blanks and samples not reported

All instrument data shall be fully restorable at the laboratory from electronic backup. Laboratories will be required to maintain all records relevant to project analyses for a minimum of 7 years. Data validation reports will be maintained in the central project files with the analytical data reports.

4.8.4 Data Reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the Laboratory QA Manager, the Project Manager, the Project QA Manager, and independent reviewers. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

Chemistry data will be presented with accompanying regulatory criteria. Data exceeding the regulatory criteria will be highlighted or boxed, rather than shaded, to allow for photocopying. SEDQUAL and EIM templates (in the appropriate format) will be submitted with the data report to Ecology via electronic email.

5 REFERENCES

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TABLES

Table 1
Summary of Sediment Management Standards Chemical Criteria for Puget Sound

Chemicals	Sediment Quality Standard	Cleanup Screening Level
Conventionals (%)		
Total organic carbon	--	--
Total volatile solids (%)	--	--
Porewater sulfide (mg/L)	--	--
Metals (mg/kg)		
Arsenic	57	93
Cadmium	5.1	6.7
Chromium	260	270
Copper	390	390
Lead	450	530
Mercury	0.41	0.59
Silver	6.1	6.1
Zinc	410	960
PCBs (mg/kg-OC)		
Total PCBs	12	65
LPAHs (mg/kg-OC)		
Naphthalene	99	170
Acenaphthylene	66	66
Acenaphthene	16	57
Fluorene	23	79
Phenanthrene	100	480
Anthracene	220	1,200
2-Methylnaphthalene	38	64
Total LPAH	370	780
HPAHs (mg/kg-OC)		
Fluoranthene	160	1,200
Pyrene	1,000	1,400
Benzo(a)anthracene	110	270
Chrysene	110	460
Total benzofluoranthenes	230	450
Benzo(a)pyrene	99	210
Indeno(1,2,3-cd)pyrene	34	88
Dibenzo(a,h)anthracene	12	33
Benzo(g,h,i)perylene	31	78
Total HPAH	960	5,300
Misc. SVOCs (mg/kg-OC)		
1,2-Dichlorobenzene	2.3	2.3
1,4-Dichlorobenzene	3.1	9
1,2,4-Trichlorobenzene	0.81	1.8
Hexachlorobenzene	0.38	2.3
Dimethylphthalate	53	53
Diethylphthalate	61	110

Table 1
Summary of Sediment Management Standards Chemical Criteria for Puget Sound

Chemicals	Sediment Quality Standard	Cleanup Screening Level
Di-n-butylphthalate	220	1,700
Butylbenzylphthalate	4.9	64
bis(2-ethylhexyl)phthalate	47	78
Di-n-octylphthalate	58	4,500
Dibenzofuran	15	58
Hexachlorobutadiene	3.9	6.2
n-Nitroso-di-phenylamine	11	11
Misc. Ionizable SVOCs (µg/kg)		
Phenol	420	1,200
2-Methylphenol	63	63
4-Methylphenol	670	670
2,4-Dimethylphenol	29	29
Pentachlorophenol	360	690
Benzyl alcohol	57	73
Benzoic acid	650	650

Table 2
Summary of Sediment Management Standards Biological Effects Criteria for Puget Sound

Biological Test	Test Performance Standards	Sediment Quality Standards	Sediment Cleanup Screening Levels, or Minimum Cleanup Levels
Amphipod	The control sediment shall have less than 10 percent mortality over the test period. The reference sediment shall have less than 25 percent mortality.	The test sediment has a significantly higher (t-test, P≤ 0.05) mean mortality than the reference sediment, and the test sediment mean mortality exceeds 25 percent on an absolute basis.	The test sediment has a significantly higher (t-test, P≤ 0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30 percent greater, on an absolute basis, than the reference sediment mean mortality.
Larval	The seawater control sample shall have less than 30 percent combined abnormality and mortality (i.e., a 70 percent normal survivorship at time final).	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤ 0.05) than the mean normal survivorship in the reference sediment, and the combined abnormality and mortality in the test sediment is more than 15 percent greater, on an absolute basis, than the reference sediment.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤ 0.05) than the mean normal survivorship in the reference sediment, and the combined abnormality and mortality in the test sediment is more than 30 percent greater, on an absolute basis, than that in the reference sediment.
Juvenile polychaete	The control sediment shall have less than 10 percent mortality and mean individual growth (MIG) of ≥ 0.72 mg/ind/day per dry weight basis. The reference sediment shall have a MIG that is at least 80 percent of the MIG found in the control sediment.	The MIG of polychaetes in the test sediment is less than 70 percent of the MIG of the polychaetes in the reference sediment, and the test sediment MIG is significantly different (t-test, P≤ 0.05) from the reference sediment MIG	The MIG of polychaetes in the test sediment is less than 50 percent of the MIG of the polychaetes in the reference sediment, and the test sediment MIG is significantly different (t-test, P≤ 0.05) from the reference sediment MIG.
Benthic infauna	The reference benthic macroinvertebrate assemblage shall be representative of areas of Puget Sound removed from significant sources of contaminants, and to the extent possible shall reflect seasonality and natural physical-chemical conditions and normally abundant species.	The test sediment has less than 50 percent of the reference sediment mean abundance of any one of the following major taxa: Class Crustacea, Phylum Mollusca, or Class Polychaeta, and the test sediment abundance is statistically different (t-test, P≤0.05) from the reference sediment abundance.	The test sediment has less than 50 percent of the reference sediment mean abundance of any two of the following major taxa: Class Crustacea, Phylum Mollusca, or Class Polychaeta, and the test sediment abundance is statistically different (t-test, P≤0.05) from the reference sediment abundances.

Source: Washington State Department of Ecology. 1995. Sediment Management Standards - Chapter 173-204 WAC

Table 3
Surface Sediment Data Summary: Ecology August 2008 Bay-wide Sampling

Parameter	Sediment Quality Standard Chemical Criteria (a)	Area Background Surface Sediment Concentration Range (b)			Bay Wood Site Area Surface Sediment Concentration Range (c)		
Conventionals							
Fines (Silt/Clay; % WW)	--	1	to	30	45	to	74
Total Organic Carbon (% DW)	--	0.1	to	2.5	1.0	to	2.2
TVS (% DW)	12 (d)	1.0	to	6.4	4.6	to	8.3
Total Solids (% DW)	--	64	to	85	56	to	59
Ammonia (mg-N/kg DW)	--	0.03 UJ	to	5.4 J	4.3	to	6.3
Total Sulfides (mg/kg DW)	--	0.01 U	to	24.5 J	3.4	to	23.0
Metals in mg/kg DW							
Arsenic	57	0.6 U	to	11	11	to	13
Cadmium	5.1			0.03 U			0.04 U
Chromium	260	22 J	to	41	41	to	46
Copper	390	13	to	29	35	to	46
Lead	450	3	to	8	7	to	11
Mercury	0.41			0.007 U	0.008 U	to	0.1
Silver	6.1			0.18 U			0.2 U
Zinc	410	36	to	67	63	to	79
LPAH in ug/kg DW							
Naphthalene	2,100			8.7 U	8.4 U	to	31
Acenaphthylene	560			8.6 U			8.6 U
Acenaphthene	500			8.2 U			8.2 U
Fluorene	540			8.9 U			8.9 U
Phenanthrene	1,500			12 U	11 J	to	34
Anthracene	960			7.7 U			7.7 U
1-Methylnaphthalene	--			7.2 U			7.2 U
2-Methylnaphthalene	670			8.2 U			8.2 U
Total LPAH	5,200	8.7 U	to	12 J	11 J	to	61
HPAH in ug/kg DW							
Fluoranthene	1,700	7.7 U	to	30	38	to	53
Pyrene	2,600	7.5 U	to	26	34	to	46
Benzo(a)anthracene	1,300	5.7 U	to	11 J	5.7 U	to	18 J
Chrysene	1,400	6.4 U	to	16 J	28	to	37
Total Benzofluoranthenes	3,200	9.2 U	to	10 J	9.5 U	to	32 J
Benzo(a)pyrene	1,600			8.1 U	7.9 U	to	14 J
Indeno(1,2,3-cd)pyrene	600			8.6 U			8.6 U
Dibenz(a,h)anthracene	230			8.5 U			8.5 U
Benzo(g,h,i)perylene	670			6.7 U			6.7 U
Total HPAH	12,000	9.2 U	to	70 J	112 U	to	164 J
Detected PAHs in mg/kg OC							
Naphthalene	99			5.9 U	0.9 U	to	1.4
Phenanthrene	100	0.3 U	to	1.7 J	1.1 J	to	3.5
Total LPAH	370	0.4 U	to	1.7 J	1.1 J	to	3.5
Fluoranthene	160	0.8 U	to	3.2	1.8	to	5.4
Pyrene	1,000	0.8 U	to	3.8	1.6	to	4.7
Benzo(a)anthracene	110	0.2 U	to	1.1 J	0.3 U	to	1.8 J
Chrysene	110	0.3 U	to	1.7 J	1.7	to	2.9
Total Benzofluoranthenes	230	0.4 U	to	1.0 J	0.4 U	to	3.3 J
Benzo(a)pyrene	99			5.5 U	0.4 U	to	1.4 J
Total HPAH	960	1.0 U	to	8.7 J	5.0	to	17 J
Chlorinated Aromatics in ug/kg DW							
1,3-Dichlorobenzene	170			7.4 U			7.4 U
1,4-Dichlorobenzene	110			7.3 U			7.3 U

Table 3
Surface Sediment Data Summary: Ecology August 2008 Bay-wide Sampling

Parameter	Sediment Quality Standard Chemical Criteria (a)	Area Background Surface Sediment Concentration Range (b)	Bay Wood Site Area Surface Sediment Concentration Range (c)
1,2-Dichlorobenzene	45	7.9 U	7.9 U
1,2,4-Trichlorobenzene	31	9.1 U	9.1 U
Hexachlorobenzene	22	8 U	8 U
Phthalate Esters in ug/kg DW			
Dimethylphthalate	71	7.7 U	7.7 U
Diethylphthalate	48	16 U	16 U
Di-n-Butylphthalate	1,400	12 U	12 U
Butylbenzylphthalate	63	11 U	11 U
bis(2-Ethylhexyl)phthalate	1,300	11 U to 62	11 U to 23
Di-n-Octylphthalate	420	8.3 U	8.3 U
Detected Phthalates in mg/kg OC			
bis(2-Ethylhexyl)phthalate	47	0.4 U to 6.6	0.5 U to 2.4
Phenols in ug/kg DW			
Phenol	420	13 U to 14 J	14 U
2-Methylphenol	63	14 U	14 U
4-Methylphenol	670	13 U	13 U
2,4-Dimethylphenol	29	15 U	15 U
Pentachlorophenol	360	47 U	47 U
Guaiacols and Resins in ug/kg DW			
Guaiacol	--	20 U	19 U
4,5-Dichloroguaiacol	--	20 U	19 U
4,5,6-Trichloroguaiacol	--	20 U	19 U
3,4,5-Trichloroguaiacol	--	20 U	19 U
Tetrachloroguaiacol	--	20 U	19 U
Pimaric Acid	--	98 U	200 U
Isopimaric Acid	--	98 U	200 U
Dehydroabietic Acid	--	98 U	230
Abietic Acid	--	98 U	200 UJ
Miscellaneous Extractables in ug/kg DW			
Benzyl Alcohol	57	14 U	14 U
Benzoic Acid	650	110 U	110 U
Dibenzofuran	540	7.5 U	7.5 U
Hexachlorobutadiene	11	8.1 U	8.1 U
N-Nitrosodiphenylamine		8.7 U	8.7 U
PCBs in ug/kg DW			
Total PCBs	130	6.6 U	6.6 U
Dioxins/Furans ng/kg DW			
2,3,7,8-TCDD	--	0.06 U to 0.47 J	0.08 U
1,2,3,7,8-PECDD	--	0.15 U to 1.2 J	1.02 J
1,2,3,4,7,8-HXCDD	--	0.21 U to 1.7 J	0.30 U
1,2,3,6,7,8-HXCDD	--	0.37 J to 6.5 J	5.3 J
1,2,3,7,8,9-HXCDD	--	0.35 J to 4.4 J	4.6 J
1,2,3,4,6,7,8-HPCDD	--	5.0 J to 86	83
OCDD	--	37 to 572	675
2,3,7,8-TCDF	--	0.25 J to 3.3	2.3
1,2,3,7,8-PECDF	--	0.11 U to 0.80 J	0.63 J
2,3,4,7,8-PECDF	--	0.11 J to 1.0 J	0.90 J
1,2,3,4,7,8-HXCDF	--	0.14 J to 1.5 J	1.4 J
1,2,3,6,7,8-HXCDF	--	0.13 U to 0.84 J	0.19 U
1,2,3,7,8,9-HXCDF	--	0.12 U	0.15 U
2,3,4,6,7,8-HXCDF	--	0.13 U to 0.78 J	0.92 J

Table 3
Surface Sediment Data Summary: Ecology August 2008 Bay-wide Sampling

Parameter	Sediment Quality Standard Chemical Criteria (a)	Area Background Surface Sediment Concentration Range (b)	Bay Wood Site Area Surface Sediment Concentration Range (c)
1,2,3,4,6,7,8-HPCDF	--	0.91 J to 18	16
1,2,3,4,7,8,9-HPCDF	--	0.10 U to 1.5 J	0.95 J
OCDF	--	2 J to 47	37
TEQ (0 DL)	5.2	0.2 J to 5.2 J	4.0 J

Notes

(a) Sediment quality standard chemical criteria for low organic carbon (< 0.5%) sediments based on 1988 LAETs (DW basis).

(b) Area background stations include A2-08, A2-18B, A2-22, A2-26, A2-28, A2-29, and A2-30.

(c) Bay Wood Site area stations include A2-23, A2-25, and A2-25B.

(d) Preliminary TVS screening criteria from lowest site-specific standards developed at other regional wood debris sites (see text).

(e) Based on Interim DMMP Guidelines for the Port Gardner non-dispersive disposal site (updated November 14, 2008).

Table 4
Proposed Sediment Sampling Location Coordinates

Sample Type	Station ID	NAD 1983 Washington North (ft)	
		X	Y
Surface Grab	AN-1	1303468.4	373465.7
Surface Grab	AN-2	1303305.3	373628.8
Surface Grab	AN-3	1303165.5	373776.4
Surface Grab	AN-4	1302963.6	373993.9
Surface Grab	AN-5	1302823.7	374304.6
Surface Grab	AN-6	1303538.3	374421.1
Surface Grab	AN-7	1303810.2	374506.5
Surface Grab	AN-8	1304198.6	374576.4
Surface Grab	AN-9	1304260.7	374335.6
Surface Grab	AN-10	1304602.5	374545.4

Table 5
Guidelines for Sample Handling and Storage

Sample Type	Container Size and Type	Holding Time	Preservation Technique
Grain size	16-oz Glass	6 months	Cool/4°C
Total solids (TS), Total Volatile Solids (TVS), and Total Organic Carbon (TOC)	8-oz Glass	14 days	Cool/4°C
		6 months	Freeze/ -18°C
Ammonia Porewater	32-oz glass	7 days to porewater extraction	Cool/4°C
		28 days to analysis	Cool/4°C; H_2SO_4 to pH<2
Sulfide Porewater	from ammonia porewater container	7 days to porewater extraction	Cool/4°C
		7 days to analysis	Cool/4°C; NaOH/ZnAC to pH>9
Metals	4-oz Glass	6 months; 28 days for Hg	Cool/4°C
		2 years; 28 days for Hg	Freeze/ -18°C
Diesel/Motor Oil	8 oz Glass	14 days until extraction	Cool/4^{o} C
		1 year until extraction	Freeze -20°C
		40 days after extraction	Cool/4^{o} C
Dioxins/Furans	8 oz Glass	14 days until extraction	Cool/4^{o} C
		1 year until extraction	Freeze -20°C
		40 days after extraction	Cool/4^{o} C
Semivolatile Organics (SVOCs) and Polychlorinated Biphenyls (PCBs)	16-oz Glass	14 days until extraction	Cool/4^{o} C
		1 year until extraction	Freeze -20°C
		40 days after extraction	Cool/4^{o} C

Table 6
Data Quality Objectives

Parameter	Units	Precision	Accuracy	Completeness
Grain size	%	±20 RPD	NA	95%
Total solids	%	±20 RPD	NA	95%
Total volatile solids	%	±20 RPD	NA	95%
Total organic carbon	%	±20 RPD	65-135 %R	95%
Ammonia Porewater	mg/L	±20 RPD	75-125 %R	95%
Sulfide Porewater	mg/L	±20 RPD	75-125 %R	95%
Metals	mg/kg	±20 RPD	65-135 %R	95%
PCDD/PCDF	ng/kg	±40 RPD	50-140% R	95%
Diesel/Motor Oil	mg/kg	±40 RPD	50-140% R	95%
SVOCs	µg/kg	±40 RPD	50-140% R	95%
PCBs	µg/kg	±40 RPD	50-140% R	95%

Notes:

RPD = Relative percent difference

%R = Percent recovery

NA = Not applicable

Table 7
Laboratory Quality Control Sample Analysis Minimum Frequencey Requirements

Analysis Type	Initial Calibration[b]	Ongoing Calibration	Standard Reference Material[e]	Replicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes	Laboratory Control Samples
Grain size	Each batch[a]	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total solids	Each batch	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total volatile solids	Each batch	NA	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total organic carbon	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
Ammonia Porewater	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
Sulfide Porewater	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
Metals	Daily	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA	1 per 20 samples
PCDD/PCDF	As needed[c]	Prior to 12 hour analytical batch	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
Diesel/Motor Oil	As needed [c]	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
Semivolatile organics	As needed[c]	Prior to 12 hour analytical batch	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples
PCBs[d]	As needed[c]	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample	1 per 20 samples

Note:

NA - not applicable.

a - Calibration and certification of drying ovens and weighing scales are conducted bi-annually.

b - Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.

c - Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.

d - Pesticides/PCB will have all detects confirmed via second column confirmation. The second column must be of a dissimilar stationary phase from the primary column and meet all method requirements for acceptance. Primary column is considered the column which contains the highest value with the least interference.
Primary column is considered the column which contains the highest value with the least interference.

e - When an SRM is available.

NA - Not applicable.

Table 8
Chemical Physical Analysis Methods and Target Detection Limits

Parameter	Target Detection Limits	Analytical Method
Conventionals, %		
Total solids	0.10	EPA 160.3
Total volatile solids	0.01	ASTM D-2974C
Grain size	0.10	PSEP
Total organic carbon	0.10	EPA 9060
Conventionals, mg/L		
Ammonia porewater	0.10	EPA 350.1
Sulfide porewater	1.0	EPA 9030B
Metals, mg/kg dry weight		
Antimony	15	EPA 6010/6020
Arsenic	10	EPA 6010/6020
Cadmium	0.40	EPA 6010/6020
Chromium	5.0	EPA 6010/6020
Copper	0.40	EPA 6010/6020
Lead	5.0	EPA 6010/6020
Mercury	0.10	EPA 7471A
Nickel	14	EPA 6010/6020
Silver	0.60	EPA 6010/6020
Zinc	0.80	EPA 6010/6020
Nonionizable Organic Compounds, µg/kg dry weight		
LPAHs		
Naphthalene	20	EPA 8270
Acenaphthylene	20	EPA 8270
Acenaphthene	20	EPA 8270
Fluorene	20	EPA 8270
Phenanthrene	20	EPA 8270
Anthracene	20	EPA 8270
2-Methylnaphthalene	20	EPA 8270
HPAHs		
Fluoranthene	20	EPA 8270
Pyrene	20	EPA 8270
Benzo(a)anthracene	20	EPA 8270
Chrysene	20	EPA 8270
Benzo(b)fluoranthene	20	EPA 8270
Benzo(k)fluoranthene	20	EPA 8270
Benzo(a)pyrene	20	EPA 8270
Indeno(1,2,3-cd)pyrene	20	EPA 8270
Dibenzo(a,h)anthracene	20	EPA 8270
Benzo(g,h,i)perylene	20	EPA 8270
Chlorinated Organic Compounds		
1,2-Dichlorobenzene	5	EPA 8270 SIM
1,3-Dichlorobenzene	20	EPA 8270
1,4-Dichlorobenzene	5	EPA 8270 SIM
1,2,4-Trichlorobenzene	5	EPA 8270 SIM
Hexachlorobenzene	5	EPA 8270 SIM
Phthalates		
Dimethyl phthalate	20	EPA 8270
Diethyl phthalate	20	EPA 8270
Di-n-butyl phthalate	20	EPA 8270

Table 8
Chemical Physical Analysis Methods and Target Detection Limits

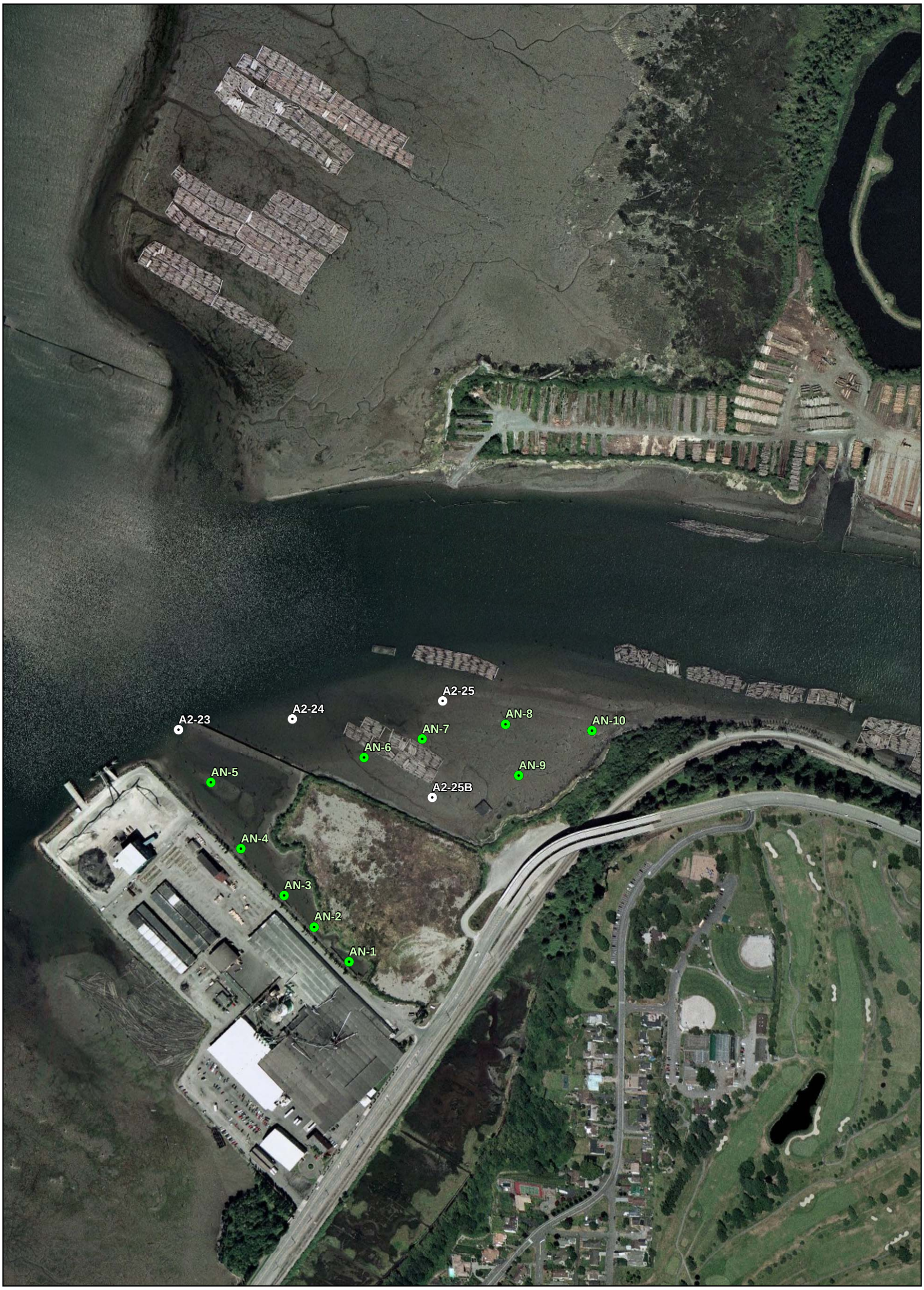
Parameter	Target Detection Limits	Analytical Method
Butyl benzyl phthalate	20	EPA 8270
Bis(2-ethylhexyl)phthalate	20	EPA 8270
Di-n-octyl phthalate	20	EPA 8270
Miscellaneous Extractables		
Dibenzofuran	20	EPA 8270
Hexachlorobutadiene	5	EPA 8270 SIM
N-Nitroso-diphenylamine	20	EPA 8270
Ionizable Organic Compounds, µg/kg dry weight		
Phenol	20	EPA 8270
2-Methylphenol	20	EPA 8270
4-Methylphenol	20	EPA 8270
2,4-Dimethylphenol	20	EPA 8270
Pentachlorophenol	20	EPA 8270
Benzyl alcohol	20	EPA 8270
Benzoic acid	200	EPA 8270
Polychlorinated Biphenyls (PCBs), µg/kg dry weight		
Aroclor 1016	10	EPA 8082
Aroclor 1221	10	EPA 8082
Aroclor 1232	10	EPA 8082
Aroclor 1242	10	EPA 8082
Aroclor 1248	10	EPA 8082
Aroclor 1254	10	EPA 8082
Aroclor 1260	10	EPA 8082
Aroclor 1268	10	EPA 8082
Total PCBs	10	EPA 8082
Total Petroleum Hydrocarbons (TPH), mg/kg dry weight		
Diesel	10	NWTPH-DX
Motor Oil	25	NWTPH-DX
Dioxins/Furans, ng/kg dry weight		
2,3,7,8-TCDD	1	1613B
1,2,3,7,8-PeCDD	5	1613B
1,2,3,4,7,8-HxCDD	5	1613B
1,2,3,6,7,8-HxCDD	5	1613B
1,2,3,7,8,9-HxCDD	5	1613B
1,2,3,4,6,7,8-HxCDD	5	1613B
OCDD	10	1613B
2,3,7,8-TCDF	1	1613B
1,2,3,7,8-PeCDF	5	1613B
2,3,4,7,8-HxCDF	5	1613B
1,2,3,4,7,8-HxCDF	5	1613B
1,2,3,6,7,8-HxCDF	5	1613B
1,2,3,7,8,9-HxCDF	5	1613B
2,3,4,6,7,8-HxCDF	5	1613B
1,2,3,4,5,6,8-HpCDF	5	1613B
1,2,3,4,7,8,9-HPCDF	5	1613B
OCDF	10	1613B

Notes:

LPAH = Low molecular weight polynuclear aromatic hydrocarbon

LPAH = Low molecular weight polynuclear aromatic hydrocarbon

FIGURES



Aerial Imagery © 2007 ESRI, i-cubed

- Proposed Sediment Sampling Station
- Existing Sediment Sampling Station

0 500
Feet

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ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Existing and Proposed Sediment Sampling Stations