SAMPLING AND QUALITY ASSURANCE PROJECT PLAN
FOR COMPLIANCE MONITORING
WHATCOM WATERWAY CLEANUP IN PHASE 1 SITE AREAS

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

AFDW	ash-free dry weight
ASTM	American Society for Testing Materials
CLP	Contract Laboratory Program
cm	centimeter
CMCRP	Compliance Monitoring and Contingency Response Plan
COC	chain-of-custody
D/F	dioxin/furans
DGPS	Differential Global Positioning System
DO	dissolved oxygen
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDL	estimated detection limit
EDR	Engineering Design Report
GP	Georgia-Pacific
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
L	liter
MDL	method detection limit
mL	milliliter
MLLW	mean lower low water
mm	millimeter
MNR	monitored natural recovery
MRL	method reporting limit
MTCA	Model Toxics Control Act
NMDS	nylon mesh diffusion sampler
PAH	polycyclic aromatic hydrocarbon
PDCR	Preliminary Design Conceptual Report

Port	Port of Bellingham
PRDI	pre-remedial design investigation
Project	Whatcom Waterway Cleanup in Phase 1 Site Areas
PSEP	Puget Sound Estuary Program
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RI/FS	Remedial Investigation and Feasibility Study
Site	Whatcom Waterway Site
SMARM	Sediment Management Annual Review Meeting
SMS	Sediment Management Standards
SOP	standard operating procedure
SQAPP	Sampling and Quality Assurance Project Plan
SQS	Sediment Quality Standard
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife

1 INTRODUCTION

The Whatcom Waterway Cleanup in Phase 1 Site Areas (Project) is to be conducted by the Port of Bellingham (Port) to implement the cleanup of the Whatcom Waterway Site (Site) as required by Consent Decree (No. 07-2-02257-7) as amended (Ecology 2007 and 2011). The Project includes dredging, upland disposal, and capping in Phase 1 site areas. Cleanup activities are described in detail in the Engineering Design Report (EDR; Anchor QEA 2015a).

This cleanup action is being performed in compliance with the requirements of the Model Toxics Control Act (MTCA) and Sediment Management Standards (SMS) regulations. Compliance requirements include monitoring during and after the cleanup action in Phase 1 site areas. As such, a *Compliance Monitoring and Contingency Response Plan* (CMCRP) was included as Appendix G of the EDR (Anchor QEA 2015b), which describes performance and confirmation monitoring and associated contingency response actions that will be implemented in support of cleanup activities within Phase 1 areas of the Site.

This *Sampling and Quality Assurance Project Plan* (SQAPP) describes the sampling and analysis plan for compliance monitoring to be conducted during and immediately following cleanup construction actions (performance monitoring) as well as long-term (confirmation) monitoring at the Site. This SQAPP describes data quality objectives (DQOs), sampling and analytical methods, quality assurance/quality control (QA/QC) procedures, and data management for sediment, porewater, and tissue performance and confirmation monitoring.

Compliance monitoring and contingency response actions within Phase 2 areas of the Site, described in the Preliminary Design Conceptual Report (PDCR; Anchor QEA 2012), will be addressed in a future separate document. Phase 1 construction water quality protection monitoring will be performed as described in the Water Quality Monitoring Plan (EDR Appendix L, Anchor QEA 2015c).

1.1 Project Overview

A combination of recent source control efforts and natural recovery has improved conditions such that Site cleanup levels are currently being met in surface sediment in a large portion of

the Site. However, where this layer of clean sediment is subject to potential disturbance from wind and wave events, navigational traffic, and planned future maintenance dredging, active remediation is required to prevent exposure to contaminants in subsurface sediment. Major activities within these areas include dredging, capping, containment wall installation, structure removal, structure replacement, and ancillary nearshore habitat improvements.

In summary, the net environmental effects of the Project include the following:

- Removing up to 158,900 cubic yards of contaminated sediment
- Placing up to 126,600 cubic yards of clean capping and residuals management materials to prevent potential erosion and recontamination
- Removing approximately 263 tons of creosote-treated timber (e.g., piling and bulkheads) from the Site
- Removing manmade debris from 46,950 square feet of shoreline and intertidal areas within the Waterway, including concrete waste, asphalt rubble, and other miscellaneous debris
- Providing a net reduction of more than 4,300 square feet of overwater cover by removing unused existing structures
- Eliminating existing vertical bulkheads and providing new slopes at 2 horizontal to 1 vertical (2H:1V) or flatter in various shoreline areas
- Increasing the quantity and quality of intertidal and shallow subtidal habitat within the Project area and significantly improving habitat connectivity for a variety of fish and invertebrate species, including Endangered Species Act-listed Chinook salmon

Compliance monitoring includes water quality, performance (during and immediately following construction), and confirmation (long-term) monitoring to address overall project compliance objectives, including the following:

- **Water Quality Monitoring:** described in the *Water Quality Monitoring Plan* included as Appendix L of the EDR (Anchor QEA 2015c)
- **Performance Monitoring:** described in this SQAPP including collection and analysis of the following:
  - Surface Sediment in Phase 1 cleanup areas
  - Physical Surveys in Phase 1 cleanup areas

  - Crab Tissue in monitored natural recovery (MNR) areas
  - Juvenile Crab Tissue from Log Pond areas
  - Clam Tissue and Co-located Porewater in MNR areas

- **Confirmation Monitoring**: described in this SQAPP including collection and analysis of the following:

  - Surface Sediment in Phase 1 cleanup and MNR areas
  - Subsurface Sediment in MNR areas
  - Physical Surveys in Phase 1 cleanup areas
  - Crab Tissue in MNR areas
  - Juvenile Crab Tissue from Log Pond areas
  - Clam Tissue and Co-located Porewater in MNR areas
  - Benthic Fish Tissue in MNR areas
  - Porewater in Phase 1 cleanup areas

Performance and confirmation monitoring is described in detail in this SQAPP.

1.2 Study Area

The Project is located along the Bellingham City waterfront in Whatcom County, Washington, including Bellingham Bay and adjacent areas. Adjacent MTCA cleanup sites include the Central Waterfront, GP West, I&J Waterway, Cornwall Avenue landfill, former South State Street Manufactured Gas Plant, and R.G. Haley sites.

Industrial activities adjacent to the Site, dating back to the late 1800s, have resulted in sediment contamination. Additionally, the shorelines are generally devoid of vegetation and over-steepened because of manmade structures (e.g., creosote-treated timber bulkheads) or armored with concrete, asphalt, or other manmade debris. The Site also contains a number of derelict structures, including creosote-treated bulkheads, piles, and dolphins and overwater structures that limit habitat conditions and connectivity. The combination of contaminated sediments, over-steepened and armored shorelines, and derelict structures has resulted in the severely degraded habitat conditions within the Site.

The Site is broken into units by geographic area and required cleanup action within each unit; Phase 1 cleanup units are shown in Figure 1. Compliance monitoring will be conducted within Phase 1 cleanup units as well as in MNR areas within Bellingham Bay.

1.3 Project Schedule

Phase 1 cleanup activities are anticipated to be completed by March 2016. Performance monitoring will be conducted during cleanup activities and immediately following completion of construction (Year 0). Confirmation monitoring will be conducted over the long term (Years 1, 3, 5, 10, 20, and 30).

1.4 Contaminants of Concern

The Site includes sediments that have been impacted by contaminants historically released from industrial waterfront activities, including mercury discharges from the former Georgia-Pacific (GP) chlor-alkali plant. The chlor-alkali plant was located on a portion of the adjacent GP West mill site and operated between 1965 and 1999, when it was permanently closed. The chlor-alkali plant discharged mercury-containing wastewater into the Waterway, primarily during the late 1960s and 1970s.

The Site boundary shown in Figure 1 was determined based on the extent of potentially significant surface and subsurface mercury contamination in sediments as determined during the Remedial Investigation and Feasibility Study (RI/FS; Hart Crowser 2000) process and during subsequent pre-remedial design investigations (PRDI) conducted during 2008 (Anchor QEA 2010).

Other site-associated contaminants include wood waste and degradation products from historical log rafting activities and phenolic compounds from pulp mill wastewater discharges.

Some contaminants (hydrocarbon compounds and heavy metals) associated with the Central Waterfront site are commingled with subsurface contamination in shoreline areas along the northern portion of the Waterway and are being remediated as part of the Site cleanup action described in this report. Soil and groundwater contaminants of concern for that

portion of the Central Waterfront site are described in the draft RI Report (Anchor QEA, 2015d) prepared for that site.

Likewise, mercury and other contaminants are present in soils groundwater in portions of the GP West Mill Site along the southern shoreline of the Whatcom Waterway. Soil and groundwater contaminants of concern for the GP West site are described in the Final RI Report (Aspect, 2013) prepared for that site.

Dioxin/furan compounds (D/F) are also known to be present in surface and subsurface sediments throughout most of Bellingham Bay. The full range of sources for these compounds in Bellingham Bay may include former combustion sources, former GP pulp and paper mill operations, former wood-treating facilities, historic and ongoing stormwater and wastewater discharges, and atmospheric deposition.

The Washington State Department of Ecology (Ecology) has conducted sampling and issued a final data report documenting the regional background concentrations of D/F in Bellingham Bay from these multiple sources. Regional background concentrations are reported in that document to be 15 nanograms per kilogram (Ecology 2015).

In addition, Ecology has revised the SMS regulations to consider regional background concentrations when establishing sediment cleanup levels.

These Ecology efforts could result in a future amendment to the Consent Decree/Cleanup Action Plan (Ecology 2007) addressing D/F within the Site. Until then, reasonable and prudent measures to address D/F as part of the monitoring plan have been incorporated into the cleanup action and associated monitoring requirements.

Compliance monitoring includes testing for the following:

- Site-related contaminants: mercury, copper, zinc, polycyclic aromatic hydrocarbons (PAH), and phenolic compounds
- Regional co-contaminants: D/F

1.5 Cleanup and Screening Levels

Table 1 defines cleanup levels and screening levels applicable to compliance monitoring.

- Cleanup levels for the Site were documented in the Consent Decree (Ecology 2007).
- Additional screening levels were developed as part of the EDR for use in evaluation of potential groundwater-associated recontamination risks for sediments in Unit 4 (Log Pond) (Anchor QEA 2015a). These screening levels (Table 2) are more stringent than levels protective of marine aquatic species.

In addition to the foregoing, Ecology has defined regional background concentrations for D/F in Bellingham Bay as 15 nanograms per kilogram (Ecology 2015).

Detailed response actions for each type of monitoring are provided in the CMCRP (Anchor QEA 2015b). The results of compliance monitoring will be reviewed by the Port and Ecology in the context of that document.

1.6 Document Organization

The remainder of this document is organized as follows:

- **Section 2, Performance Monitoring:** This section summarizes the sampling design, and sampling and processing methods for performance monitoring.
- **Section 3, Confirmation Monitoring:** This section summarizes the sampling design, and sampling and processing methods for confirmation monitoring.
- **Section 4, General Sampling Methods:** This section summarizes general procedures for sample handling and chain-of-custody procedures, laboratory analytical methods, and QA/QC procedures.
- **Section 5, Project Management:** This section describes DQOs, special training requirements, and documentation.
- **Section 6, Assessments and Oversight:** This section includes compliance assessments, response and corrective actions, and reports to management.
- **Section 7, Data Validation and Usability:** This section describes data validation and verification methods and criteria for usability of data.
- **Section 7, References:** This section presents relevant citations or reference material.

2 PERFORMANCE (YEAR 0) MONITORING

2.1 Sampling Design

The overall compliance monitoring sampling design is summarized in Table 3 and includes the anticipated schedule based on current knowledge of the construction schedule. The sampling design is described in detail in subsequent sections. Performance monitoring includes the collection and analysis of sediment, tissue, and porewater as well as physical surveys. Performance monitoring will be conducted during Year 0 during and immediately after construction.

2.1.1 Sediment

Performance monitoring will include the collection of sediment at six locations during two events:

- Post-dredge in Unit 1C (prior to sand placement): sediment will be collected targeting two sample intervals.
  - The residuals layer will be sampled to verify thickness and composition of dredging residuals
  - The underlying (native) sediment layer will be sampled to verify dredging has achieved full removal of target sediments
- Post-dredge in Unit 1C (after sand placement): surface sediment from the biologically active zone will be collected to ensure sediment quality was achieved after placement of residuals management cover.
- Post-dredge in Units 2A and 3B (prior to sand placement): sediment will be collected from the layer of non-dredged sediment (underlying the residuals layer) to supplement existing data documenting chemical concentrations in the sediments being capped.

2.1.2 Crab Tissue

Crab tissue will be collected during performance monitoring to assess temporal impacts associated with Phase 1 construction and provide resource agencies, the Lummi Nation, and stakeholders with information on potential Site-related effects on crab tissue quality.

Performance monitoring will include the collection of adult crab tissue at three MNR locations and two reference locations, as well as juvenile crab tissue at two locations in Log Pond and one reference location. Crab tissue will be collected in Year 0, immediately following construction in Phase 1 cleanup areas.

2.1.3 Clam Tissue

Clam tissue will be collected during performance monitoring to assess temporal impacts associated with Phase 1 construction and provide resource agencies, the Lummi Nation, and stakeholders with information on potential Site-related effects on clam tissue quality. Performance monitoring will include the collection of clam tissue at five MNR locations and five reference locations in Year 0, immediately following construction in Phase 1 cleanup areas.

2.1.4 Porewater Monitoring – Co-Located With Clam Tissue

Porewater will be collected during performance monitoring to document mercury concentrations in sediment bioactive zone samples from areas used for clam testing and to supplement (along with bulk sediment data) results of clam tissue quality. Monitoring will include the collection of porewater at all clam tissue locations (five MNR locations and five reference locations) in Year 0.

2.1.5 Physical Surveys

Performance monitoring includes bathymetric surveys to verify 1) dredging has achieved target elevations as defined in the EDR; and 2) the effectiveness of residuals cover in Unit 1C and cap placement within Unit 4 (Log Pond) and Units 2A and 3B (Inner Waterway). Bathymetric surveys will be conducted during and immediately after construction.

2.2 Performance Monitoring Sample Collection and Processing

This section describes activities, methods, and procedures for sample collection and processing for performance monitoring. A list of station identifications, sampling locations, sample type and method, and analytical testing is provided in Tables 4 and 5. Station locations are shown in Figures 2, 3, and 4. Field forms are provided in Appendix A.

2.2.1 Sediment

Sediment will be collected using either a hydraulic or gravity-driven Van Veen grab sampler onboard a vessel equipped with an A-frame and sufficient deck space for staging of gear and sample processing. Three separate sampling events will be conducted:

- Samples will be collected at six locations in Unit 1C (Figure 2 and Table 4) following the completion of dredging and prior to cap placement.
- Samples will be collected from the same six locations in Unit 1C (Figure 2 and Table 4) after cap placement.
- Samples will be collected in Units 2A and 3B (Figure 3 and Table 4) following the completion of dredging and prior to cap placement.

More than one grab may be necessary at each station to provide sufficient sediment for chemical analyses, potential re-analysis, and contingent bioassays. The following field forms (provided in Appendix A) will be completed for surface sediment monitoring:

- Daily Log
- Surface Sediment Grab Log

Surface Sediment Collection

Samples will be collected in the following manner in accordance with Puget Sound Estuary Program (PSEP) protocols (PSEP 1997):

- Vessel will maneuver to proposed station.
- Van Veen will be decontaminated.
- Van Veen will be deployed at an approximate speed of 0.3 foot per second.
- The winch cable to the grab sampler will be drawn taut and as near vertical as possible.
- Station location will be measured and recorded.
- The Van Veen will be closed to collect the sediment sample to a penetration depth of between 10 and 30 centimeters (cm), depending upon sediment type and location-specific sampling interval.
- 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 the sampler).
- Sediment surface is relatively flat, indicating minimal disturbance or winnowing.
- Overlying water is present, indicating minimal leakage.
- Overlying water has low turbidity, indicating minimal sample disturbance.
- Penetration depth consistent with PSEP protocols and project objectives is achieved.

Grab samples not meeting these criteria will be rejected, and the sample collection steps will be repeated until the acceptance criteria are met. Deployments will be repeated within a 25-foot radius of the proposed sample location. If adequate penetration is not achieved after three attempts, less penetration may be accepted or an alternate station will be identified in conjunction with the project manager. Any deviations will be noted on the daily log (Appendix A).

Surface Sediment Processing

The following protocols will be used to process accepted surface sediment samples:

- **Siphon Water:** Siphon off water overlying the sediment, taking care not to remove sediment.
- **Photograph Grab:** Take digital photographs of each grab with project, sample station, and date labeled on a white board, or similar.
- **Sample Logging:** Record the sample description on the surface sediment log (Appendix A), including, but not limited to, the following observations, as appropriate:
  - Physical soil description in accordance with the Unified Soil Classification System (American Society for Testing Materials [ASTM] Method D2488; includes soil type, density/consistency, and color)
  - Substantial product and sheens
  - Odor (e.g., hydrogen sulfide or petroleum)
  - Vegetation
  - Human-made debris
  - Biological activity (e.g., shells, tubes, bioturbation, or organisms)
  - Any other distinguishing characteristics or features

- **Remove Debris:** Materials in the sample more than 2 inches in diameter and debris will not be placed into sample containers.

Different depth intervals will be targeted for chemical analyses for each of the two performance monitoring events; further sample processing details are described in the following sections.

Analysis of Post-Dredge Samples (Prior to Cap Placement) – Units 2A and 3B

Performance monitoring conducted prior to cap placement in Units 2A and 3B will include the collection of surface sediment from one depth interval, the apparent undredged sediment layer (excluding the dredging residuals layer). The dredging residuals layer is expected to be approximately 6 cm thick and consist of thick, poorly consolidated materials; the thickness of this layer will be judged visually by the field team and removed to expose the underlying sediment. Samples will be collected from the underlying sediment layer, and the depth of this layer will be measured and noted on field logs.

Processing for all target intervals will proceed as follows:

- **Homogenize Sediment Layer:** Collect sediment samples from the appropriate depth interval from inside the grab sampler, without touching the sidewalls, using a decontaminated stainless steel trowel or equivalent. Place the sediment into a single decontaminated stainless steel bowl and homogenize until uniform color and texture is achieved.
- **Fill Sample Containers:** Using a decontaminated stainless steel spoon, homogenized sediment will be placed into appropriate pre-labeled sample containers and stored in a cooler equipped with ice or another cold source to keep the samples cool prior to final packing for transport to the analytical laboratory following the handling and chain-of-custody (COC) protocols described in Section 2.7.

Surface sediment samples will be analyzed for the following parameters (see Table 8):

- Mercury
- Copper
- Zinc

- Semi-volatile organic compounds (including PAHs and phenolic compounds)
- D/F
- Total solids
- Total organic carbon (TOC)

Analysis of Post-Dredge Samples (Prior to Cover Placement) – Unit 1C

Performance monitoring conducted prior to sand cover placement in Unit 1C will include the collection of surface sediment from two depth intervals, the dredging residuals layer and the underlying (native, non-dredged) layer. The dredging residuals layer is expected to be approximately 6 cm thick and consist of thick, poorly consolidated materials; the thickness of this layer will be judged visually by the field team. The underlying sediment will consist of sediment from the base of sampler. To ensure the collection of undisturbed sediments underlying the residuals, the samples will be collected from a 10-cm interval beginning 10 cm beneath the apparent residuals layer (e.g., assuming 6 cm of residuals, the sample would be collected between 16 and 26 cm below mudline). The depth of each layer collected will be measured and noted on field logs.

The dredging residuals layer will be collected first and then sediment will be removed until the underlying sediment layer is encountered. Processing for both target intervals will proceed as follows:

- **Homogenize Sediment Layer:** Collect sediment samples from the appropriate depth interval from inside the grab sampler, without touching the sidewalls, using a decontaminated stainless steel trowel or equivalent. Place the sediment into a single decontaminated stainless steel bowl and homogenize until uniform color and texture is achieved.
- **Fill Sample Containers:** Using a decontaminated stainless steel spoon, homogenized sediment will be placed into appropriate pre-labeled sample containers and stored in a cooler equipped with ice or another cold source to keep the samples cool prior to final packing for transport to the analytical laboratory following the handling and chain-of-custody (COC) protocols described in Section 2.7.

Surface sediment samples will be analyzed for the following parameters (see Table 8):

- Mercury
- D/F
- Total solids
- Total organic carbon (TOC)

Analysis of Post-Dredge Samples (After Cover Placement) – Unit 1C

Performance monitoring conducted after sand cover placement will include the collection of surface sediment from one depth interval, 0 to 12 cm (biologically active zone). Processing will proceed as follows:

- **Homogenize Grab:** Collect sediment samples from the 0- to 12-cm depth interval from inside the grab sampler, without touching the sidewalls, using a decontaminated stainless steel trowel or equivalent. Place the sediment into a single decontaminated stainless steel bowl and homogenize until uniform color and texture is achieved.
- **Fill Sample Containers:** Using a decontaminated stainless steel spoon, homogenized sediment will be placed into appropriate pre-labeled sample containers and stored in a cooler equipped with ice or another cold source to keep the samples cool prior to final packing for transport to the analytical laboratory following the handling and COC protocols described in Section 2.7.

Surface sediment samples will be analyzed for the following parameters (see Table 8):

- Mercury
- D/F
- Total solids
- TOC

In addition, contingent bioassays will be conducted if site cleanup levels for sediment are exceeded (see Table 1). If required, contingent bioassays will include three standard Puget Sound Estuary Program (PSEP) tests:

- 10-day amphipod test
- 20-day juvenile polychaete growth test
- Larval development test

Further information regarding bioassay testing is provided in Section 4.6.

2.2.2 Physical Surveys

Performance monitoring will include multi-beam bathymetric surveys conducted in dredged, residual, and capped areas (see Figure 1). Surveys will be conducted by a licensed surveyor and will meet or exceed the accuracy standards for a U.S. Army Corps of Engineers (USACE) Navigation and Dredging Support Survey as referenced in the USACE Hydrographic Survey Manual, April 2004 Revision (USACE 2004). Multiple surveys will be conducted over each transect to ensure accurate results. Surveys will be conducted after dredging, and results will be used to compare current mudline elevations against previous surveys to confirm target elevations have been achieved. Additionally, bathymetric surveys will be conducted after cap placement to provide a baseline for comparison purposes to determine cap integrity and track changes to the cap (e.g., settling, sedimentation) over the long term.

2.2.3 Crab Tissue

Performance monitoring will include the collection of Dungeness crab tissue during Year 0 between April and June immediately following construction. Crab tissue will be collected using crab pots deployed and retrieved from a vessel equipped with sufficient deck space for staging of gear. Adult crabs will be collected at three locations within the Site and two reference areas in Samish Bay; juvenile crabs will be collected in the Log Pond and at a reference location near Brant and Portage Islands (Figures 4 and 5, Table 5). The following field forms (provided in Appendix A) will be completed for crab tissue monitoring:

- Daily Log
- Crab Log

Scientific collection permits will be obtained from the Washington Department of Fish and Wildlife (WDFW) prior to crab collection.

Crab Tissue Collection

Crab traps will be baited and deployed for the collection of adult Dungeness crabs at each sampling location. Cages will be soaked in clean seawater overnight or pressure washed with

fresh water prior to deployment. Cages will be affixed with a rope and buoy to aid in recovery. Juvenile crabs will be collected from the intertidal zone using ring nets. Global Positioning System (GPS) locations will be recorded on field forms.

Adult male Dungeness crabs with a minimum carapace width of 16.5 cm will be targeted for collection at MNR and reference locations; retention of female and soft-shell crabs is not allowed. Two to three crab traps will be placed for 24 to 48 hours at each of the five sampling locations. If no crabs are caught in the first attempt, the crab traps will be replaced for an additional 24 hours. The target locations of the crab traps may be moved around each sampling location if necessary.

At a minimum, one adult male crab will be collected at each sampling location (from any of the replicate cages). If, after 24 hours, few or none of the male crabs collected are larger than 16.5 cm, then adult male crabs smaller than 16.5 cm may be retained for analysis, per the best professional judgment of field staff conducting the crab sampling.

Juvenile Dungeness crabs with a target carapace width of 5 to 8 cm (maximum width of 12 cm) will be collected along the shoreline in the Log Pond area and at the reference location near Brant Island; crabs may be collected anywhere within the buffer zone shown in Figure 4 to create one composite for analysis. Two to three juvenile crabs will be collected at each station to create station composites. However, a minimum tissue volume of 20 grams is needed for analyses, and the number of crabs needed may vary amongst the stations.

Crab Tissue Processing

Upon retrieval of the traps, the crab species and sex will be identified. The carapace width of the crabs will be measured with calipers. Crabs will be collected based on target width requirements depending on the station location (discussed above). Upon retrieval of crab traps, retained crabs' claws may be rubber banded, and crabs from each station will be separately placed on ice within a labeled cooler.

Crabs will be transported to the chemical laboratory, where they will be frozen at -20°C until processing. Adult crabs will be thawed and weighed, and the carapace width of each will be

measured again. The muscles of the sternal plates, legs, and claws will be dissected from each crab and individually weighed (to the nearest gram). Muscle tissues of one crab will be pooled for each sampling location and placed into pre-cleaned glass jars. Juvenile crabs will be analyzed as whole-body composites.

Samples will be stored frozen until analyzed for the following parameters (see Table 9):

- Lipids
- Mercury

2.2.4 Clam Tissue

Performance monitoring will include the collection of clam tissue from a vessel at five locations within the Site and five locations in the Samish Bay reference area (Figures 4 and 5, Table 5). Caged clams will be placed at locations in April or May immediately following construction and left in situ for 30 days in accordance with ASTM Method E2122-02. The following field forms (provided in Appendix A) will be completed for clam tissue monitoring:

- Daily Log
- Clam Log

Caged Clam Preparation and Deployment

Cages will be constructed of wire mesh consistent with ASTM Method E2122-02 and affixed with a rope and buoy to facilitate identification and recovery. Cages will be soaked in clean seawater overnight or pressure washed with fresh water prior to use.

The target clam species for monitoring is *Venerupis japonica* (manila clam), which will be purchased from a local shellfish supplier. 30 clams will be placed in each of three replicate cages per station at all 10 stations (5 site locations and 5 reference locations) to provide adequate tissue volume for analyses. Cages will be pushed slightly into the sediment surface by divers and anchored in place. GPS coordinates will be logged on field forms. Cages will be left in situ for 30 days.

Clam Tissue Collection and Processing

Cages will be retrieved by divers from a vessel. Clams from replicate cages will be kept separate, labeled, and placed in a cooler on ice. Processing will occur at the analytical laboratory. Clams will be depurated in clean saltwater for 24 hours; shells will be scrubbed free of debris and measured for shell length. Clams will be shucked using a clean stainless steel shucking knife on a clean surface (Alconox® scrubbed and rinsed). Clam tissue will not contact the work surface during preparation, and only clams collected live will be selected for analysis. Clam tissue will be weighed in a clean aluminum weigh boat. Soft body tissue samples will be composited from each cage separately and then an overall station composite will be created. For each station, clam tissue composite samples from each of the three cages deployed will be archived in the event additional analyses are necessary.

Composited tissue samples will be stored in glass containers until laboratory analyses are conducted (see Table 9). In addition, tissue samples from clams obtained from the supplier and not exposed to sediments will also be submitted for analyses to measure background contaminant levels that may be present. Tissue will be analyzed for the following parameters:

- Lipids
- Mercury

2.2.5 Co-Located Porewater

Performance monitoring will include the collection of porewater co-located at clam monitoring locations (five locations within the Site and five locations in the Samish Bay reference area; Figures 4 and 5, Table 5). Sediment porewater will be collected near clam cages using either nylon mesh diffusion samplers (NMDS) or temporary mini-piezometers. NMDS is the preferred method due to ease of use in all sediment types (sand and silts/clay) and reliability and consistency of data obtained using this method. The following field forms (provided in Appendix A) will be completed for clam tissue and co-located porewater monitoring:

- Daily Log
- Well Installation Log (if mini-piezometer is used)
- Porewater Collection Log (if mini-piezometer is used)

Co-Located Porewater Collection

Option 1 (preferred): Nylon-mesh Diffusion Samplers

Porewater may be collected using NMDS following methods used by the U.S. Geological Survey and U.S. Environmental Protection Agency (USGS and USEPA 2003). NMDS are a type of passive sampler that can be used in both course and fine sediments, provide a comparable measure with which to compare clam exposure over the duration of the incubation period, and limit the introduction of confounding factors (such as erroneously drawing surface water or sediment into the sample).

NMDS consist of 250-milliliter (mL) polypropylene jars and screw-on lids. NMDS are constructed prior to the field effort using the following procedures:

- Remove the center of the lid so that just the rim remains.
- Place all equipment in buckets/tubs with deionized water that has been purged of oxygen via aerating with nitrogen for at least 1 hour. Continue aerating with nitrogen while assembling the NMDS.
- Place a piece of 120-micron nylon screen mesh over the top of the jar and screw on the lid rim.
- Store jars in the assembly buckets with lids firmly sealed and under nitrogen headspace to prevent contamination until deployment.

NMDS will be deployed by divers near clam cages using the following procedures:

- Attach a small buoy to each NMDS using an electrical tie and rope.
- A small shovel-like device made from polyvinyl chloride (PVC) may be used to create a hole in the sediment in which the samplers will reside (see USGS and USEPA 2003 for details).
- Bury jars 6 to 12 cm in the sediment placed on their sides to prevent the mesh from being punctured during deployment and retrieval.
- Cover the NMDS with sediment.
- Record GPS coordinates on field forms.
- NMDS will be left in situ for a minimum of 4 days to equilibrate.

NMDS will be retrieved using GPS coordinates and the buoys in the following manner:

- Gently pull the samplers to the surface using the rope attached to each NMDS. Caution will be used while removing samplers from the sediment to avoid damaging the nylon mesh.
- Once on board the vessel, any sediment remaining on the top of the mesh will be gently removed to minimize the loss of water from the sampler.
- Porewater will be extracted using a 60-mL disposable syringe:
  - For dissolved mercury analysis, a 13-gage, 8.9-cm hypodermic needle and a 25-millimeter (mm), 0.45-micron filter unit mounted between the syringe and needle (see USGS and USEPA 2003 method for a picture of the assembly) will be used to collect the sample.
  - For total mercury analysis, the filter will be removed, and the hypodermic needle connected directly to the syringe to collect the sample.
- For each sample (total and dissolved), the syringe assembly will be pushed into the mesh and 100 mL will be drawn in the syringe.
- The filter and hypodermic needle will be removed from the syringe and the sample volume gently pushed into the sample container. The sample container will be tightly sealed.

Option 2: Mini-piezometers

Alternatively, porewater may be collected using diver-assisted push-point mini-piezometers. A mini-piezometer is a mini well point constructed of a stainless-steel rod with a screened end at the tip. The design includes a probe with a heavier-weight stainless-steel construction, approximately 2-inch screened (0.5-mm slot) interval with a smaller aperture size near the tip of the probe, and a base plate attachment that sits at the mudline elevation to minimize drawdown from the overlying surface water. A schematic of the porewater sampling device is shown on Figure 6. Larger screen (4- and 6-inch) intervals will be used if the screen becomes clogged due to fine-grained sediment. If used, mini-piezometers will be placed by divers and driven approximately 6 to 12 cm into the sediment.

Clean polyethylene tubing will be connected to the end (opposite end of screened portion) of the mini-piezometer and extended through the water column to the deck of the sampling vessel and into a peristaltic pump or similar type pumping device. Samples for total mercury

analysis will be collected directly into sample containers; samples for dissolved mercury analysis will be filtered through a 0.45-mm cartridge as the sample is pumped directly into sample containers.

Co-Located Porewater Processing

Porewater sample containers will be appropriately labeled and stored in coolers with ice at approximately 4°C until delivery to the laboratory. Samples will be analyzed for the following parameters (see Table 10):

- Total and dissolved mercury

3 CONFIRMATION MONITORING (YEAR 1–30)

3.1 Sampling Design

The overall compliance monitoring sampling design is summarized in Table 3 and includes the anticipated schedule. The sampling design is described in detail in subsequent sections. Confirmation monitoring includes the collection and analysis of surface and subsurface sediment, tissue, and porewater as well as physical surveys. Confirmation monitoring will be conducted in Years 1, 3, 5, 10, 20, and 30. Additional monitoring may be required to assess the effectiveness of any necessary contingency actions.

3.1.1 Surface Sediment

Surface sediment will be collected during confirmation monitoring to document the effectiveness of remediation in maintaining cleanup levels for site contaminants. Confirmation monitoring will include the collection of surface sediment at 11 locations within Phase 1 remediation areas and 11 MNR locations throughout Bellingham Bay during the summer season in Years 1, 3, 5, 10, 20, and 30.

3.1.2 Subsurface Sediment

Subsurface sediment will be collected during confirmation monitoring to assess changes over time in the thickness of a clean sediment cover overlying subsurface sediments containing elevated mercury concentrations. Confirmation monitoring will include the collection of subsurface sediment at five stations co-located with MNR surface sediment stations in Bellingham Bay during the summer season in Years 1, 10, 20, and 30.

3.1.3 Crab Tissue

Confirmation monitoring will be conducted to evaluate mercury tissue concentrations over time and provide resource agencies, the Lummi Nation, and stakeholders with information on potential Site-related effects on crab tissue quality. Crab tissue monitoring will be conducted between April and June during Years 1, 3, 5, and 10 unless mercury concentrations in Site samples are not statistically different than reference sample concentrations for two consecutive sampling rounds. At that point, crab tissue monitoring will be discontinued.

3.1.4 Clam Tissue

Confirmation monitoring will be conducted to evaluate mercury tissue concentrations over time and provide resource agencies, the Lummi Nation, and stakeholders with information on potential Site-related effects on clam tissue quality. Clam tissue monitoring will be conducted between April and June during Years 1, 3, 5, and 10 unless mercury concentrations in Site samples are not statistically different than reference sample concentrations for two consecutive sampling rounds. At that point, clam tissue monitoring will be discontinued.

3.1.5 Benthic Fish Tissue

Benthic fish tissue will be collected during confirmation monitoring to: 1) measure mercury and D/F concentrations in benthic fish tissue within the Site compared to those in fish collected from reference areas; 2) evaluate mercury tissue concentrations and trends over time; 3) provide resource agencies, the Lummi Nation, and stakeholders with information on potential Site-related effects on benthic fish tissue quality; and 4) provide D/F data to Ecology to support the understanding of regional conditions in Bellingham Bay.

Confirmation monitoring will include the collection of benthic fish tissue along trawl lines within Site and Samish Bay (reference) areas in Year 3. Benthic fish will be collected between March 1 and July 15. Additionally, benthic fish tissue may be collected in Years 5 and 10 if fish mercury concentrations are significantly elevated in comparison to fish tissue collected from clean reference sites during the previous monitoring event, as confirmed by a statistical comparison.

3.1.6 Pelagic Fish Tissue

Pelagic fish tissue monitoring will only be conducted if analysis of benthic fish tissue indicates a potential for Site-related sediment contamination to measurably impact tissue mercury concentrations in pelagic species. If required, confirmation monitoring will include the collection of pelagic fish tissue within Site as well as Samish Bay (reference) areas between March 1 and July 15. If collected, data will be used to: 1) evaluate concentrations of mercury in pelagic fish (i.e., salmon) caught from within the Site; 2) compare pelagic fish tissue data quality with tissue from a clean reference site and available literature data;

3) inform resource agencies, the Lummi Nation, and stakeholders regarding potential Site-related effects on pelagic fish tissue quality; and 4) if confirmation monitoring indicates elevated concentrations of Site-related mercury in pelagic fish tissue concentrations, evaluate long-term trends in mercury concentrations in pelagic fish caught from within the Site.

3.1.7 Porewater in Unit 4 (Log Pond)

Porewater will be collected during confirmation monitoring in Unit 4 to assess groundwater as a source of potential sediment recontamination and ensure protection of marine aquatic species. Monitoring will include the collection of porewater at two locations during years 1, 3, 5, and 10.

3.1.8 Porewater Monitoring – Co-Located With Clam Tissue

Porewater will be collected during confirmation monitoring to document mercury concentrations in sediment bioactive zone samples from areas used for clam testing and to supplement (along with bulk sediment data) results of clam tissue quality. Monitoring will include the collection of porewater at all clam tissue locations (five MNR locations and five reference locations) during any clam tissue collection events during subsequent monitoring periods.

3.1.9 Physical Surveys

Confirmation monitoring includes bathymetric and visual surveys in Years 1, 3, 5, and 10 to assess the long-term physical integrity of capped areas. Bathymetric surveys will be used to 1) verify cap integrity is being maintained and not being adversely affected by natural and anthropogenic forces in Phase 1 capping areas (Units 2A, 3B, 4, and the transition cap between Unit 1C and 2C); and 2) document conditions in the natural recovery area at the head of Whatcom Waterway (Unit 3A).

Visual monitoring will be conducted in parallel with bathymetry surveys along shoreline areas of the Inner Waterway (Units 2A and 3B) and Log Pond (Unit 4). Visual monitoring will be used to document the condition of the bank armoring materials and exposed portions of containment structures and bulkheads above the line of Ordinary High Water and to look for indications of settlement, seepage, or other conditions (outside of the anticipated conditions).

3.2 Confirmation Monitoring Sample Collection and Processing

This section describes activities, methods, and procedures for sample collection and processing. A list of station identifications, sampling locations, sample type and method, and analytical testing is provided in Tables 5 and 6. Station locations are shown in Figures 4, 5, and 7. Field forms are provided in Appendix A.

3.2.1 Surface Sediment

Confirmation monitoring will include the collection of surface sediment using either a hydraulic or gravity-driven Van Veen grab sampler onboard a vessel equipped with an A-frame and sufficient deck space for staging of gear and sample processing. Samples will be collected at 22 locations (11 locations within Phase 1 remediation areas and 11 MNR locations throughout Bellingham Bay; Figure 7 and Table 6). More than one grab may be necessary at each station to provide sufficient sediment for chemical analyses, potential re-analysis, and contingent bioassays. Surface sediment will be collected in Years 1, 3, 5, 10, 20, and 30. The following field forms (provided in Appendix A) will be completed for surface sediment monitoring:

- Daily Log
- Surface Sediment Grab Log

Surface Sediment Collection

Samples will be collected in the following manner in accordance with PSEP protocols (1997):

- Vessel will maneuver to proposed station.
- Van Veen will be decontaminated.
- Van Veen will be deployed at an approximate speed of 0.3 foot per second.
- The winch cable to the grab sampler will be drawn taut and as near vertical as possible.
- Station location will be measured and recorded.
- The Van Veen will be closed to collect the sediment sample to a penetration depth of approximately 20 cm, depending upon sediment type.

- 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 the sampler).
  - Sediment surface is relatively flat, indicating minimal disturbance or winnowing.
  - Overlying water is present, indicating minimal leakage.
  - Overlying water has low turbidity, indicating minimal sample disturbance.
  - Penetration depth consistent with PSEP protocols and project objectives is achieved.

Grab samples not meeting these criteria will be rejected, and the sample collection steps will be repeated until the acceptance criteria are met. Deployments will be repeated within a 25-foot radius of the proposed sample location. If adequate penetration is not achieved after three attempts, less penetration may be accepted or an alternate station will be identified in conjunction with the project manager. Any deviations will be noted on the daily log (Appendix A).

Surface Sediment Processing

One depth interval will be collected for all samples, 0 to 12 cm, with one exception:

- PICM-11-SS will have 2 sample intervals: 0 to 2 cm (to provide information on potential recent sedimentation because the location is near an outfall) and 0 to 12 cm (used to assess cleanup).

The following protocols will be used to process accepted surface sediment samples:

- **Siphon Water:** Siphon off water overlying the sediment, taking care not to remove sediment.
- **Photograph Grab:** Take digital photographs of each grab with project, sample station, and date labeled on a white board, or similar.
- **Sample Logging:** Record the sample description on the surface sediment log (Appendix A), including, but not limited to, the following observations, as appropriate:

  - Physical soil description in accordance with the Unified Soil Classification System (ASTM Method D2488; includes soil type, density/consistency, and color)
  - Substantial product and sheens
  - Odor (e.g., hydrogen sulfide or petroleum)
  - Vegetation
  - Human-made debris
  - Biological activity (e.g., shells, tubes, bioturbation, or organisms)
  - Any other distinguishing characteristics or features

- **Remove Debris:** Materials in the sample more than 2 inches in diameter and debris will not be placed into sample containers.
- **Homogenize Sediment Layer:** Collect sediment samples from the appropriate depth interval (0 to 12 cm except station PICM-11-SS, which includes two intervals, 0 to 2 cm and 0 to 12 cm) from inside the grab sampler, without touching the sidewalls, using a decontaminated stainless steel trowel or equivalent. Place the sediment into a single decontaminated stainless steel bowl and homogenize until uniform color and texture is achieved.
- **Fill Sample Containers:** Using a decontaminated stainless steel spoon, homogenized sediment will be placed into appropriate pre-labeled sample containers and stored in a cooler equipped with ice or another cold source to keep the samples cool prior to final packing for transport to the analytical laboratory following the handling and COC protocols described in Section 2.7.

Surface sediment samples will be analyzed for the following parameters (see Table 8):

- Mercury
- Copper
- Zinc
- PAH
- Phenolic compounds
- D/F
- Total solids
- TOC

In addition, contingent bioassays will be conducted at each station where site cleanup levels for sediment are exceeded (see Table 1). If required, contingent bioassays will include three standard Puget Sound Estuary Program (PSEP) tests:

- 10-day amphipod test
- 20-day juvenile polychaete growth test
- Larval development test

Further information regarding bioassay testing is provided in Section 4.6.

3.2.2 Subsurface Sediment

Subsurface sediment will be collected using a vibracore onboard a vessel equipped with an A-frame and sufficient deck space for staging of gear and sample processing. Samples will be collected at five locations in MNR areas (Figure 7 and Table 6). Subsurface sediment will be collected in Years 1, 10, 20, and 30. The following field forms (provided in Appendix A) will be completed for subsurface sediment monitoring:

- Daily Log
- Sediment Core Collection Log
- Sediment Core Processing Log

Subsurface Sediment Collection

Sediment cores will be collected using a vibracore. A new core tube (or liner) will be used for sampling at each station to eliminate the possibility of cross contamination among stations. The vibracore will be deployed from the vessel using the A-frame and hydraulic winch. The vibracore will be energized as it nears the bottom and supported upright with the winch line during penetration into the sediment. The vibracore will penetrate into the sediment to the target core depth of 3 feet below the sediment water interface or refusal, whichever comes first. Upon completing penetration at a station, the vibracore will be shut down, the position recorded, and the sampler recovered. After the core is on deck, the liner containing sediment will be extracted onto a core tray.

Refusal will be defined as less than 5 cm of penetration per minute. If refusal is encountered, the vessel will be slightly moved and a second core attempted, then, if needed, a third

attempt. If refusal is encountered after the third attempt, additional cores will not be attempted unless operational problems are suspected. The longest of the three cores will be retained for analysis.

Subsurface Sediment Processing

Cores will be processed onboard the sampling vessel. Core tubes will be cut open using electric shears. Each core will be photographed and visually characterized according to the Unified Soils Classification System (ASTM Method D2488) and visually examined for evidence of deposition/erosion. Sub-samples will be collected in 0.5-foot sections using clean stainless-steel spoons, homogenized in stainless-steel bowls, and placed into appropriate sample containers for subsequent analyses of chemical and physical parameters. Sample containers will be appropriately labeled and stored in coolers on ice until delivery to the laboratory (see Section 2.7).

Subsurface sediment samples will be analyzed for the following parameters (see Table 8):

- Mercury
- Total solids

3.2.3 Physical Surveys

Confirmation monitoring will include multi-beam bathymetric surveys and visual surveys to verify the physical integrity of capped areas (see Figure 1) over the long term. Bathymetry and visual surveys will be conducted in parallel for capping in Units 2A, 3B, and 4. In addition, a bathymetric survey will be conducted in the capped transition area between Unit 1C and Unit 2C.

Bathymetric surveys will be conducted by a licensed surveyor and will meet or exceed the accuracy standards for a USACE Navigation and Dredging Support Survey as referenced in the USACE Hydrographic Survey Manual, April 2004 Revision (USACE 2004). Multiple surveys will be conducted over each transect to ensure accurate results. Survey results will be used to evaluate changes in mudline elevations in comparison to previous surveys. Changes in mudline elevations over time will be compared with anticipated cap

settlement/consolidation parameters defined in the EDR and area sedimentation rates defined during the RI/FS.

Visual surveys will be conducted by field staff from a vessel to document the condition of the bank armoring materials and exposed portions of containment structures above the line of Ordinary High Water. The following field form will be used during visual surveys:

- Daily Log
- Visual Observations Log

3.2.4 Crab Tissue

Confirmation monitoring will include the collection of adult Dungeness crab tissue in Year 1; adult crab tissue monitoring may also be conducted in Years 3, 5, and 10 depending upon whether elevated tissue concentrations are measured during the previous monitoring events. Adult crab tissue monitoring will be discontinued once contaminant concentrations in Site tissues are not statistically elevated above reference tissue concentrations for two consecutive monitoring events. Confirmation monitoring will also include the collection of juvenile Dungeness crab tissue in Year 3.

Adult crab tissue will be collected using crab pots deployed and retrieved from a vessel equipped with sufficient deck space for staging of gear. Samples will be collected at three locations within the Site and two reference areas in Samish Bay (Figures 4 and 5, Table 5).

Juvenile crab tissue will be collected from the intertidal zone using ring nets. Samples will be collected from the Log Pond and from the reference location near Portage and Brant Islands (Figures 4 and 5, Table 5).

The following field forms (provided in Appendix A) will be completed for crab tissue monitoring:

- Daily Log
- Crab Log

Scientific collection permits will be obtained from WDFW prior to crab collection.

Crab Tissue Collection

Crab traps will be baited and deployed for the collection of adult Dungeness crabs at each sampling location. Cages will be soaked in clean seawater overnight or pressure washed with fresh water prior to deployment. Cages will be affixed with a rope and buoy to aid in recovery. Juvenile crabs will be collected from the intertidal zone using ring nets. GPS locations will be recorded on field forms.

Adult male Dungeness crabs with a minimum carapace width of 16.5 cm will be targeted for collection at MNR and reference locations; retention of female and soft-shell crabs is not allowed. Two to three crab traps will be placed for 24 to 48 hours at each of the five sampling locations. If no crabs are caught in the first attempt, the crab traps will be replaced for an additional 24 hours. The target locations of the crab traps may be moved around each sampling location if necessary.

At a minimum, one adult male crab will be collected at each sampling location (from any of the replicate cages). If, after 24 hours, few or none of the male crabs collected are larger than 16.5 cm, then adult male crabs smaller than 16.5 cm may be retained for analysis, per the best professional judgment of field staff conducting the crab sampling.

Juvenile Dungeness crabs with a target carapace width of 5 to 8 cm (maximum of 12 cm) will be collected within the Log Pond and at the reference location on Brant Island; crabs may be collected anywhere within the buffer zone shown in Figure 4. The number of juvenile crabs needed will be dependent upon the size of crabs attained. A minimum tissue volume of 20 grams is needed for analyses.

Crab Tissue Processing

Upon retrieval of the traps or net, the crab species and sex will be identified. The carapace width of the crabs will be measured with calipers. Crabs will be collected based on target width requirements depending on the station location (discussed above). Upon retrieval, retained crabs' claws may be rubber banded, and crabs from each station will be separately placed on ice within a labeled cooler.

Crabs will be transported to the chemical laboratory, where they will be frozen at -20°C until processing. Adult crabs will be thawed and weighed, and the carapace width of each will be measured again. The muscles of the sternal plates, legs, and claws will be dissected from each crab and individually weighed (to the nearest gram). Muscle tissues of one crab will be pooled for each sampling location and placed into pre-cleaned glass jars. Juvenile crabs will be analyzed as whole-body composites.

Samples will be stored frozen until analyzed for the following parameters (see Table 9):

- Lipids
- Mercury

3.2.5 Clam Tissue

Confirmation monitoring will include the collection of co-located clam tissue and porewater in Year 1. Clam tissue and co-located porewater monitoring may also be conducted in Years 3, 5, and 10 dependent upon whether elevated concentrations are measured during the previous monitoring events. Clam tissue and co-located porewater monitoring will be discontinued once contaminant concentrations in Site tissues are not statistically elevated above reference tissue concentrations for two consecutive monitoring events.

Clams and co-located porewater will be deployed and retrieved from a vessel at five locations within the Site and five locations in the Samish Bay reference area (Figures 4 and 5, Table 5). Caged clams will be placed at locations and left in situ for 30 days in accordance with ASTM Method E2122-02. Temporary mini-piezometers will be used to collect sediment porewater near clam cages. The following field forms (provided in Appendix A) will be completed for clam tissue and co-located porewater monitoring:

- Daily Log
- Clam Log
- Well Installation Log
- Porewater Collection Log

Caged Clam Preparation and Deployment

Cages will be constructed of wire mesh consistent with ASTM Method E2122-02 and affixed with a rope and buoy to facilitate identification and recovery. Cages will be soaked in clean seawater overnight or pressure washed with fresh water prior to use.

The target clam species for monitoring is *Venerupis japonica* (manila clam), which will be purchased from a local shellfish supplier. Thirty clams will be placed in each of three replicate cages per station to provide adequate tissue volume for analyses. Cages will be pushed slightly into the sediment surface by divers and anchored in place. GPS coordinates will be logged on field forms. Cages will be left in situ for 30 days.

Clam Tissue Collection and Processing

Cages will be retrieved by divers from a vessel. Clams from replicate cages will be kept separate, labeled, and placed in a cooler on ice. Processing will occur at the analytical laboratory. Clams will be depurated in clean saltwater for 24 hours; shells will be scrubbed free of debris and measured for shell length. Clams will be shucked using a clean stainless steel shucking knife on a clean surface (Alconox® scrubbed and rinsed). Clam tissue will not contact the work surface during preparation, and only clams collected live will be selected for analysis. Clam tissue will be weighed in a clean aluminum weigh boat. Soft body tissue samples will be composited from each cage separately and then an overall station composite will be created. For each station, clam tissue composite samples from each of the three cages deployed will be archived in the event additional analyses are necessary.

Composited tissue samples will be stored in glass containers until the following analyses (see Table 9) are conducted:

- Lipids
- Mercury

3.2.6 Co-Located Porewater

Confirmation monitoring will include the collection of porewater co-located at clam monitoring locations (five locations within the Site and five locations in the Samish Bay reference area; Figures 4 and 5, Table 5). Sediment porewater will be collected near clam cages

using either NMDS or temporary mini-piezometers. NMDS is the preferred method due to ease of use in any sediment type (sand and silts/clay) and reliability and consistency of data obtained using this method. The following field forms (provided in Appendix A) will be completed for clam tissue and co-located porewater monitoring:

- Daily Log
- Well Installation Log (if mini-piezometer is used)
- Porewater Collection Log (if mini-piezometer is used)

Co-Located Porewater Collection

Option 1 (preferred): Nylon-mesh Diffusion Samplers

Porewater may be collected using NMDS following methods used by the U.S. Geological Survey and U.S. Environmental Protection Agency (USGS and USEPA 2003). NMDS are a type of passive sampler that can be used in both course and fine sediments, provide a comparable measure with which to compare clam exposure over the duration of the incubation period, and limit the introduction of confounding factors (such as erroneously drawing surface water or sediment into the sample).

NMDS consist of 250-mL polypropylene jars and screw-on lids. NMDS are constructed prior to the field effort using the following procedures:

- Remove the center of the lid so that just the rim remains.
- Place all equipment in buckets/tubs with deionized water that has been purged of oxygen via aerating with nitrogen for at least 1 hour. Continue aerating with nitrogen while assembling the NMDS.
- Place a piece of 120-micron nylon screen mesh over the top of the jar and screw on the lid rim.
- Store jars in the assembly buckets with lids firmly sealed and under nitrogen headspace to prevent contamination until deployment.

NMDS will be deployed by divers near clam cages using the following procedures:

- Attach a small buoy to each NMDS using an electrical tie and rope.
- A small shovel-like device made from PVC may be used to create a hole in the sediment in which the samplers will reside (see USGS and USEPA 2003 for details).

- Bury jars 6 to 12 cm in the sediment placed on their sides to prevent the mesh from being punctured during deployment and retrieval.
- Cover the NMDS with sediment.
- Record GPS coordinates on field forms.
- NMDS will be left in situ for a minimum of 4 days to equilibrate.

NMDS will be retrieved using GPS coordinates and the buoys in the following manner:

- Gently pull the samplers to the surface using the rope attached to each NMDS. Caution will be used while removing samplers from the sediment to avoid damaging the nylon mesh.
- Once on board the vessel, any sediment remaining on the top of the mesh will be gently removed to minimize the loss of water from the sampler.
- Porewater will be extracted using a 60-mL disposable syringe.
  - For dissolved mercury analysis, a 13-gage, 8.9-cm hypodermic needle and a 25-mm, 0.45-micron filter unit mounted between the syringe and needle (see USGS and USEPA 2003 method for a picture of the assembly) will be used to collect the sample.
  - For total mercury analysis, the filter will be removed, and the hypodermic needle connected directly to the syringe to collect the sample.
- For each sample (total and dissolved), the syringe assembly will be pushed into the mesh and 100 mL will be drawn in the syringe.
- The filter and hypodermic needle will be removed from the syringe and the sample volume gently pushed into the sample container. The sample container will be tightly sealed.

Option 2: Mini-piezometers

Alternatively, porewater may be collected using diver-assisted push-point mini-piezometers. A mini-piezometer is a mini well point constructed of a stainless-steel rod with a screened end at the tip. The design includes a probe with a heavier-weight stainless-steel construction, approximately 2-inch screened (0.5-mm slot) interval with a smaller aperture size near the tip of the probe, and a base plate attachment that sits at the mudline elevation to minimize drawdown from the overlying surface water. A schematic of the porewater

sampling device is shown on Figure 6. Larger screen (4- and 6-inch) intervals will be used if the screen becomes clogged due to fine-grained sediment. If used, mini-piezometers will be placed by divers and driven approximately 6 to 12 cm into the sediment.

Clean polyethylene tubing will be connected to the end (opposite end of screened portion) of the mini-piezometer and extended through the water column to the deck of the sampling vessel and into a peristaltic pump or similar type pumping device. Samples for total mercury analysis will be collected directly into sample containers; samples for dissolved mercury analysis will be filtered through a 0.45-mm cartridge as the sample is pumped directly into sample containers.

Co-Located Porewater Processing

Porewater sample containers will be appropriately labeled and stored in coolers with ice at approximately 4°C until delivery to the laboratory. Samples will be analyzed for the following parameters (see Table 10):

- Total and dissolved mercury

3.2.7 Benthic Fish

Confirmation monitoring will include the collection of benthic fish tissue in Year 3 and 5 and potentially in Year 10 if tissue concentrations of mercury measured in Years 3 or 5 are significantly elevated in comparison to fish collected in reference areas. Benthic fish tissue monitoring will be discontinued once contaminant concentrations in Site tissues are not statistically elevated above reference tissue concentrations for two consecutive monitoring events.

Benthic fish tissue will be collected via trawling from a vessel equipped with sufficient deck space for staging of gear. Methods will be in accordance with Ecology and PSEP protocols. Samples will be collected at Site and reference locations; three approximate target trawl lines for within the Site and three within Samish Bay (reference area) are shown in Figures 5 and 7. Coordinates are provided in Table 5. Final trawl locations will be determined in coordination with the captain of the sampling vessel, and additional trawls may be conducted to acquire sufficient numbers of fish.

The following field forms (Appendix A) will be completed for fish tissue monitoring:

- Daily Log
- Fish Log

Scientific collection permits will be obtained from WDFW prior to benthic fish collection.

Benthic Fish Collection Methods

The target benthic fish species for monitoring is English sole (*Parophrys vetulus;* family: Pleuronectidae). If insufficient English sole are caught, starry flounder (*Platichthys stellatus)* will be collected as an alternate species.

Benthic fish will be collected using a high-rise otter trawl. A pre-trawl survey will be conducted to determine if the site is suitable for trawling. The pre-trawl survey will consist of examining the seafloor for obstructions using a fathometer. The sampling site will be abandoned after three unsuccessful pre-trawl attempts, and the sampling site will either be moved or attempts will be made at the other target locations. Once a pre-trawl survey has been conducted and the area is found suitable for trawling, the trawl net will be prepared using the following procedures:

- Nets will be inspected for holes prior to deployment and repaired as needed. The net should be laid out and stacked on the stern of the vessel in the same configuration that it will be deployed: cod-end to the stern, floats up, and foot rope down.
- The trawl net should be checked to make sure that the cod-end is tied correctly, the doors should be connected properly to the leg lines, and the bridles should be securely fastened to the doors and to the tow wire.

Once prepared, the trawl net will be deployed using the following procedures:

- While the vessel is underway, the net and doors will be placed in the water. It is important that the floats skim the surface and that the net is not entangled (e.g., crossed leg lines, bunched or hooked portions of the net) prior to paying out the bridles.

- The bridles should be paid out by personnel on either side of the net, so as to avoid becoming entangled in the rigging during deployment.
- Use of the proper scope (i.e., length of hydrowire paid out versus the water depth) is important for successful trawls.
- After the net touches the bottom, a sufficient length of hydrowire (towing wire) should be paid out to ensure that the net is pulled from a horizontal rather than a vertical position. (Insufficient scope will prevent the net from consistently fishing the bottom and will result in a no-catch or a short-catch situation.)
- The trawl is towed at a speed of 1.0 meter per second for 5 to 10 minutes.
- At the end of the prescribed trawl, the net will be retrieved and brought onboard the vessel, the cod-end will be opened, and the catch will be deposited into a tub or holding tank. The catch will subsequently be released to the scientific crew for processing.

The Site trawl samples will be collected first so that it is possible to match the fish sample size classes with those collected from the Samish Bay reference area.

Benthic Fish Processing Methods

Once the catch is onboard the vessel, the targeted species will be identified and separated for subsequent processing. Only English sole, pleuronectid flatfish, and starry flounder will be retained. As required by WDFW, specimens of non-target species will be identified to the lowest practical taxon and their numbers estimated. Special care will be taken to return non-target organisms to the water quickly, with minimal handling.

Specimens of target species that do not meet size requirements will be counted, their lengths will be approximated, and they will be returned to the water. Target fish will be temporarily held in a live well on the boat until all three trawls are completed. Individual fish of the selected target species will be rinsed in water from the collection location to remove any foreign material from the external surface. Target fish will be measured for length and physically dispatched after wrapping the fish in aluminum foil. Each fish will be placed in a re-sealable plastic bag and placed on ice. A unique sample ID tag will be placed into the bag and the sample ID will also be written on the outside of the bag.

Five composite samples will be prepared for each test area (e.g., Site or reference). English sole can live more than 10 years, and fish age and size can affect tissue chemical concentrations (Hart Crowser 2000). To help account for this confounding factor, the composite samples will be created to contain fish of similar sizes. The composite samples will be prepared at the laboratory after review of the species and size data. The goal is to obtain enough fish to create five composite samples of five fish each. If fewer than 25 fish are collected at the Site or reference area, composites will be prepared using the available fish. The composite samples will consist of skin-off fillets prepared in the laboratory.

Benthic fish tissue will be analyzed for the following parameters (see Table 9):

- Lipids
- Mercury
- D/F (Year 3 only)

3.2.8 Pelagic Fish

Although not anticipated, confirmation monitoring may include the collection of pelagic fish tissue if benthic fish tissue concentrations are elevated. If required, an addendum will be provided detailing sampling and analysis methods based on methods outlined in the CMCRP (provided below for context) and in conjunction with WDFW.

Pelagic fish, including salmon, may occur near the Site. However, the tissue quality in pelagic fish species is typically influenced less by localized sediment contamination than for benthic fish or shellfish due to differences in lifecycle, on-Site residence time, home range, and foraging behavior.

The home range of salmon species is very extensive relative to the localized nature of the Whatcom Waterway Site. In addition, historical comparisons of fish returning to the Nooksack River versus other regional rivers have found no difference in tissue mercury concentrations (Hart Crowser 2000).

At other Puget Sound cleanup sites, such as the Lower Duwamish Waterway (LDW) in Seattle, it was determined that returning adult salmon were exposed to site-related

contaminants for a relatively short duration (de minimus on-site residence time) as juveniles during out-migration and that the contribution of this short-term exposure to total adult body burdens is likely insignificant (O'Neill et al. 1998). Adult salmon were not considered receptors of concern for the LDW risk assessment conducted under the joint oversight of the U.S. Environmental Protection Agency and Ecology.

Based on these considerations and the similarity of salmon tissue mercury concentrations between fish from the Nooksack River and other watersheds (Hart Crowser 2000), the analysis of pelagic fish tissue will be implemented only if the Year 3 results of the benthic fish tissue monitoring show mercury concentrations statistically significantly elevated above reference area benthic fish tissue concentrations. If concentrations in benthic fish tissue are significantly elevated, Ecology may require monitoring of salmon tissue if that information (in conjunction with available data regarding the lifecycle, home range, and feeding behavior of salmon) suggests that the Site conditions could result in a potentially significant and measurable impact on pelagic fish tissue mercury concentrations.

If monitoring of salmon is performed, the sampling would consist of the collection of salmon using hook and line or net methods (i.e., purse seine). The WDFW SalmonScape[1] tool documents the presence of fall Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and sockeye salmon (*O. nerka*) in the Lummi River, the Nooksack River, Whatcom Creek, and the Samish River. The selected species and sampling method would depend on fish availability and location at the time of sampling. Testing of sockeye salmon is preferred because these salmon make up a significant portion of the diets of local tribal seafood consumers as reported during recent surveys conducted by the Lummi Nation, and potential bycatch of Chinook salmon can be minimized.

Frequency

Monitoring of pelagic fish tissue will be conducted at up to three monitoring events, potentially including Years 3, 5, and 10. Confirmation monitoring of pelagic fish during Year 3 will be conducted if benthic fish tissue mercury concentrations during Year 3 are found to be statistically significantly elevated above reference area benthic fish tissue

[1] SalmonScape is available at http://apps.wdfw.wa.gov/salmonscape/map.html.

concentrations, and if Ecology determines that the benthic tissue concentrations suggest that the Site could significantly impact salmon tissue mercury concentrations (in consideration of available data regarding the lifecycle, home range, and feeding behavior of salmon). The determination of the need for pelagic monitoring in subsequent years will also be made relative to benthic fish tissue results. If benthic fish monitoring is terminated because tissue mercury concentrations from the Site are not statistically significantly greater than reference area tissue mercury concentrations, then pelagic fish monitoring will also be discontinued.

Sampling and Analysis Approach

Pelagic fish tissue monitoring, if performed, will be conducted by collecting five tissue composites from salmon collected within the Site. Five composite samples of salmon tissue will be similarly collected from Samish Bay.

Five composite samples from each area (Whatcom Waterway and Samish Bay) will be prepared by combining tissue from each of three fish. If fewer than 15 fish are collected at the Site or reference area, composites will be prepared using the available fish. The composite samples will consist of skin-off fillets prepared in the laboratory.

Laboratory analysis of the samples will consist of percent moisture, percent lipid content, and total mercury (see Table 9). All methods will be in accordance with Ecology and PSEP protocols.

All work will be conducted pursuant to the requirements of a scientific collection permit obtained from WDFW prior to collection of fish.

3.2.9 Unit 4 (Log Pond) Porewater Monitoring

Confirmation monitoring will include the collection of porewater in Years 1, 3, 5, and 10. Sediment porewater will be collected at two sampling locations in Unit 4 (Figure 3 and Table 6) using either temporary mini-piezometers or nylon mesh diffusion samplers (NMDS). The following field forms (Appendix A) will be completed for porewater monitoring:

- Daily Log
- Well Installation Log

- Porewater Collection Log

Porewater Collection

Option 1 (Preferred): Nylon-mesh Diffusion Samplers

Alternatively, porewater may be collected using NMDS following methods used by USGS and USEPA (2003). NMDS are a type of passive sampler that can be used in both course and fine sediments, provide a comparable measure with which to compare clam exposure over the duration of the incubation period, and limit the introduction of confounding factors (such as erroneously drawing surface water or sediment into the sample).

NMDS consist of 250-mL polypropylene jars and screw-on lids. NMDS are constructed prior to the field effort using the following procedures:

- Remove the center of the lid so that just the rim remains.
- Place all equipment in buckets/tubs with deionized water that has been purged of oxygen via aerating with nitrogen for at least 1 hour. Continue aerating with nitrogen while assembling the NMDS.
- Place a piece of 120-micron nylon screen mesh over the top of the jar and screw on the lid rim.
- Store jars in the assembly buckets with lids firmly sealed and under nitrogen headspace to prevent contamination until deployment.

NMDS will be deployed at low tide by field technicians with knee-high boots or waders using the following procedures:

- Attach a small buoy to each NMDS using an electrical tie and rope.
- A small shovel-like device made from PVC may be used to create a hole in the sediment in which the samplers will reside (see USGS and USEPA 2003 for details).
- Bury jars 1 foot in the sediment placed on their sides to prevent the mesh from being punctured during deployment and retrieval.
- Cover the NMDS with sediment.
- Record GPS coordinates on field forms.
- NMDS will be left in situ for a minimum of 4 days to equilibrate.

NMDS will be retrieved using GPS coordinates and the buoys in the following manner:

- Gently remove the samplers from the sediment using caution to avoid damaging the nylon mesh.
- Once recovered, any sediment remaining on the top of the mesh will be gently removed to minimize the loss of water from the sampler.
- Porewater will be extracted using a 60-mL disposable syringe.
  - For dissolved mercury analysis, a 13-gage, 8.9-cm hypodermic needle and a 25-mm, 0.45-micron filter unit mounted between the syringe and needle (see USGS and USEPA 2003 method for a picture of the assembly) will be used to collect the sample.
  - For total mercury analysis, the filter will be removed, and the hypodermic needle connected directly to the syringe to collect the sample.
- For each sample (total and dissolved), the syringe assembly will be pushed into the mesh and 100 mL will be drawn in the syringe.
- The filter and hypodermic needle will be removed from the syringe and the sample volume gently pushed into the sample container. The sample container will be tightly sealed.

Option 2: Mini-piezometers

Porewater may be collected using push-point mini-piezometers. A mini-piezometer is a mini well point constructed of a stainless-steel rod with a screened end at the tip. The design includes a probe with a heavier-weight stainless-steel construction, approximately 2-inch screened (0.5-mm slot) interval with a smaller aperture size near the tip of the probe, and a base plate attachment that sits at the mudline elevation to minimize drawdown from the overlying surface water. A schematic of the porewater sampling device is shown on Figure 6. Larger screen (4- and 6-inch) intervals will be used if the screen becomes clogged due to fine-grained sediment. If used, mini-piezometers will be driven approximately 1 foot into the sediment at low tide by field technicians with knee-high boots or waders.

Clean polyethylene tubing will be connected to the end (opposite end of screened portion) of the mini-piezometer and extended through the water column to the deck of the sampling vessel and into a peristaltic pump or similar type pumping device. Samples for total mercury

analysis will be collected directly into sample containers; samples for dissolved mercury analysis will be filtered through a 0.45-mm cartridge as the sample is pumped directly into sample containers.

Porewater Processing

Porewater samples will be stored in coolers on ice until delivery to the analytical laboratory. Samples will be analyzed for the following parameters (see Table 10):

- Total and dissolved mercury

4 GENERAL SAMPLING METHODS

This section describes general sampling methods and procedures that apply to both performance and confirmation monitoring programs.

4.1 Station and Sample Identification

Station and sample identifications are provided in Tables 4 through 6. Each sample will be assigned a unique alphanumeric identifier. The identifier will have the format of "Project Identifier-Station ID-Species or Media Code-Sample Interval-Date." Samples will be identified according to the following procedure:

- The project designator will be WW to denote Whatcom Waterway.
- The station ID will correspond to sample locations shown in Figures 2, 3, 4, 5, and 7.
- Species/media codes are as follows:
  - RE = residuals layer (collected from a sediment grab sampler)
  - UD = underlying sediment layer (collected from a sediment grab sampler)
  - SS = surface sediment grab (confirmation monitoring)
  - SC = subsurface sediment core
  - CM = crab tissue
  - CL = clam tissue
  - PW = porewater
  - BF = benthic fish tissue
  - PF = pelagic fish tissue
- Sample interval will be the depth at which the sample is collected in feet below the mudline. For tissue, 0 feet will be used.
- Date of collection, in the form of YYMMDD.
- As an example, a Dungeness crab muscle tissue sample collected on August 24, 2015, from station MNR-4 will have an ID of WW-MNR-4-CM-0-150824.

Each sample will have an adhesive plastic or waterproof paper label affixed to the container or baggie 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 identifier
- Date and time of sample collection
- Analysis to be performed

4.2 Navigation

A vessel-mounted Differential Global Positioning System (DGPS) will be used to navigate to the desired sampling location. GPS coordinates for sampling stations are provided in Tables 4 through 6. Collection at the sampling location will be guided by the navigation system with an accuracy of ±10 feet. The coordinates will be recorded, when positioned at the sampling location, in latitude and longitude in decimal degrees (to 5 decimal places). Positions will be relative to the Washington State Plane Coordinates, North, North American Datum of 1983.

Vertical positioning will be achieved using the vessel's fathometer or a lead line and converted to MLLW elevation. Tidal elevations will be determined after sample collection using the National Oceanic and Atmospheric Administration's tide station (ID 9449211) located in Bellingham, Washington.

4.3 Permitting and Approvals

Scientific collection permits are required for collection of crab and fish tissue samples; these will be obtained from WDFW prior to collection.

4.4 Sample Handling Requirements

Sample container requirements, holding times, and preservation requirements are outlined in Table 7. Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sample material must meet high standards of cleanliness. All equipment and instruments that will be used and are in direct contact with various media collected for chemical analyses must be made of glass, stainless steel, high density polyethylene, or polytetrafluoroethylene and will be cleaned prior to each day's use and between sampling or compositing events.

4.4.1 Decontamination Procedures

The following general decontamination procedures will be followed for field sampling equipment:

1. Pre-wash rinse with tap or site water
2. Wash with solution of tap water or site water and phosphate-free soap (e.g., Alconox)
3. Rinse three times with distilled water
4. Cover (no contact) all decontaminated items with aluminum foil
5. Store in a clean, closed container for next use

Cages and associated equipment (mesh, ropes, anchors, etc.) will be pressure-washed with fresh water or soaked in saltwater for 24 hours prior to use and kept clean until deployment.

4.4.2 Investigation-Derived Waste

All disposable sampling materials and personal protective equipment used in sample collection and processing (e.g., disposable gloves and paper towels) will be placed in heavy-duty garbage bags for disposal as non-hazardous solid waste. No hazardous materials requiring disposal will be used during fieldwork for this study.

Sediment recovered in grab samples from MNR and cap areas not retained for chemical analysis will be returned to the target sampling location. Sediment recovered in post-dredging grab samples from the Inner Waterway stations (presumed to contain elevated contaminant levels) will be retained as investigation-derived waste and will be managed by subtitle D landfill disposal.

Core samples will be processed at the analytical laboratory or alternative upland location. Samples of coring sample sediment not retained for chemical analysis will be stored in buckets or drums at the processing location. Core samples not used for analysis will be retained and will be managed as investigation-derived waste. This material will be managed by subtitle D landfill disposal in compliance with applicable regulations.

Tissue samples will be processed in the laboratory. Expired animals identified at the point of collection and not retained for chemical analysis will be returned to the water in the middle

of the bay. Expired animals or dissection materials not retained for chemical analysis will be disposed of in accordance with applicable regulations.

Any porewater waste generated during the purging process and sample collection will be collected in 5-gallon buckets or similar and disposed of in accordance with applicable regulations.

4.4.3 Sample Custody and Shipping Requirements

COC procedures will be followed for all samples throughout the collection, handling, and analysis process. The principal document used to track possession and transfer of samples is the COC form. Each sample will be represented on a COC form the day it is collected. All manual data entries will be made using an indelible ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, and then dating and initialing the change. Blank lines and spaces on the COC form will be lined out, dated, and initialed by the individual maintaining custody. Electronic COC forms generated from a custom field application will be emailed directly to the laboratory and QA managers.

A COC form will accompany each shipment of samples to the analytical laboratory. Each person in custody of samples will sign the COC form and ensure 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 hand delivered to the analytical laboratory no later than 1 day after collection. Samples collected on Friday may be held until the following Monday for shipment, provided that this delay does not jeopardize any holding time requirements. Specific sample shipping procedures are as follows:

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

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

- Coolant ice will be sealed in separate 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 chain-of-custody forms accompanying 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 custody 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 person(s) transferring custody of the sample container will sign the COC form. Upon receipt of samples at the laboratory, the custody seals 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 laboratory to track sample handling and final disposition.

4.5 Laboratory Analytical Methods – Chemistry

Chemical analyses will be conducted at a laboratory accredited through the State of Washington's Department of Ecology Laboratory Accreditation Program.

4.5.1 Surface Sediment

Surface sediment samples for performance monitoring will be analyzed for total solids, TOC, mercury, PAH, phenolic compounds, and D/F. Surface sediment samples for confirmation monitoring will be analyzed for mercury, copper, zinc, total solids, TOC, PAH, phenolic compounds, and D/F. A complete list of surface sediment parameters, analytical methods, and target quantitation limits is provided in Table 8.

4.5.2 Subsurface Sediment

Subsurface sediment samples for confirmation monitoring will be analyzed for total solids and mercury. Subsurface sediment parameters, analytical methods, and target quantitation limits are listed in Table 8.

4.5.3 Tissue

Tissues to be analyzed during performance and confirmation monitoring include crab, clam, benthic fish, and contingent pelagic fish. All tissues will be analyzed for percent moisture, and mercury. These results will be reported on a wet weight basis. Benthic fish will also be analyzed for lipids and D/F in Year 3, with results for D/F reported on both a wet weight and lipid-normalized basis. Tissue parameters, analytical methods, and target quantitation limits are listed in Table 9.

4.5.4 Porewater

Porewater collected during performance and confirmation monitoring will be analyzed for total and dissolved mercury. Analytical methods and target quantitation limits are listed in Table 10.

4.6 Laboratory Analytical Methods – Toxicity

Contingent toxicity testing will be conducted if analytical chemistry results indicate a Sediment Quality Standard (SQS) exceedance for mercury or other contaminants. Toxicity testing will include three standard bioassays, the 10-day amphipod survival test, the 20-day juvenile polychaete growth test, and the larval bivalve development test. Testing will be conducted in accordance with PSEP (1995) methods and Sediment Management Annual

Review Meeting (SMARM) updates. Test results will be compared to SMS Biological Effects Criteria for Puget Sound marine waters. Test performance standards, SQS, and Cleanup Screening Levels are provided in Table 11.

4.6.1 10-Day Acute Toxicity Amphipod Test

The amphipod bioassay will be performed using the amphipod *E. estuarius*, *R. abronius*, or *A. abdita*. Species selection will be determined in coordination with Ecology and based upon grain size, salinity, and collection season prior to test initiation.

Control sediment will consist of native amphipod sediment. Amphipods will be exposed to sediments for 10 days under static conditions with continuous light. Test chambers will be 1-liter (L) glass jars with approximately 2 cm of sediment and 900 mL of overlying seawater. Water quality parameters including pH, temperature, dissolved oxygen (DO), and salinity will be measured daily during testing. Overlying ammonia and sulfides will be measured at test initiation and termination. There will be five replicates per treatment.

At test initiation, 20 organisms will be placed in each replicate. Test chambers will be randomized and gently aerated during testing. Organisms will not be fed for the duration of the test. After 10 days, organisms will be sieved from the sediment and survivorship will be recorded. Test acceptability will be evaluated by survivorship in the control, which should be at least 90%. If the test does not meet control acceptability criteria, it should be repeated. The relative sensitivity of each batch of amphipods will be assessed by conducting a 96-hour, water-only reference toxicant test using cadmium chloride.

Ammonia is not a contaminant of concern but may be responsible for confounding toxicity test results, which is especially true with the amphipod test. Interstitial ammonia concentrations will be measured on project sediments prior to testing. If ammonia concentrations are elevated, the bioassay laboratory will contact the consultant project manager prior to setting up the tests to discuss the necessity of ammonia reduction procedures.

4.6.2 20-Day Juvenile Polychaete Growth Test

The polychaete bioassay will be performed using *Neanthes arenaceodentata*. *N. arenaceodentata* are cultured from a laboratory population; therefore, native control sediment is not available. Consequently, the amphipod control sediment will be used in the polychaete test. Tests will be conducted using juvenile organisms.

Polychaetes will be exposed to sediments for 20 days with a 16-hour light and 8-hour dark photoperiod. Test chambers will be 1-L glass jars with approximately 2 cm of sediment and 900 mL of overlying seawater. Water quality parameters including pH, temperature, DO, and salinity will be measured daily during testing. Overlying ammonia will be measured at test initiation and termination. There will be five replicates per treatment.

At test initiation, five organisms will be placed into each replicate. In addition, 'time zero' samples will be collected, dried, and weighed. Test chambers will be randomized and gently aerated during testing. Organisms will be fed a slurry composed of Tetramin fish feed and seawater as needed at test initiation and every other day until test termination. Water renewals will be conducted every third day. After 20 days, organisms will be sieved from the sediment and survivorship will be recorded. The ash-free dry weight (AFDW; Gardiner 2010 method will be used to determine growth rate. Polychaetes will be placed in a drying oven at 60 degrees and then dry weights will be recorded. Polychaetes will then be placed in a muffle furnace to remove organic material, and the remaining material will be weighed and recorded as the ashed weight. Growth rate will be calculated by comparing AFDWs of test organisms against 'time zero' AFDWs.

Test acceptability will be evaluated by survivorship in the control, which should be at least 90%. If the test does not meet control acceptability criteria, it should be repeated. The relative sensitivity of each batch of polychaete will be assessed by conducting a 96-hour, water-only reference toxicant test using cadmium chloride.

4.6.3 Larval Bivalve Development Test

The larval bivalve survival and development test will be conducted with either *Mytilus galloprovincialis or Dendraster excentricus*. Species selection will be determined in coordination with Ecology and based on spawning season prior to test initiation.

Control sediment will consist of native amphipod sediment. Test chambers will be 1-L glass jars with 18 grams of sediment weighed into each test chamber and approximately 900 mL of clean seawater. Resuspension will be ensured by mixing vigorously for 10 seconds. Sediments will be allowed to settle for 4 hours prior to test initiation.

Adult organisms will be induced to spawn. Resulting embryos will be exposed to sediments until formation into the larval stage occurs in 90% of the control organisms (typically 48 to 96 hours). Tests will be conducted under static conditions with a 14-hour light/10-hour dark photoperiod. Water quality parameters including pH, temperature, DO, and salinity will be measured daily during testing. Overlying ammonia and sulfides will be measured at test initiation and termination. There will be five replicates per treatment.

At test initiation, a pre-determined aliquot of embryos (in solution) will be placed in each replicate chamber. Test chambers will be randomized; no aeration is required unless DO levels fall below the acceptable tolerance limit. Organisms will not be fed during the test. The resuspension method (Gardiner 2010) will be used at approximately 42 hours after initiation to free any larvae trapped in fine sediments or the flocculent layer; this method consists of using a perforated plunger to gently homogenize the water, larvae, and settled sediment. At test termination (development stage reached in controls), three 10-mL aliquots will be removed from each test chamber, placed in screw cap vials, and preserved with 5% buffered formalin. The number of alive, normally developed, and abnormal larvae will be enumerated under a microscope.

Test acceptability will be evaluated by normal development in the control, which should be at least 70%. If the test does not meet control acceptability criteria, it should be repeated. The relative sensitivity of each batch of larvae will be assessed by conducting a 96-hour, water-only reference toxicant test using cadmium or copper chloride, dependent upon the test species selected.

4.7 Quality Assurance and Quality Control

QA/QC requirements will include the collection of field samples as well as laboratory testing. Field and laboratory QA/QC analytical frequencies are provided in Table 12. Laboratory DQOs for precision, accuracy, and completeness are listed in Table 13.

Field sampling activities will be assessed by rinsate blanks and field duplicates. The quality of laboratory data will be assessed by precision, accuracy, representativeness, comparability, completeness, and sensitivity as defined in Section 3.1. Chemical laboratory QA/QC samples include method blanks, laboratory control samples, matrix spike/matrix spike duplicates, and matrix duplicates. Toxicity laboratory QA/QC includes negative and positive controls, water quality measurements, reference sediments, and reference toxicant tests.

4.8 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

This section describes procedures for testing, inspection, and maintenance of field and laboratory equipment.

4.8.1 Field Instruments/Equipment

The field coordinator or designee will maintain inventories of field instruments and equipment and will be responsible for the preparation, documentation, and implementation of preventative maintenance. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturers' instruction manuals.

The field coordinator or designee will also be responsible for navigation and 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. Samplers will be inspected daily for any mechanical

problems, and problems will be noted in the field logbook and corrected prior to continuing sampling operations.

4.8.2 Laboratory Instruments/Equipment

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by each laboratory in accordance with the requirements identified in the laboratory's standard operating procedures (SOPs) and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup, tuning, and critical operating parameters. Instrument maintenance and repair will be documented in the maintenance log or record book.

4.9 Inspection/Acceptance of Supplies and Consumables

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and QC purposes.

Reagents of appropriate purity and suitably cleaned laboratory equipment will be used for all stages of laboratory analyses. Details of acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs. All supplies will be obtained from reputable suppliers with appropriate documentation or certification.

4.10 Non-Direct Measurements

Existing chemical data from previous investigations will be used to guide this SQAPP.

5 PROJECT MANAGEMENT

This section provides a description of DQOs, special training needed to perform the tasks, and documentation procedures.

5.1 Data Quality Objectives

The overall DQO for field sampling and laboratory analysis is to produce data of known and appropriate quality to support the project objectives. DQOs for the project are provided in Table 13. The quality of laboratory data is assessed by precision, accuracy, representativeness, comparability, completeness, and sensitivity. The definitions for the data quality indicators are as follows.

5.1.1 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 laboratory analysis.

5.1.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value.

5.1.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition.

5.1.4 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 the use of common traceable calibration and reference materials.

5.1.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected.

5.1.6 Sensitivity

Sensitivity is related to the instrument calibration low-level standard, method detection limits (MDLs) and/or estimated detection limits (EDLs). Analytical methods will be selected to achieve reporting limits that comply with, or are close to, target detection limits.

5.2 Special Training Requirements/Certifications

A technical team will be assembled with the requisite experience and technical skills to successfully complete the sampling for this monitoring program. Personnel involved in sample collection will have extensive environmental sampling experience. All sampling personnel will be required to have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and the 8-hour refresher course, as necessary, to meet the 29 Code of Federal Regulations 1910.120 Occupational Safety and Health Administration regulations. The training provides employees with knowledge and skills that enable them to perform their jobs safely and with minimum risk to their personal health. Documentation of course completion will be maintained in personnel files.

5.3 Documentation and Records

Records will be maintained documenting all activities and data related to sample collection and laboratory analyses. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section.

5.3.1 Field Records

Field samples will be documented using a custom field application or field collection logs. Additionally, the field coordinator or designee will keep a daily record of significant events, observations, and measurements on a daily log. Entries for each day will begin on a new page. The person recording information must enter the date and time and initial each entry.

In general, sufficient information will be recorded during sampling to reconstruct the event without relying on the memory of the field personnel.

The daily log will contain the following information, at a minimum:

- Project name
- Field personnel on site
- Site visitors
- Weather conditions
- Field observations
- Maps and/or drawings
- Sample collection date and time
- Sample collection method and description of activities
- Deviations from this SQAPP
- Conferences associated with field sampling activities

5.3.2 Analytical Records

Analytical data records (bookmarked PDF and electronic data deliverable formats) will be generated by the laboratory and submitted to the QA manager upon completion. If files are too large to be emailed, a notification email with download instructions will be sent to the project data management team. Level IV data reports will be provided by the laboratory.

The analytical laboratory will be required to report the following, where applicable:

- **Case Narrative:** This summary will discuss problems encountered during any aspect of analysis, if any. It should discuss, but is not limited to, QC issues, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate. Analytical QC samples that exceed project performance criteria and/or laboratory performance criteria should also be discussed in the case narrative.
- **Chain-of-Custody Records:** Legible copies of chain-of-custody 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 sample shipping container temperatures measured at the time of sample receipt.

- **Sample Results:** The data package will summarize results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identifier and corresponding laboratory identification code
  - Sample matrix
  - Date and time of sample extraction
  - Date and time of analysis
  - Final concentration volumes and dilution factors
  - Instrument and analyst identification
  - Method reporting limits (MRLs) and MDLs accounting for sample-specific factors (e.g., dilution and total solids)
  - Analytical results with reporting units identified
  - Data qualifiers and their definitions
  - Raw data including instrument printouts, chromatograms, and bench sheets (required for full data packages)
- **QA/QC Summaries:** Contract Laboratory Program (CLP)-like form summaries should be generated for all required laboratory QC components and samples (i.e., method blanks, instrument daily tunes, surrogate spikes, internal standards, and laboratory control samples). These summaries should include spike volumes, parent sample concentrations, percent recoveries, relative percent differences, area counts, and laboratory control limits as applicable. For full data packages, associated raw data files should be included.
- **Instrument Calibration Data:** CLP-like form summaries of calibration data (i.e., initial calibration, initial calibration verification, and continuing calibration verification) should be included in all data packages. For full data packages, associated raw data files should be included.

All instrument data shall be fully restorable at the laboratory from electronic backup. The laboratory will be required to maintain all records relevant to project analyses for a minimum of 5 years.

5.3.3 Data Reduction

Data reduction is the conversion of raw data to final results. Methods or procedures for data reduction shall be documented. The following procedures will be implemented to verify the accuracy of data reduction:

- Technical staff will document, review, and QC their own work to ensure accuracy.
- Major calculations will be subject to an independent senior technical review to ensure that both the methods and the calculations are correct and consistent with the approved work plan.
- The project manager will be responsible for ensuring that data reduction is conducted in a manner that produces high quality data via review and approval of concepts, methods, assumptions, and calculations.

6 ASSESSMENTS AND OVERSIGHT

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.

6.1 Compliance Assessments

Laboratory and field performance audits consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Audits will not be conducted as part of this study. However, 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. When these procedures have been submitted, the project QA manager will review them to ensure compliance with this SQAPP. The laboratory must ensure that personnel engaged in sampling and analysis tasks have appropriate training. As part of the audit process, the laboratory will provide the consultant with written details of any method modifications planned.

6.2 Response and Corrective Actions

The project manager, QA manager, and field coordinator will work together to determine actions to be taken in the event of an error, problem, or nonconformance to protocols identified in this SQAPP.

6.2.1 Field Activities

The field coordinator will be responsible for correcting equipment malfunctions during the field sampling effort. The QA manager will be responsible for resolving situations identified by the field coordinator that may result in noncompliance with the SQAPP. All corrective measures will be immediately documented in the field logbook.

6.2.2 Laboratory

The laboratories are required to comply with their SOPs. The laboratory managers will be responsible for ensuring that appropriate corrective actions are initiated as required for

conformance with this SQAPP. All laboratory personnel will be responsible for reporting problems that may compromise quality data.

The laboratory managers will be notified if any QC sample grossly exceeds the laboratory in-house control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. If the anomaly cannot be corrected, the laboratory manager will notify the QA manager. A narrative describing the anomaly, 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.

6.3 Reports to Management

QA reports to project management will 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 manager.

7 DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories will be verified and validated according to methods and procedures described in this section.

7.1 Data Review, Validation, and Verification

During the validation process, analytical data will be electronically and/or manually evaluated for method and laboratory QC compliance, and their validity and applicability for program purposes will be determined.

Based on findings of the validation process, data validation qualifiers may be assigned. Validated project data, including qualifiers, will be entered into the project database, thus enabling this information to be retained or retrieved as needed.

7.2 Validation and Verification Methods

Field and laboratory data for this task will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification includes a review for completeness and accuracy by the field coordinator and laboratory manager, review by the data manager for outliers and omissions, and the use of performance criteria to identify laboratory QC sample outliers. Data verification will be conducted manually by the project consultant or an external validator.

For this program, Stage 2B validation (USEPA 2009) will be conducted following National Functional Guidelines for data validation (USEPA 1999, 2004, 2005, 2008), this SQAPP, and by using professional judgment. Data will be reviewed with regard to the following, as appropriate to the particular analysis:

- Completeness
- Holding times
- MRLs, MDLs, and EDLs

- Laboratory control samples
- Matrix spike/matrix spike duplicates
- Standard reference materials
- Surrogate recoveries
- Method blanks
- Field QC samples
- Initial calibration data
- Continuing calibration data
- Instrument performance check

A data validation report will be generated to document any issues with data quality and any qualifications applied to data. All validated data will be entered into the database established for this program, and a final data file will be exported. Verification of the database export against the PDF data report will be performed by the QA manager or designee. Any errors found in the data file export will be corrected in the database and reviewed for systemic reporting errors. Once all discrepancies are resolved, the database will be established.

The QA manager will be responsible for the final review of all data validation reports.

7.3 Reconciliation with User Requirements

The QA manager will review data at the completion of the task to determine if DQOs have been met. If data do not meet the project's specifications, the QA manager will review the errors and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors and will suggest corrective action, if appropriate. It is expected that the problem would be able to be corrected by retraining, revising techniques, or replacing supplies/equipment; if not, the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the QA manager will recommend appropriate modifications. If matrix interference is suspected to have attributed to the exceedance, adequate laboratory documentation must be presented to demonstrate that instrument performance and/or laboratory technique did not bias the result. In cases where the DQOs have been exceeded and corrective actions did not resolve the outlier, data will be qualified per USEPA National Functional Guidelines (1999, 2004, 2005, 2008). In these instances, the usability of data will

be determined by the extent of the exceedance. Rejected data will be assigned an "R" qualifier and will not be used for any purposes.

8 REPORTING

All monitoring data from a given year will be summarized in a compliance monitoring report to be prepared and submitted to Ecology. Monitoring data will also be entered into EIM. The report will include copies of final survey data and any validated analytical data and will include the following sections:

- Site background and context for the current report
- Monitoring objective(s) and methods
- Method deviations in sampling and/or analysis from this SQAPP
- Results of monitoring, including data validation, bathymetric survey results, and sediment, porewater, and/or tissue testing results
- Comparison of monitoring results to site cleanup levels and previous testing results
- Identification of any areas of concern, including any recommended contingency response measures (as defined in the CMCRP; Anchor QEA 2015b) or areas for supplemental testing

9 REFERENCES

Anchor QEA (Anchor QEA, LLC), 2010. *Pre-Remedial Design Investigation Data Report – Whatcom Waterway Cleanup Site*. Prepared for Port of Bellingham.

Anchor QEA, 2012. *Preliminary Design Concept Report – Whatcom Waterway Site*. Prepared for Port of Bellingham.

Anchor QEA, 2015a. *Final Engineering Design Report*. Whatcom Waterway Cleanup in Phase 1 Site Areas. Prepared for Port of Bellingham. February 2015.

Anchor QEA, 2015b. *Compliance Monitoring and Contingency Response Plan*. Appendix G, Final Engineering Design Report, Whatcom Waterway Cleanup in Phase 1 Site Areas. Prepared for Port of Bellingham. February 2015.

Anchor QEA, 2015c. *Water Quality Monitoring Plan*. Appendix L, Final Engineering Design Report, Whatcom Waterway Cleanup in Phase 1 Site Areas. Prepared for Port of Bellingham. February 2015.

Anchor QEA, 2015d. *Draft Remedial Investigation Report for the Central Waterfront Site*. Prepared for Port of Bellingham. May 2015.

Aspect, 2013. *Remedial Investigation Report for the Georgia Pacific West Site*. Prepared for the Port of Bellingham. August 2013.

Ecology (Washington State Department of Ecology), 2007. Exhibit B to Consent Decree: Cleanup Action Plan, Whatcom Waterway Site, Bellingham, Washington. 2007.

Ecology, 2011. First Amendment to Consent Decree. 2011.

Ecology, 2007. *Consent Decree No. 07-2-022577-7 for the Whatcom Waterway Site* (with Exhibits). Available online at: https://fortress.wa.gov/ecy/gsp/CleanupSiteDocuments.aspx?csid=219

Ecology, 2015. *Bellingham Bay Regional Background Sediment Characterization Final Data Evaluation and Summary Report*. Publication No. 15-09-044. February 2015.

Gardiner, W., 2010. Bioassay Testing Issues. Public Issue Paper presented by Mr. William Gardiner (NewFields, Inc.) at 2010 Sediment Management Annual Review Meeting, Federal Center South.

Hart Crowser, 2000. *Remedial Investigation/Feasibility Study*. Whatcom Waterway Site, Bellingham, Washington. July 25, 2000.

O'Neill, S.M., J.E. West, and J.C. Hoeman, 1998. Spatial trends in the concentration of polychlorinated biphenyls (PCBs) in chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) in Puget Sound and factors affecting PCB accumulation: results from the Puget Sound Ambient Monitoring Program. In: Puget Sound Research '98 Proceedings, Puget Sound Water Quality Action Team, Olympia, Washington. 312–328.

PSEP (Puget Sound Estuary Program), 1995. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington, and Puget Sound Water Quality Authority, Olympia, Washington, by King County Environmental Lab, Seattle, Washington. 1995.

PSEP, 1997. *Puget Sound Estuary Program: Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound*. Prepared for USEPA Region 10 and the Puget Sound Water Quality Authority. Puget Sound Water Quality Authority, Olympia, Washington.

USACE (U.S. Army Corps of Engineers), 2004 Revision. Engineering and Design - Hydrographic Surveying. Publication number: EM 1110-2-1003. CECW-EE and CECW-OD. April 1, 2004.

USEPA (U.S. Environmental Protection Agency), 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. U.S. Environmental Protection Agency, Office of Emergency Response. EPA 540/R-99/008. October 1999.

USEPA, 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation (OSRTI). EPA 540-R-04-004. October 2004.

USEPA, 2005. *USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data*

Review. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation (OSRTI). EPA 540-R-05-001. September 2005.

USEPA, 2008. *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. Office of Superfund Remediation and Technical Innovation. EPA 540-R-08-01. June 2008.

USEPA, 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. EPA 540-R-08-005. January 2009.

USGS (U.S. Geological Survey) and USEPA, 2003. Field Tests of Nylon-Screen Diffusion Samplers and Pushpoint Samplers for Detection of Metals in Sediment Pore Water, Ashland and Clinton, Massachusetts.

TABLES

Table 1
Site Cleanup Levels for Surface Sediment

Parameter	Cleanup Levels Defined in Consent Decree for Surface Sediment (0-12 cm)	
	Benthic Protection[1]	Other[2]
Metals, mg/kg dry weight		
Copper	390	
Mercury	0.41	1.2
Zinc	410	
SVOCs		
Polycyclic Aromatic Hydrocarbons, µg/kg organic carbon		
Total LPAH	5,200	
Naphthalene	2,100	
Acenaphthylene	560	
Acenaphthene	500	
Fluorene	540	
Phenanthrene	1,500	
Anthracene	960	
2-Methylnaphthalene	670	
Total HPAHs	12,000	
Fluoranthene	1,700	
Pyrene	2,600	
Benzo(a)anthracene	1,300	
Chrysene	1,400	
Total benzo(b,j,k)fluoranthenes	3,200	
Benzo(a)pyrene	1,600	
Indeno(1,2,3-cd)pyrene	600	
Dibenz(a,h)anthracene	230	
Benzo(g,h,i)perylene	670	
Phenols, µg/kg dry weight		
Phenol	420	
2-Methylphenol	63	
4-Methylphenol	670	
2,4-Dimethylphenol	29	

Notes:

1. These criteria were defined based on the Sediment Quality Standards (SQS). Exceedances of these values are subject to confirmational bioassay testing provisions.
2. Site-specific bioaccumulation screening level (BSL)

cm = centimeter
HPAH = high-molecular-weight polycyclic aromatic hydrocarbon
LPAH = low-molecular-weight polycyclic aromatic hydrocarbon
µg/kg = microgram per kilogram
mg/kg = milligram per kilogram
ng/kg = nanogram per kilogram
SVOC = semivolatile organic compound

Table 2
Interpretive Framework for Compliance Monitoring Program

Parameter	Units	Interpretive Framework
Unit 1C Performance Monitoring (Year 0)		
Testing of Dredging Residuals Layer Before Sand Placement		
Mercury	mg/kg	Compare to estimated residuals thickness and concentrations as defined in EDR Appendix A.
D/F as Total TEQ	ng/kg	
Testing for Missed Inventory Before Sand Placement		
Mercury	mg/kg	0.41
D/F as Total TEQ	ng/kg	4.0
Surface Sediment Testing After Sand Placement		
Mercury	mg/kg	0.41
D/F as Total TEQ	ng/kg	15 [1]
Compliance Monitoring (Years 1-30)		
Surface Sediment		
Metals, PAH, phenolic compounds	Varies	Compare to Table 1 Values (SQS) and BSL (mercury).
Contingent Bioassays	Varies	SQS Interpretive Criteria in Table 11
Subsurface Sediment		
Mercury	mg/kg	Document increase in thickness of clean (< 0.41 mg/kg) surface sediment over time.
Mercury in Tissue (Crab, Clam, Benthic Fish, Pelagic Fish)		
Mercury in Tissue	mg/kg	Compare site-specific tissue collected within Site with that collected from reference areas. Terminate monitoring when Site tissues not significantly greater than tissue from reference areas.
Mercury in Porewater (Co-located with clam tissue collection)	µg/L	Use to inform review of the clam tissue mercury data.
D/F in Benthic Fish Tissue (Year 3)		
D/F in Tissue	ng/kg	Sampling event at Year 3 to help inform Ecology's estimate of regional background conditions.

Table 2
Interpretive Framework for Compliance Monitoring Program

Parameter	Units	Interpretive Framework
Mercury in Log Pond Pore-Water		
Mercury – Dissolved	µg/L	0.0594 Value expected to be protective of sediment quality at the SQS (0.41 mg/kg) in the Log Pond area. Value is less than the water quality reference values protective of marine aquatic organisms under acute and chronic toxicity thresholds. [2]

Notes:
Refer to Appendix G of the EDR (Anchor QEA 2015) for a discussion of contingencies that may be employed in response to exceedances of the criteria listed in this table.

1. Assessment of anti-degradation provisions based on final data report documenting regional background concentration of dioxin/furans in Bellingham Bay (Ecology 2015).
2. Reference value protective of aquatic organisms under acute exposures is 1.8 µg/L as dissolved mercury (WAC 173-201a-240(3)). Reference value protective of aquatic organisms under chronic exposures is 0.94 µg/L as total mercury (EPA 2015, National Reccomended Water Quality Criteria).

D/F = dioxin/furans
µg/L = microgram per liter
mg/kg = milligram per kilogram
ng/kg = nanogram per kilogram
TEQ = toxicity equivalent

Table 3
Sampling Design Summary

Monitoring Type	Monitoring Objective	Frequency	Parameters	Performance			Confirmation	
				2015-2016 (Year 0)			2017 (Year 1)	2019 (Year 3)
				During Dredging	Post Dredging	Post Construction	Spring	Spring
Residuals	Verify residuals assumptions	Post-dredging in Unit 1C	Hg, D/F, TS, TOC		X			
Underlying Sediment	Verify lack of missed inventory	Prior to sand placement in Unit 1C	Hg, D/F, TS, TOC		X			
Underlying Sediment	Characterize sediment quality prior to capping	Prior to capping in Units 2A and 3B	Cu, Hg, Zn, phenolic compounds, D/F, TS, TOC		X			
Surface Sediment	Surface sediment quality	Years 1, 3, 5, 10, 20, 30	Cu, Zn, PAH, phenolic compounds, Hg ,D/F, TS, TOC, Contingent Bioassays[1]				X	X
Subsurface Sediment	Subsurface sediment quality	Years 1, 10, 20, 30	Hg, TS				X	
Bathymetric Surveys	Post-dredge bathymetric surveys to verify removal to target depths	At completion of required dredging in material removal areas	Bathymetry		X			
	Post-placement surveys to confirm placement of residuals cover and caps to required thicknesses	At completion of material placement	Bathymetry			X		
	Confirmation surveys to document long-term cap integrity	Years 1, 3, 5, 10	Bathymetry				X	X
Visual Surveys	Visual surveys to verify integrity of intertidal caps and above-water components of containment walls	Years 0, 1, 3, 5, 10	Visual inspections for cap erosion, wall integrity, groundwater seepage			X	X	X
Tissue	Adult Dungeness Crab Tissue	Monitor in Years 0 and 1 and potentially in Years 3, 5, and 10. Discontinue when mercury in Site samples not significantly different than reference samples after 2 consecutive sampling events.	Hg, lipids			X	X	Contingent
	Juvenile Dungeness Crab Tissue	Monitor in Years 0 and 3.	Hg, lipids			X		X
	Caged Clam Tissue and Co-Located Pore-water	Monitor in Years 0 and 1 and potentially in Years 3, 5, and 10. Discontinue when mercury in Site samples not significantly different than reference samples after 2 consecutive sampling events.	Tissue Hg, lipids and Porewater Hg (total and dissolved)			X	X	Contingent
	Benthic Fish	Monitor in Year 3 and potentially in Years 5 and 10. Discontinue when mercury in Site samples not significantly different than reference samples.	Hg, lipids (D/F in Year-3)					X
	Pelagic Fish	Implement only if Year 3 benthic fish monitoring shows mercury concentrations significantly elevated above reference area benthic fish tissue concentrations and Ecology determines testing is required. Catch methods to be defined in SQAPP addendum.	Hg, lipids					Contingent
Log Pond Porewater	Assess potential recontamination risks associated with groundwater	Years 1, 3, 5, 10	Total and dissolved Hg				X	X

Notes:

1. Contingent bioassays include 3 standard PSEP tests: 10-day acute amphipod, 20-day juvenile polychaete growth, and larval development. Details are provided in Section 2.9.

Cu = copper
D/F = dioxin/furans
Hg = mercury
PAH = polycyclic aromatic hydrocarbon
TOC = total organic carbon
TS = total solids
Zn = zinc

Table 3
Sampling Design Summary

Monitoring Type	Monitoring Objective	Frequency	Parameters	Confirmation			
				2021 (Year 5)	2026 (Year 10)	2036 (Year 20)	2046 (Year 30)
				Spring	Spring	Spring	Spring
Residuals	Verify residuals assumptions	Post-dredging in Unit 1C	Hg, D/F, TS, TOC				
Underlying Sediment	Verify lack of missed inventory	Prior to sand placement in Unit 1C	Hg, D/F, TS, TOC				
Underlying Sediment	Characterize sediment quality prior to capping	Prior to capping in Units 2A and 3B	Cu, Hg, Zn, phenolic compounds, D/F, TS, TOC				
Surface Sediment	Surface sediment quality	Years 1, 3, 5, 10, 20, 30	Cu, Zn, PAH, phenolic compounds, Hg ,D/F, TS, TOC, Contingent Bioassays[1]	X	X	X	X
Subsurface Sediment	Subsurface sediment quality	Years 1, 10, 20, 30	Hg, TS		X	X	X
Bathymetric Surveys	Post-dredge bathymetric surveys to verify removal to target depths	At completion of required dredging in material removal areas	Bathymetry				
	Post-placement surveys to confirm placement of residuals cover and caps to required thicknesses	At completion of material placement	Bathymetry				
	Confirmation surveys to document long-term cap integrity	Years 1, 3, 5, 10	Bathymetry	X	X		
Visual Surveys	Visual surveys to verify integrity of intertidal caps and above-water components of containment walls	Years 0, 1, 3, 5, 10	Visual inspections for cap erosion, wall integrity, groundwater seepage	X	X		
Tissue	Adult Dungeness Crab Tissue	Monitor in Years 0 and 1 and potentially in Years 3, 5, and 10. Discontinue when mercury in Site samples not significantly different than reference samples after 2 consecutive sampling events.	Hg, lipids	Contingent	Contingent		
	Juvenile Dungeness Crab Tissue	Monitor in Years 0 and 3.	Hg, lipids				
	Caged Clam Tissue and Co-Located Pore-water	Monitor in Years 0 and 1 and potentially in Years 3, 5, and 10. Discontinue when mercury in Site samples not significantly different than reference samples after 2 consecutive sampling events.	Tissue Hg, lipids and Porewater Hg (total and dissolved)	Contingent	Contingent		
	Benthic Fish	Monitor in Year 3 and potentially in Years 5 and 10. Discontinue when mercury in Site samples not significantly different than reference samples.	Hg, lipids (D/F in Year-3)	Contingent	Contingent		
	Pelagic Fish	Implement only if Year 3 benthic fish monitoring shows mercury concentrations significantly elevated above reference area benthic fish tissue concentrations and Ecology determines testing is required. Catch methods to be defined in SQAPP addendum.	Hg, lipids	Contingent	Contingent		
Log Pond Porewater	Assess potential recontamination risks associated with groundwater	Years 1, 3, 5, 10	Total and dissolved Hg	X	X		

Notes:

1. Contingent bioassays include 3 standard PSEP tests: 10-day acute amphipod, 20-day juvenile polychaete growth, and larval development. Details are provided in Section 2.9.

Cu = copper
D/F = dioxin/furans
Hg = mercury
PAH = polycyclic aromatic hydrocarbon
TOC = total organic carbon
TS = total solids
Zn = zinc

Table 4
Sediment Sampling Locations and Methods – Performance Monitoring

Station ID		Proposed Coordinates[1] Easting	Northing	Sample Method	Surface Sampling	Sample ID	Additional Subsurface Testing	Sample ID	Analytical Testing Chemistry	Archive
Unit 1C Sampling – After Dredging and Before Placement of Residuals Cover										
1C	WW-P1PM-01	1239591.9	641253.6	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-01-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-01-US	Hg, D/F, TS, TOC	8-oz.
	WW-P1PM-02	1239701.7	641144.5	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-02-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-02-US	Hg, D/F, TS, TOC	8-oz.
	WW-P1PM-03	1239736.2	641390.7	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-03-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-03-US	Hg, D/F, TS, TOC	8-oz.
	WW-P1PM-04	1239839.3	641277.0	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-04-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-04-US	Hg, D/F, TS, TOC	8-oz.
	WW-P1PM-05	1239875.2	641528.1	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-05-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-05-US	Hg, D/F, TS, TOC	8-oz.
	WW-P1PM-06	1239983.3	641423.1	Van Veen grab	Apparent Residuals Layer (Typically 0–6 cm)	WW-P1PM-06-RE	Underlying (native) sediment (10–20 cm below apparent residuals layer)	WW-P1PM-06-US	Hg, D/F, TS, TOC	8-oz.
Unit 2A and 3B Sampling – After Dredging and Before Placement of Residuals Cover										
2A	WW-P1PM-07	1241514.6	642837.3	Van Veen grab	Apparent undredged sediment (excluding residuals layer)[2]	WW-P1PM-07-UD	--	--	Cu, Hg, Zn, phenolic compounds, PAHs, D/F, TS, TOC	8-oz.
	WW-P1PM-08	1241343.7	642989.4	Van Veen grab	Apparent undredged sediment (excluding residuals layer)[2]	WW-P1PM-08-UD	--	--	Cu, Hg, Zn, phenolic compounds, PAHs, D/F, TS, TOC	8-oz.
	WW-P1PM-09	1241146.6	642800.0	Van Veen grab	Apparent undredged sediment (excluding residuals layer)[2]	WW-P1PM-09-UD	--	--	Cu, Hg, Zn, phenolic compounds, PAHs, D/F, TS, TOC	8-oz.
3B	WW-P1PM-10	1241712.8	643039.0	Van Veen grab	Apparent undredged sediment (excluding residuals layer)[2]	WW-P1PM-10-UD	--	--	Cu, Hg, Zn, phenolic compounds, PAHs, D/F, TS, TOC	8-oz.
	WW-P1PM-11	1241562.6	643186.2	Van Veen grab	Apparent undredged sediment (excluding residuals layer)[2]	WW-P1PM-11-UD	--	--	Cu, Hg, Zn, phenolic compounds, PAHs, D/F, TS, TOC	8-oz.

Table 4
Sediment Sampling Locations and Methods – Performance Monitoring

Station ID		Proposed Coordinates[1] Easting	Northing	Sample Method	Surface Sampling	Sample ID	Additional Subsurface Testing	Sample ID	Analytical Testing Chemistry	Archive
Unit 1C Sampling – After Placement of Residuals Cover										
1C	WW-P1PM-01	1239591.9	641253.6	Van Veen grab	0 to 12 cm	WW-P1PM-01-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]
	WW-P1PM-02	1239701.7	641144.5	Van Veen grab	0 to 12 cm	WW-P1PM-02-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]
	WW-P1PM-03	1239736.2	641390.7	Van Veen grab	0 to 12 cm	WW-P1PM-03-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]
	WW-P1PM-04	1239839.3	641277.0	Van Veen grab	0 to 12 cm	WW-P1PM-04-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]
	WW-P1PM-05	1239875.2	641528.1	Van Veen grab	0 to 12 cm	WW-P1PM-05-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]
	WW-P1PM-06	1239983.3	641423.1	Van Veen grab	0 to 12 cm	WW-P1PM-06-SS	--	--	Hg, D/F, TS, TOC	Contingent Bioassays[3]

Notes:
1. NAD 83/98 (Washington State Plane NAD 83 Lambert Conformal North Zone Grid, Per the 1998 Adjustment)
2. Actual thickness of this layer will vary dependent upon penetration of grab sampler and thickness of dredging residuals layer.
3. Contingent bioassays include 3 standard PSEP tests: 10-day acute amphipod, 20-day juvenile polychaete growth, and larval development. Details are provided in Section 2.9.

cm = centimeter
Cu = copper
D/F = dioxin/furans
Hg = mercury
PAH = polycyclic aromatic hydrocarbon
TOC = total organic carbon
TS = total solids
Zn = zinc

Table 5
Tissue and Co-Located Porewater Sampling Locations and Methods – Performance and Confirmation Monitoring

Site Unit	Station ID	Proposed Coordinates[1]		Sample Media	Sample Method	Sampling Interval	Sample ID	Analytical Testing	Archive
		Easting	Northing					Chemistry[2]	
1C	WW-P1CM-01	1239693.5	641212.3	Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-P1CM-01-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-P1CM-01-PW	Total and dissolved Hg	--
2A	WW-P1CM-07	1241343.7	642989.4	Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-P1CM-07-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-P1CM-07-PW	Total and dissolved Hg	--
4	WW-P1CM-12	1240846.6	642752.9	Juvenile Dungeness Crab Tissue	Ring net	5 composited tissue samples	WW-P1CM-12-CM	Hg, lipids	Individual crab tissue
5A	WW-MNR-07	1238791.5	641463.6	Male Dungeness Crab Muscle	Crab traps	2 composites (each created from at least 3 tissue samples)	WW-MNR-07-CM	Hg, lipids	Individual crab tissue
				Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-MNR-07-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-MNR-07-PW	Total and dissolved Hg	--
9	WW-MNR-03	1237324.4	643041.7	Male Dungeness Crab Muscle	Crab traps	2 composites (each created from at least 3 tissue samples)	WW-MNR-03-CM	Hg, lipids	Individual crab tissue
				Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-MNR-03-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-MNR-03-PW	Total and dissolved Hg	--
	WW-MNR-04	1237147.5	639909.2	Male Dungeness Crab Muscle	Crab traps	2 composites (each created from at least 3 tissue samples)	WW-MNR-04-CM	Hg, lipids	Individual crab tissue
				Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-MNR-04-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-MNR-04-PW	Total and dissolved Hg	--
Site Areas				Benthic Fish	Trawls	5 composites of 3 fish fillets collected from the Site (any of the 3 trawl lines)	WW-PICM-COMP-BF	Hg, lipids, D/F [2,3]	Individual fish tissue
Reference Areas (Samish Bay)									
Ref	WW-REF-01	1228731.9	581840.5	Male Dungeness Crab Muscle	Crab traps	3 composites (each created from at least 3 tissue samples)	WW-REF-01-CM	Hg, lipids	Individual crab tissue
				Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-REF-01-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-REF-01-PW	Total and dissolved Hg	--
	WW-REF-02	1228771.6	580602.7	Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-REF-02-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-REF-02-PW	Total and dissolved Hg	--
	WW-REF-03	1232815.4	585637.6	Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-REF-03-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-REF-03-PW	Total and dissolved Hg	--
	WW-REF-04	1232822	583482.7	Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-REF-04-CL	Hg, lipids	Clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-REF-04-PW	Total and dissolved Hg	--
	WW-REF-05	1236802.7	587226.8	Male Dungeness Crab Muscle	Crab traps	3 composites (each created from at least 3 tissue samples)	WW-REF-05-CM	Hg, lipids	Individual crab tissue
				Clam Tissue	Clam cage	1 composite (created from at least 3 tissue samples)	WW-REF-05-CL	Hg, lipids	Individual clam tissue
				Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-REF-05-PW	Total and dissolved Hg	--
Reference Areas				Benthic Fish	Trawls	5 composites of 3 fish fillets collected from the Samish Bay (any of the 3 trawl lines)	WW-REF-COMP-BF	Hg, lipids, D/F [2,3]	individual fish tissue
Reference Areas (Other)									
Ref	WW-REF-06	1207176.3	634851.1	Juvenile Dungeness Crab Tissue	Ring net	5 composited tissue samples	WW-REF-06-CM	Hg, lipids	Individual crab tissue

Notes:

1. North American Datum 1983 (NAD83)/1998 (Washington State Plane NAD 83 Lambert Conformal North Zone Grid, Per the 1998 Adjustment)
2. Chemical testing: total and dissolved mercury will be analyzed using low level mercury methods (modified 7470).
3. Testing for D/F to be performed during Year 3 to help inform Ecology's ongoing evaluation of D/F regional conditions in Bellingham Bay.

D/F = dioxin/furans
Hg = mercury

Table 6
Sediment Sampling Locations and Methods – Confirmation Monitoring

Site Unit	Station ID	Proposed Coordinates[1]		Sample Media	Sample Method	Sampling Interval	Sample ID	Analytical Testing	Archive[4]
		Easting	Northing					Chemistry[2,3]	
Phase 1 Construction Areas									
1C	WW-P1CM-01	1239693.5	641212.3	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-01-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-02	1239872.1	641378.8	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-02-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
2A	WW-P1CM-06	1241514.6	642837.3	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-06-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-07	1241343.7	642989.4	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-07-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-08	1241146.6	642800.0	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-08-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
3B	WW-P1CM-09	1241712.8	643039.0	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-09-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-10	1241562.6	643186.2	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-10-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
4	WW-P1CM-03	1240532.8	641249.1	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-03-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-04	1240693.4	641391.5	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-04-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-05	1240815.9	641874.5	Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-05-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-P1CM-03	1240532.8	641249.1	Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-P1CM-03-PW	Hg (total and dissolved)	--
	WW-P1CM-04	1240693.4	641391.5	Porewater	NMDS samplers or mini-piezometers	6-12 cm below mudline	WW-P1CM-04-PW	Hg (total and dissolved)	--
5C	WW-P1CM-11	1240846.6	642752.9	Surface Sediment	Van Veen grab	0 to 2 cm	WW-P1CM-11-SS-0-2	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	--
				Surface Sediment	Van Veen grab	0 to 12 cm	WW-P1CM-11-SS-0-12	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
Monitored Natural Recovery Areas									
3A	WW-MNR-10	1241817.6	643425.6	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-10-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-MNR-11	1241959.2	643284.6	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-11-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
5A	WW-MNR-06	1239218.4	642296.7	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-06-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-MNR-07	1238791.5	641463.6	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-07-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays
	WW-MNR-07	1237667.4	642701.6	Subsurface Sediment	Vibracore	0-0.5 foot	WW-MNR-07-SC-0-0.5	Hg, TS	--
						0.5-1 foot	WW-MNR-07-SC-0.5-1	Hg, TS	--
						1-1.5 feet	WW-MNR-07-SC-1-1.5	Hg, TS	--
						1.5-2 feet	WW-MNR-07-SC-1.5-2	Hg, TS	--
						2-2.5 feet	WW-MNR-07-SC-2-2.5	Hg, TS	--
						2.5-3 feet	WW-MNR-07-SC-2.5-3	Hg, TS	--
6C	WW-MNR-09	1240195.7	640238.4	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-09-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
7	WW-MNR-05	1237855.1	638100.7	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-05-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
9	WW-MNR-01	1236589.3	641690.4	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-01-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-MNR-02	1236335.6	636672.7	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-02-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-MNR-03	1237324.4	643041.7	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-03-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
	WW-MNR-04	1237147.5	639909.2	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-04-SS	Hg, Cu, Zn, PAH, phenolic compounds, D/F, TS, TOC	Contingent Bioassays [4]
	WW-MNR-08	1239014.4	639146.3	Surface Sediment	Van Veen grab	0 to 12 cm	WW-MNR-08-SS	Hg, Cu, Zn, PAH, phenolic compounds, TS, TOC	Contingent Bioassays [4]
	WW-MNR-02	1236335.6	636672.7	Subsurface Sediment	Vibracore	0-0.5 foot	WW-MNR-02-SC-0-0.5	Hg, TS	--
						0.5-1 foot	WW-MNR-02-SC-0.5-1	Hg, TS	--
						1-1.5 feet	WW-MNR-02-SC-1-1.5	Hg, TS	--
						1.5-2 feet	WW-MNR-02-SC-1.5-2	Hg, TS	--
						2-2.5 feet	WW-MNR-02-SC-2-2.5	Hg, TS	--
						2.5-3 feet	WW-MNR-02-SC-2.5-3	Hg, TS	--
	WW-MNR-03	1237324.4	643041.7	Subsurface Sediment	Vibracore	0-0.5 foot	WW-MNR-03-SC-0-0.5	Hg, TS	--
						0.5-1 foot	WW-MNR-03-SC-0.5-1	Hg, TS	--
						1-1.5 feet	WW-MNR-03-SC-1-1.5	Hg, TS	--
						1.5-2 feet	WW-MNR-03-SC-1.5-2	Hg, TS	--
						2-2.5 feet	WW-MNR-03-SC-2-2.5	Hg, TS	--
						2.5-3 feet	WW-MNR-03-SC-2.5-3	Hg, TS	--
	WW-MNR-04	1237147.5	639909.2	Subsurface Sediment	Vibracore	0-0.5 foot	WW-MNR-04-SC-0-0.5	Hg, TS	--
						0.5-1 foot	WW-MNR-04-SC-0.5-1	Hg, TS	--
						1-1.5 feet	WW-MNR-04-SC-1-1.5	Hg, TS	--
						1.5-2 feet	WW-MNR-04-SC-1.5-2	Hg, TS	--
						2-2.5 feet	WW-MNR-04-SC-2-2.5	Hg, TS	--
						2.5-3 feet	WW-MNR-04-SC-2.5-3	Hg, TS	--

Table 6
Sediment Sampling Locations and Methods – Confirmation Monitoring

Site Unit	Station ID	Proposed Coordinates[1]		Sample Media	Sample Method	Sampling Interval	Sample ID	Analytical Testing	Archive[4]
		Easting	Northing					Chemistry[2,3]	
	WW-MNR-08	1238791.5	641463.6	Subsurface Sediment	Vibracore	0-0.5 foot	WW-MNR-08-SC-0-0.5	Hg, TS	--
						0.5-1 foot	WW-MNR-08-SC-0.5-1	Hg, TS	--
						1-1.5 feet	WW-MNR-08-SC-1-1.5	Hg, TS	--
						1.5-2 feet	WW-MNR-08-SC-1.5-2	Hg, TS	--
						2-2.5 feet	WW-MNR-08-SC-2-2.5	Hg, TS	--
						2.5-3 feet	WW-MNR-08-SC-2.5-3	Hg, TS	--

Notes:

1. NAD 83/98 (Washington State Plane NAD 83 Lambert Conformal North Zone Grid, Per the 1998 Adjustment)
2. Total and dissolved mercury will be analyzed using low level mercury methods (modified 7470).
3. D/F will be analyzed at a subset of surface sediment sample locations.
4. Contingent bioassays include 3 standard PSEP tests: 10-day acute amphipod, 20-day juvenile polychaete growth, and larval development. Details are provided in Section 2.9.

cm = centimeter
Cu = copper
D/F = dioxin/furans
Hg = mercury
PAH = polycyclic aromatic hydrocarbon
TOC = total organic carbon
TS = total solids
Zn = zinc

Table 7
Guidelines for Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[2]	Holding Time	Preservative
Sediments				
Total metals[1]	50 g	4-oz Glass	6 months	Cool/4° C
			2 years; 28 days for mercury	Freeze[1]/-18° C
TS/TOC	50 g		14 days	Cool/4° C
			6 months	Freeze/-18° C
PAH, phenolic compounds	100 g	1 x 16-oz Glass	14 days until extraction	Cool/4° C
			1 year until extraction	Freeze/-18° C
			40 days after extraction	Cool/4° C
D/F	100 g	8-oz Amber Glass	14 days until extraction	Cool/4° C
			1 year until extraction	Freeze/-18° C
Chemistry archive	500 g	16-oz Glass	1 year until extraction	Freeze/-18° C
Contingent bioassays	2 gallon	2-gallon HDPE buckets[2]	56 days	Cool/4°C
Tissues				
Hg[1]	25 g	4-oz Glass	28 days	Cool/4° C or Freeze[1]/-18° C
D/F	50 g		14 days until extraction	Cool/4° C
			1 year until extraction	Freeze/-18° C
Lipids	10 g		1 year	Freeze/-18° C
Waters				
Total Hg (not filtered)	100 mL	500 mL HDPE	28 days	pH≤2 with HNO_3
Dissolved Hg (field filtered)	100 mL	500 mL HDPE	28 days (dissolved fraction is field filtered)	pH≤2 with HNO_3

Notes:

1. Metals include copper, zinc, and mercury. Samples will be analyzed for mercury immediately or frozen.
2. All sample containers will have lids with Teflon inserts. Note, in some instances the sample size volume needed is less than the container size. In these instances, only the required material volume will be collected.

D/F = dioxin/furans
g = gram
HDPE = high density polyethylene
Hg = mercury
mL = milliliter
PAH = polycyclic aromatic hydrocarbons
TOC = total organic carbon
TS = total solids

Table 8
Sediment Parameters, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit
Conventional Parameters, %		
Total solids	SM2540G	0.1
Total organic carbon	Plumb 1981	0.1
Metals, mg/kg dry weight		
Copper	6010C/6020	10
Mercury	7471A	0.05
Zinc	6010C/6020	15
Semivolatile Organic Compounds (SVOCs)		
Polycyclic Aromatic Hydrocarbons, µg/kg dry weight		
Total LPAH[1]	calculated	---
Naphthalene	8270D	20.0
Acenaphthylene	8270D	20.0
Acenaphthene	8270D	20.0
Fluorene	8270D	20.0
Phenanthrene	8270D	20.0
Anthracene	8270D	20.0
2-Methylnaphthalene	8270D	20.0
Total HPAHs[2]	calculated	---
Fluoranthene	8270D	20.0
Pyrene	8270D	20.0
Benzo(a)anthracene	8270D	20.0
Chrysene	8270D	20.0
Total benzo(b,j,k)fluoranthenes	8270D	40.0
Benzo(a)pyrene	8270D	20.0
Indeno(1,2,3-cd)pyrene	8270D	20.0
Dibenz(a,h)anthracene	8270D SIM	5.0
Benzo(g,h,i)perylene	8270D	20.0
Phenols, µg/kg dry weight		
Phenol	8270D SIM	5
2-Methylphenol	8270D SIM	5
4-Methylphenol	8270D SIM	10
2,4-Dimethylphenol	8270D SIM	25
Pentachlorophenol	8270D SIM	20
Dioxin/Furans, ng/kg dry weight		
Dioxins		
2,3,7,8-TCDD	1613B	1.0
1,2,3,7,8-PeCDD	1613B	1.0
1,2,3,4,7,8-HxCDD	1613B	2.5
1,2,3,6,7,8-HxCDD	1613B	2.5
1,2,3,7,8,9-HxCDD	1613B	2.5
1,2,3,4,6,7,8-HpCDD	1613B	2.5
OCDD	1613B	5
Furans		
2,3,7,8-TCDF	1613B	1.0
1,2,3,7,8-PeCDF	1613B	2.5
2,3,4,7,8,-PeCDF	1613B	1.0
1,2,3,4,7,8-HxCDF	1613B	2.5

Table 8
Sediment Parameters, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit
1,2,3,6,7,8-HxCDF	1613B	2.5
1,2,3,7,8,9-HxCDF	1613B	2.5
2,3,4,6,7,8-HxCDF	1613B	2.5
1,2,3,4,6,7,8-HpCDF	1613B	2.5
1,2,3,4,7,8,9-HpCDF	1613B	2.5
OCDF	1613B	5
Total TEQ	1613B	4

Notes:

1. Total low-molecular-weight polycyclic aromatic hydrocarbons (LPAH) consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
2. Total high-molecular-weight polycyclic aromatic hydrocarbons (HPAH) consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

µg/kg = microgram per kilogram
mg/kg = milligram per kilogram
ng/kg = nanogram per kilogram

Table 9
Tissue Parameters, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit
Conventional Parameters, %		
Lipids	Mod. Bligh and Dyer 1959	0.1
Moisture content	SM 2540G	0.1
Metals, mg/kg wet weight		
Mercury	7471B	0.005
Dioxin/Furans, ng/kg dry weight		
Dioxins		
2,3,7,8-TCDD	1613B	1.0
1,2,3,7,8-PeCDD	1613B	5.0
1,2,3,4,7,8-HxCDD	1613B	5.0
1,2,3,6,7,8-HxCDD	1613B	5.0
1,2,3,7,8,9-HxCDD	1613B	5.0
1,2,3,4,6,7,8-HpCDD	1613B	5.0
OCDD	1613B	10
Furans		
2,3,7,8-TCDF	1613B	1.0
1,2,3,7,8-PeCDF	1613B	5.0
2,3,4,7,8,-PeCDF	1613B	5.0
1,2,3,4,7,8-HxCDF	1613B	5.0
1,2,3,6,7,8-HxCDF	1613B	5.0
1,2,3,7,8,9-HxCDF	1613B	5.0
2,3,4,6,7,8-HxCDF	1613B	5.0
1,2,3,4,6,7,8-HpCDF	1613B	5.0
1,2,3,4,7,8,9-HpCDF	1613B	5.0
OCDF	1613B	10

Notes:
Final quantitation limit values may differ slightly based on sample dry weight correction, adjustment for sample size and sample dilution due to matrix interference, or non-target analytes.
mg/kg = milligram per kilogram
ng/kg = nanogram per kilogram
SM = standard method

Table 10
Porewater Parameters, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit
Total and Dissolved Metals, µg/L		
Mercury	USEPA 7470A	0.02

Notes:
Final quantitation limit values may differ slightly based on volume of sample collected and sample dilution due to matrix interference, or non-target analytes.
µg/L = microgram per liter

Table 11
Toxicity Testing – SMS Biological Effects Criteria for Puget Sound Marine Sediments

Biological Test	Test Performance Standards	Sediment Cleanup Objectives[1]	Cleanup Screening Levels, or Minimum Cleanup Levels[2]
Amphipod	Mean mortality in control sediment <10% and mean mortality in reference sediment <25%.	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 25% greater on an absolute basis than the reference sediment mean 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 is more than 30% greater on an absolute basis than the reference sediment mean mortality.
Larval	Mean normal survivorship in seawater control >70% at time final. Reference normal survivorship must be >65% of the normal survivorship in the control.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P ≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 85% of the mean normal survivorship in reference sediment.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P ≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 70% of the mean normal survivorship in the reference sediment.
Juvenile polychaete	Mean mortality in control sediment <10%, Mean individual growth rate >0.72 mg/ind/day. Control growth rates below 0.38 mg/ind/day will be considered a QA/QC failure. Mean individual growth rate in reference sediment ≥80% of mean individual growth rate in control.	The mean individual growth rate of polychaetes in the test sediment is less than 70% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P ≤ 0.05) from the reference sediment mean individual growth rate.	The mean individual growth rate of polychaetes in the test sediment is less than 50% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P ≤0.05) from the reference sediment mean individual growth rate.

Notes:
Source: Ecology (2008)
1. The Sediment Quality Standards (SQS) are exceeded if one test fails the listed criteria [Washington Administrative Code (WAC) 173-204-320(3)].
2. The cleanup screening level (CSL), or minimum cleanup level is exceeded if one test fails the listed sediment impact zone maximum level, CSL, or minimum cleanup level criteria [WAC 173-204-420(3)] or if two tests fail the SQS criteria of WAC 173-204-320(3).

mg/ind/day = milligrams per individual per day
QA/QC = quality assurance/quality control

Table 12
Field and Laboratory QA/QC Requirements

Analysis Type	Field Quality Assurance		Laboratory Quality Control Elements							
	Rinsate Blank	Field Duplicates	Initial Calibration	Ongoing Calibration	Replicates[5]	Laboratory Control Sample/ Ongoing Precision and Recovery	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Sediments										
TS	NA	1 per event	Each batch[2]	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA	NA	NA	NA	NA
TOC	NA	1 per event	Daily or each batch	1 per 10 samples	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA
Metals[1]	1 per event	1 per event	Daily	1 per 10 samples	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA
PAH, phenolic compounds	1 per event	1 per event	As needed [3]	Every 12 hours	NA	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample
D/F	1 per event	1 per event	As needed [3]	Every 12 hours	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA[5]	NA[5]	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample[5]
Tissues										
Lipids	NA	NA	Each batch[2]	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA	NA	NA	NA	NA
Hg	1 per event	NA	Daily	1 per 10 samples	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA
D/F	1 per event	NA	As needed[2]	Every 12 hours	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA[4]	NA[4]	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample[5]
Porewater[6]										
Hg	1 per event	1 per event	Daily	1 per 10 samples	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA

Notes:
1. Metals include copper, zinc, and mercury.
2. Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.
3. Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
4. Isotope dilution with labeled compounds required in every sample.
5. Matrix spike duplicate may be used for data evaluation instead of replicate.
6. QC samples may be limited by available porewater volume. If this occurs, a matrix spike may be used for data evaluation instead of replicate.

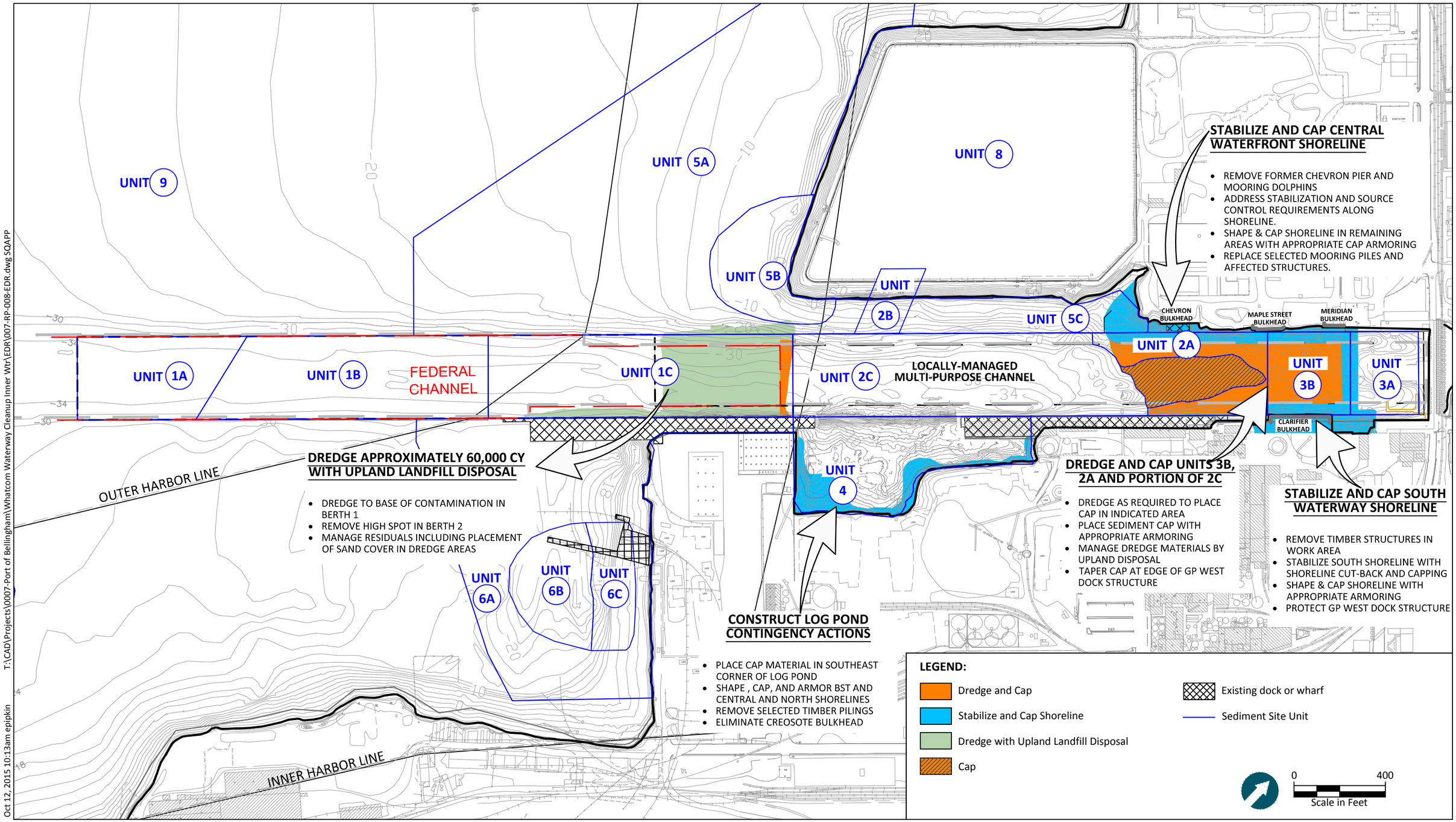
D/F = dioxin/furans
Hg = mercury
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
TOC = total organic carbon
TS = total solids

Table 13
Data Quality Objectives

Parameter	Precision	Accuracy	Completeness
Sediments			
Total organic carbon	± 30% RPD	65% – 135% R	95%
Total metals	± 30% RPD	75% – 125% R	95%
D/F	± 50% RPD	50% – 150% R	95%
Semivolatile organic compounds	± 50% RPD	50% – 150% R	95%
Tissues			
Lipids	± 30% RPD	NA	95%
Mercury	± 30% RPD	75% – 125% R	95%
D/F	± 50% RPD	50% – 150% R	95%
Porewaters			
Mercury	± 25% RPD	75% – 125% R	95%

Notes:
NA = not applicable
R = recovery
RPD = relative percent difference

FIGURES



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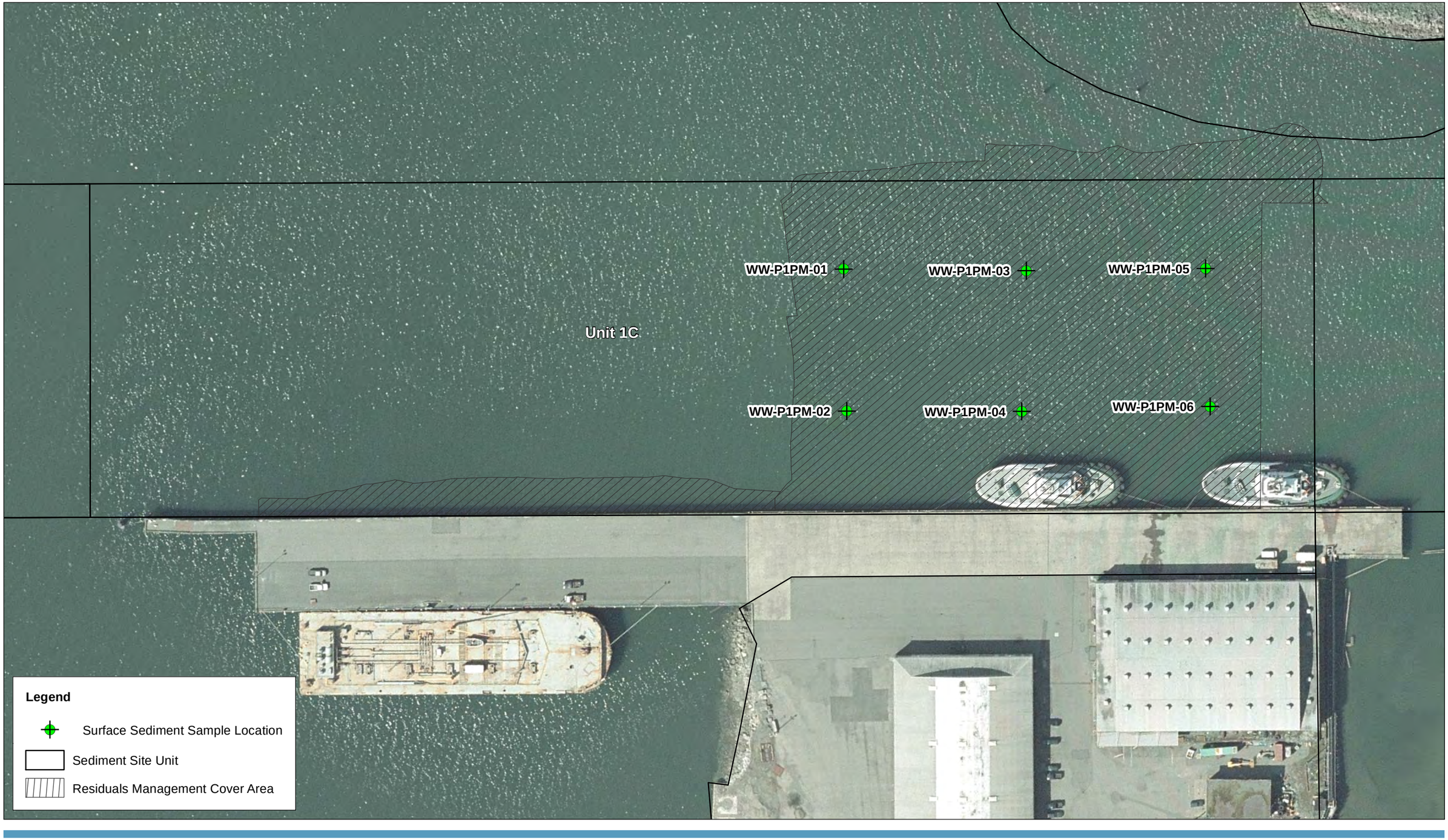
Oct 12, 2015 10:13am epipkin

ANCHOR QEA

SOURCE: Figure 6-5 of Exhibit 1 of the First Amendment to the Whatcom Waterway Site Consent Decree (2011).
HORIZONTAL DATUM: Washington State Plane North, NAD 83 Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

Figure 1
Construction Project for Phase 1 Areas
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas

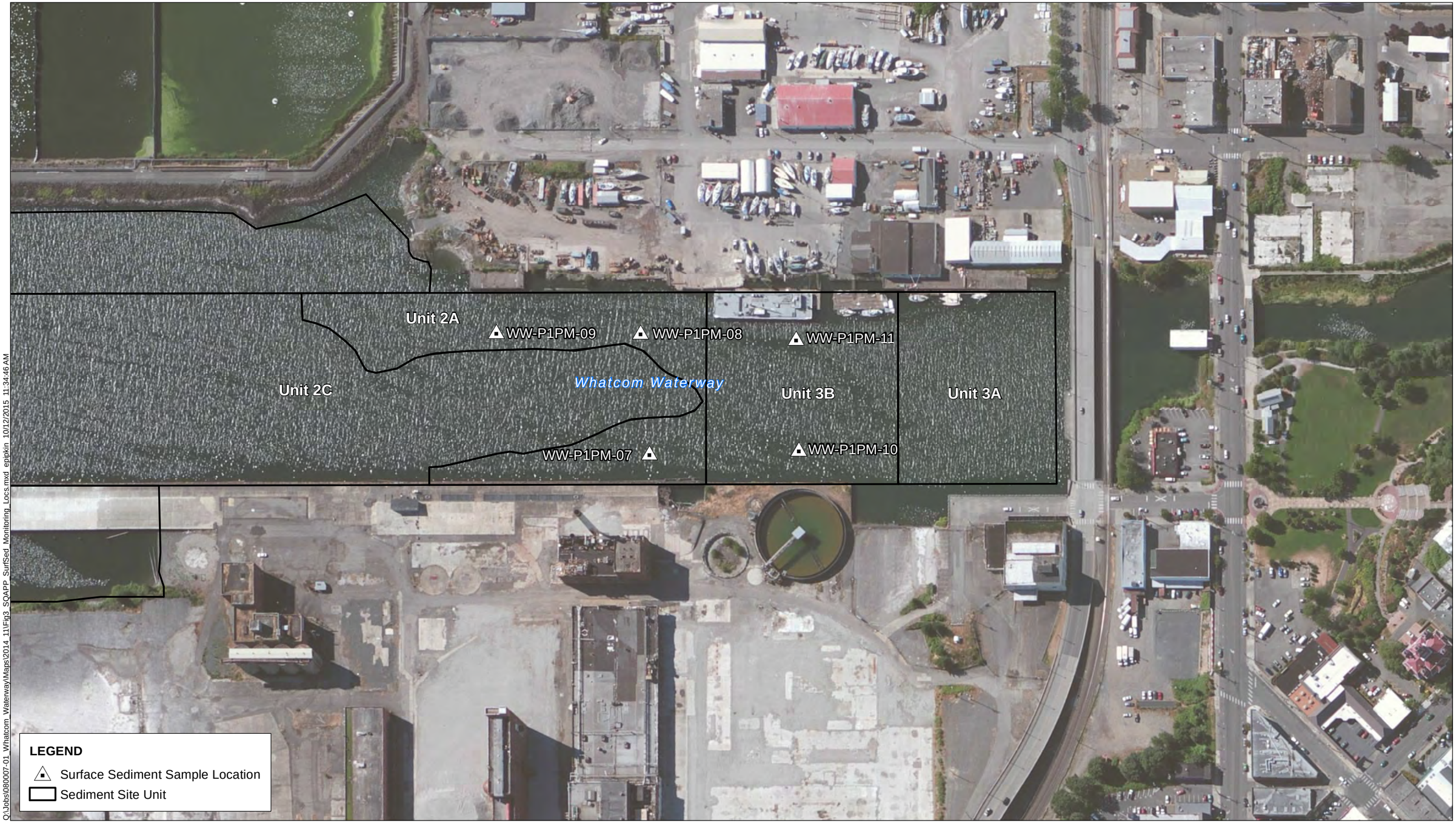


ANCHOR QEA

Notes:
1. Sediment Site Units and boundaries source: Figure 4-6, Cleanup Action Plan, Whatcom Waterway Site, September 2007.
2. Horizontal datum: Washington State Plane North, NAD 27/98.
3. Aerial photo taken in 2004.

Feet
0 40 80 120 160

Figure 2
Performance Monitoring Surface Sediment Sampling Locations
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas



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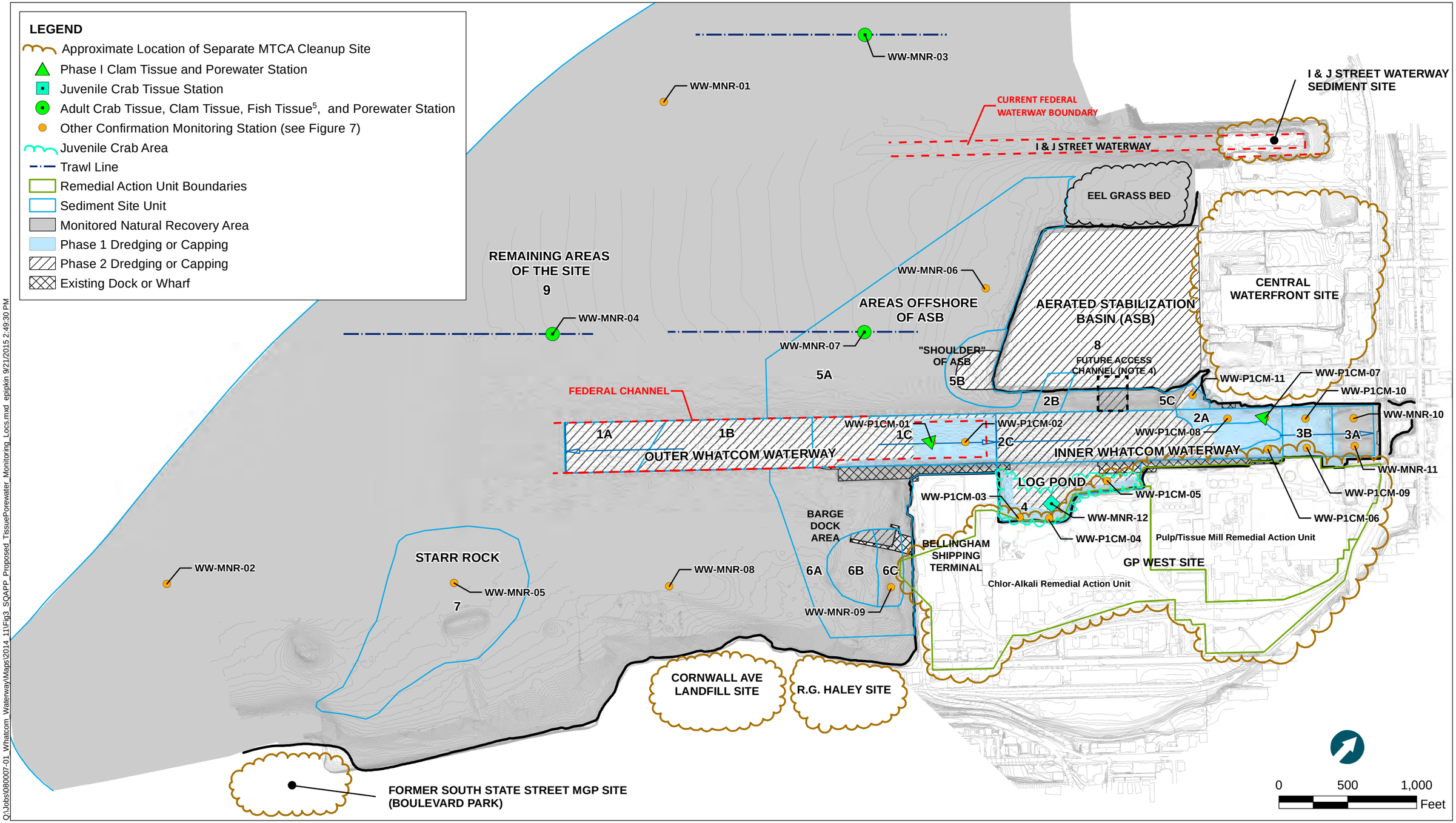
ANCHOR QEA

0 75 150 225 300
Feet

Figure 3
Performance Monitoring Surface Sediment Sampling Locations - Units 2A and 3B
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas



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NOTES:
1. Site units are shown based on those in Figure 2-3 Cleanup Action Plan, Whatcom Waterway Site, September 2007. Unit 9 boundary updated based on Pre-remedial Design Investigation findings.
2. Horizontal datum: Washington State Plane North, North American Datum 1983 (NAD83) Feet.
3. Vertical datum: Mean Lower Low Water (MLLW).
4. Unit 2B was established in the Cleanup Action Plan based on the anticipated marina access channel location. This location will be adjusted during final design.
5. These stations represent target areas in which fish will be collected. Actual locations will be dependent upon abundance and collection methods at the time of sampling. Otter trawl methods will be used for benthic fish tissue (i.e., English sole or starry flounder).
6. Contingent collection of pelagic fish (sockeye salmon) will be performed at a location within the site boundary.
7. Remedial Action Unit (RAU) boundaries were defined in the Final Cleanup Action Plan for the GP West Pulp and Tissue Remedial Action Unit (Aspect 2014).

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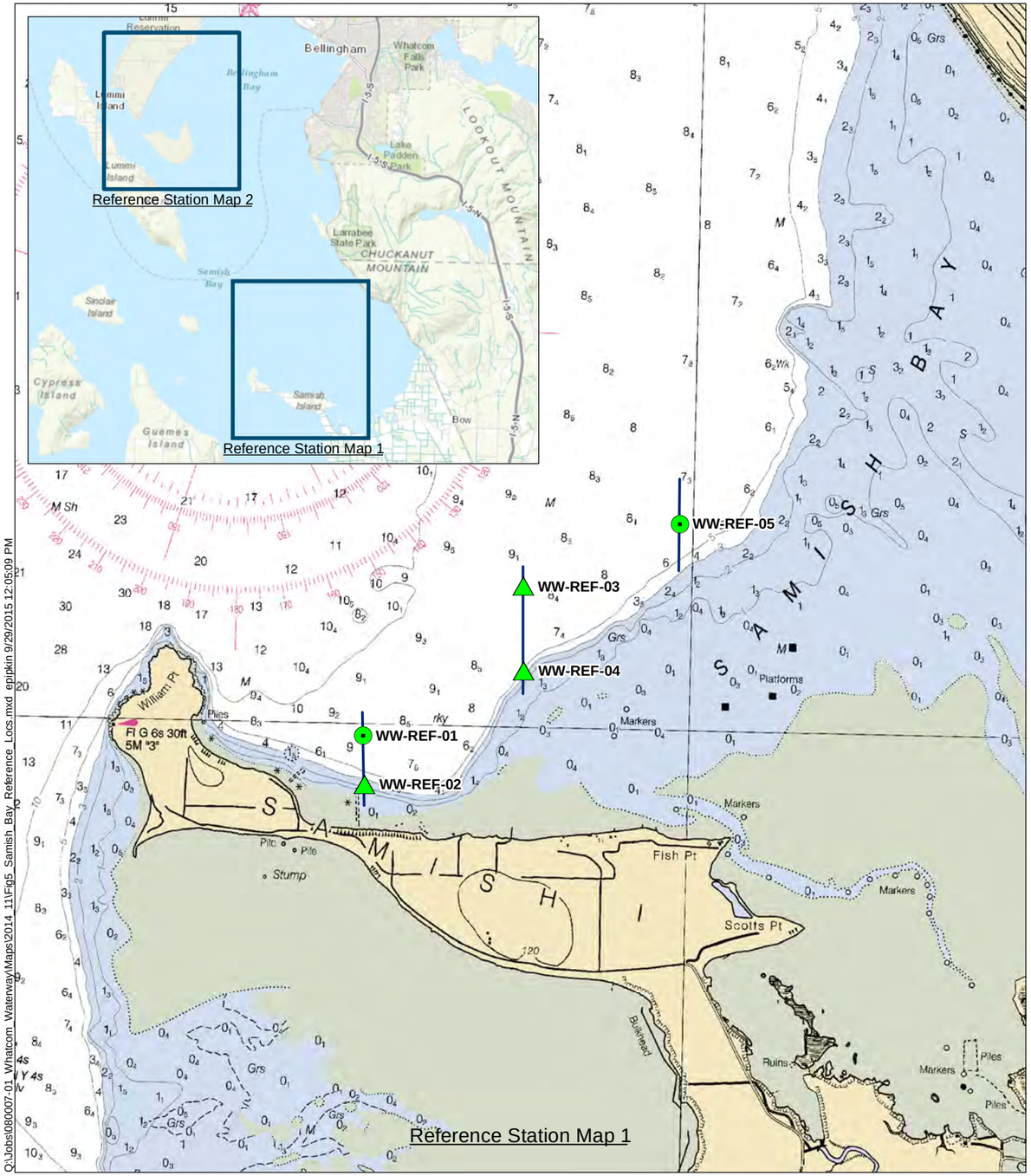
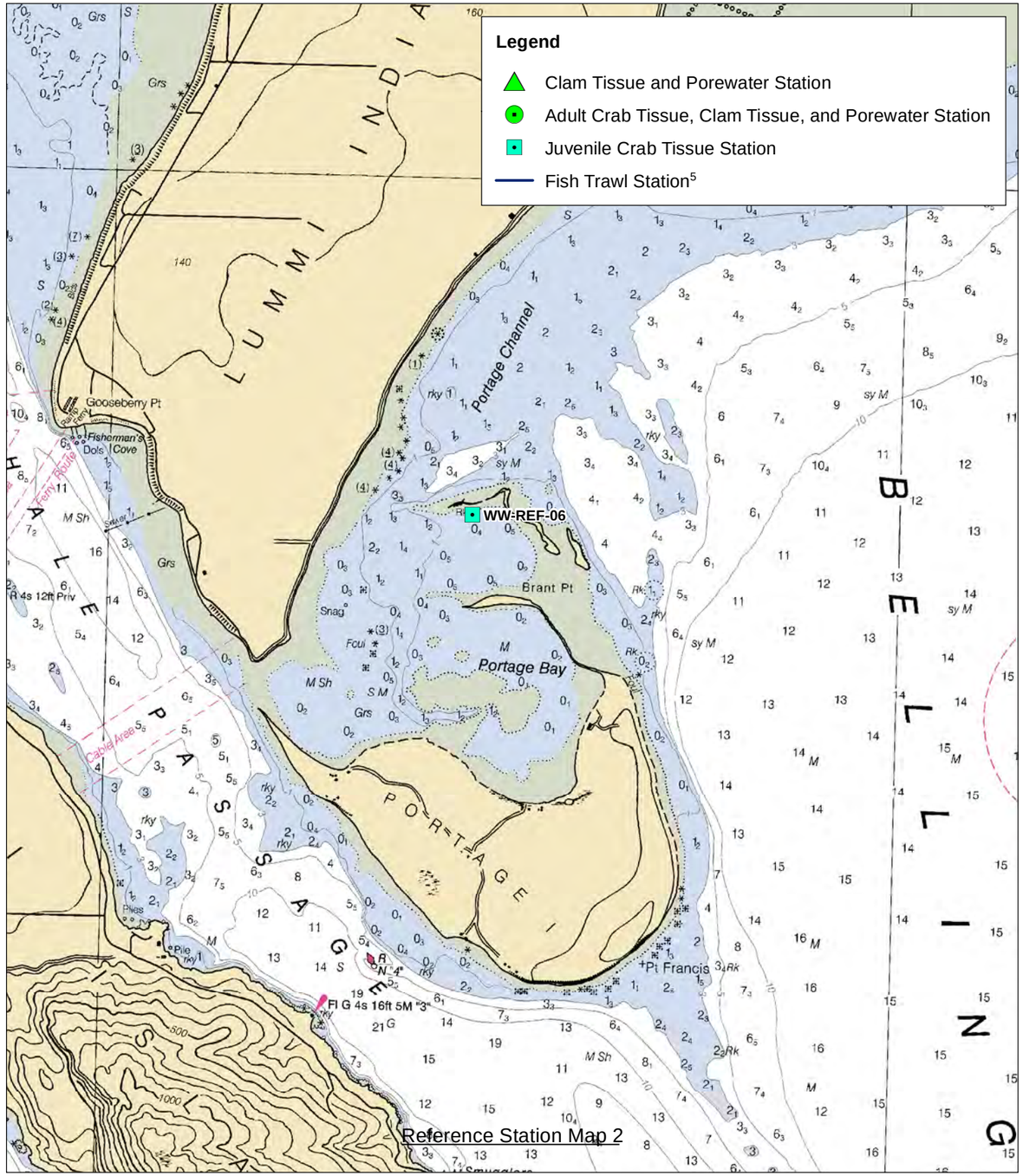
Figure 4
Proposed Locations for Tissue and Co-Located Porewater Monitoring
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas





NOTES:
1. Site units are shown based on those in Figure 2-3 Cleanup Action Plan, Whatcom Waterway Site, September 2007. Unit 9 boundary updated based on Pre-remedial Design Investigation findings.
2. Horizontal datum: Washington State Plane North, North American Datum 1983 (NAD83) Feet.
3. Vertical datum: Mean Lower Low Water (MLLW).
4. Fish trawl locations are approximate. Actual locations will be dependent upon abundances observed during the monitoring effort.
5. Crab station locations may be adjusted based on field conditions encountered.

0 0.5 1 Miles

Figure 5
Reference Area Sampling Locations
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas

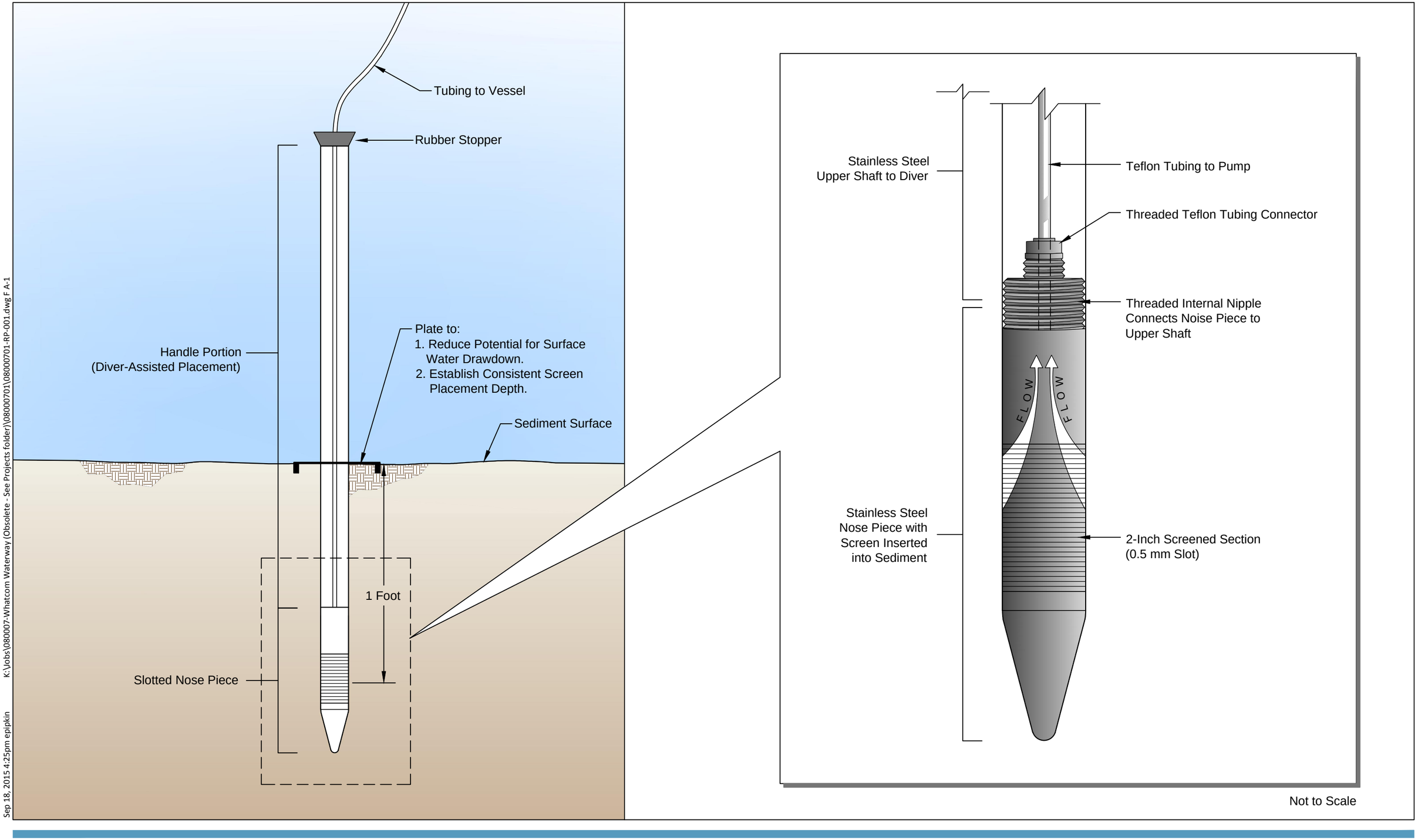
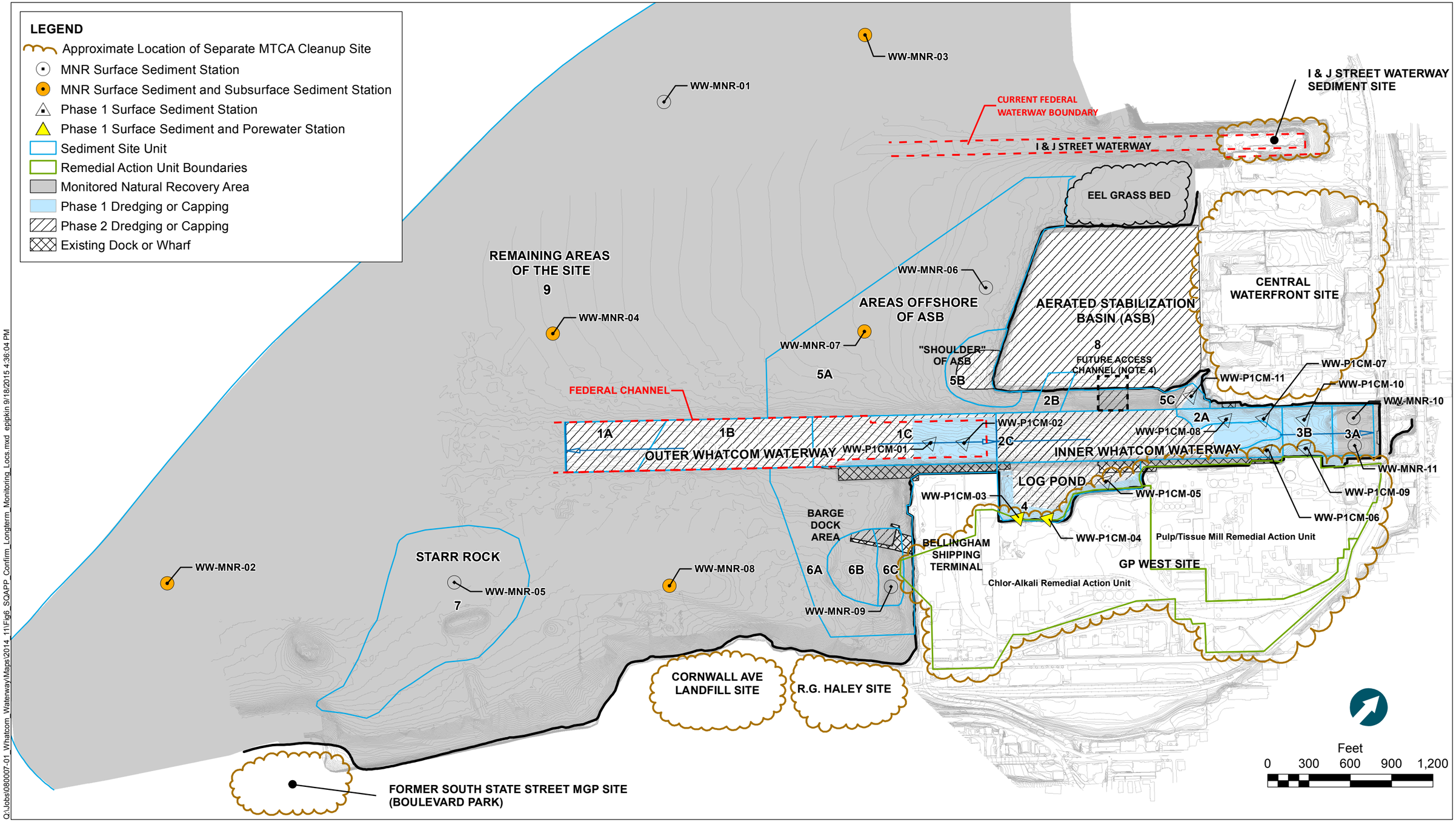


Figure 6
Porewater Piezometer Schematic
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas



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NOTES:
1. Site units are shown based on those in Figure 2-3 Cleanup Action Plan, Whatcom Waterway Site, September 2007. Unit 9 boundary updated based on PRDI findings.
2. Horizontal datum: Washington State Plane North, NAD 83 Feet.
3. Vertical datum: Mean Lower Low Water (MLLW).
4. Unit 2B was established in the Cleanup Action Plan based on the anticipated marina access channel location. This location will be adjusted during final design.
5. Refer to Figure 4 for tissue monitoring and co-located porewater monitoring stations.
6. Remedial Action Unit (RAU) boundaries were defined in the Final Cleanup Action Plan for the GP West Pulp and Tissue Remedial Action Unit (Aspect 2014).

ANCHOR QEA

Figure 7
Confirmation (Long-Term) Monitoring Sampling Locations
Compliance Monitoring Sampling and Quality Assurance Project Plan
Whatcom Waterway Cleanup in Phase 1 Site Areas

APPENDIX A
FIELD FORMS

Daily Log

Anchor QEA, LLC
720 Oive Way, Suite 1900
Seattle, Washington 98101
Phone 206.287.9130 Fax 206.287.9131

PROJECT NAME: _____ **DATE:** _____

SITE ADDRESS: _____ **PERSONNEL:** _____

WEATHER: **WIND FROM:**

N	NE	E	SE	S	SW	W	NW
SUNNY		CLOUDY		RAIN		?	

LIGHT	MEDIUM	HEAVY

TEMPERATURE: ° F . ° C
[Circle appropriate units]

TIME	COMMENTS

Signature: _____

Surface Sediment Field Log

ANCHOR QEA

Job: Station:

Job No: Date:

Field Staff: Sample Method: Van Veen Grab

Contractor: Proposed Coordinates : Lat:

Long:

Water Height

DTM Depth Sounder: _____

DTM Lead Line: _____

Tide Measurements

Time: _____

Height: _____

Sample Acceptability Criteria:

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

Mudline Elevation (datum): _____

Notes: _____

Grab #	Time	Confirmed Coordinates (datum)		Sample Accept (Y/N)	Recovery Depth (cm)	Comments: jaws close, good seal, winnowing
		NAD 83 (N)	NAD 83 (W)			

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

Grab Notes: _____

Sample containers: _____

ANCHOR QEA

Crab Log

Job:	Station Coordinates:
Job No:	
Field Staff:	
Station ID:	Number of crabs recovered:
Replicate:	

Crab ID	Date	Time	Carapace Length (cm)	Whole Organism Weight (g)	Total Muscle Weight (g)	Notes

Sample Containers:

Analyses:

ANCHOR QEA

Clam Log

Job:	Station Coordinates:
Job No:	
Field Staff:	
Station ID:	Number of clam recovered alive:
Replicate:	

Clam ID	Date	Time	Shell Length (cm)	Tissue Wet Weight (not including shell or water in shell)	Notes

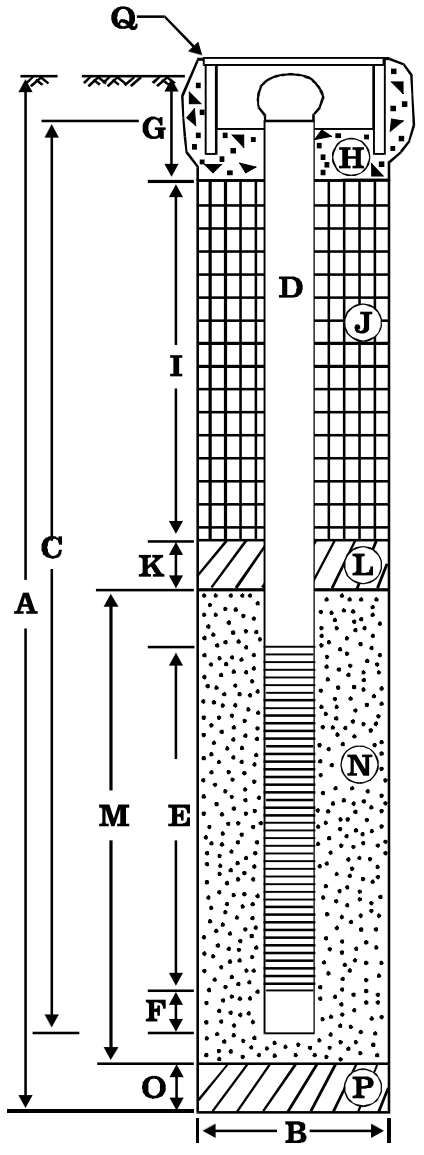
Sample Containers:

Analyses:

WELL DETAILS
FLUSH MOUNT

Project Number: _____
Client Name: _____
Project Name: _____
Location: _____
Driller: _____

Boring/Well No.: _____
Top of Casing Elev.: _____
Ground Surface Elev.: _____
Installation Date: _____
Permit/Start Card No.: _____



	Depth (ft, bgs)	Elev. (ft, msl)

EXPLORATORY BORING

A. Total depth: _____ **ft.**
B. Diameter _____ **in.**
Drilling method: _____

WELL CONSTRUCTION

C. Well casing length: _____ **ft.**
Well casing material: _____
D. Well casing diameter: _____ **in.**
E. Well screen length: _____ **ft.**
Well screen type: _____
Well screen slot size: _____ **in.**
F. Well sump/end cap length: _____ **ft.**
G. Surface seal thickness: _____ **ft.**
H. Surface seal material: _____
I. Annular seal thickness: _____ **ft.**
J. Annular seal material: _____
K. Filter pack seal thickness: _____ **ft.**
L. Filter pack seal material: _____
M. Sand pack thickness: _____ **ft.**
N. Sand pack material: _____
O. Bottom material thickness: _____ **ft.**
P. Bottom material: _____
Q. Vault box type: _____
Well centralizer depths: _____ **ft.**

NOTES:

Installed by: _____
Reviewed by: _____
Date: _____

Porewater Collection Form

ANCHOR QEA

PROJECT NAME: **WELL ID:**

SITE ADDRESS: **BLIND ID:**

DUP ID: **NA**

WIND FROM:	N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
WEATHER:	SUNNY		CLOUDY		RAIN		?		**TEMPERATURE:**	° F . ° C	

[Circle appropriate units]

HYDROLOGY/LEVEL MEASUREMENTS (Nearest 0.01 ft)

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW [Product Thickness]	DTB-DTW [Water Column]		[Water Column x Gal/ft] Volume (gal)
/ /	:	.	.	.	.	.	X 1	.
/ /	:	.	.	.	.		X 3	.

Gal/ft = (dia./2)^2 x 0.163	1" = 0.041	2" = 0.163	3" = 0.367	4" = 0.653	6" = 1.469	10" = 4.080	12" = 5.875

§ METHODS: (A) Submersible Pump (B) Peristaltic Pump (C) Disposable Bailer (D) PVC/Teflon Bailer (E) Dedicated Bailer (F) Dedicated Pump (G) Other =

GROUNDWATER SAMPLING DATA (if product is detected, do NOT sample) Sample Depth: [Ö if used]

Bottle Type	Date	Time	Method §	Amount & Volume mL	Preservative [circle]	Ice	Filter	pH	Ö
VOA Glass	/ /	:		3	40 ml HCl	YES	NO		
Amber Glass	/ /	:			250, 500, 1L (None) (HCl) (H_2SO_4)	YES	NO		
White Poly	/ /	:			250, 500, 1L None	YES	NO	NA	
Yellow Poly	/ /	:			250, 500, 1L H_2SO_4	YES	NO		
Green Poly	/ /	:			250, 500, 1L NaOH	YES	NO		
Red Total Poly	/ /	:			250, 500, 1L HNO_3	YES	NO		
Red Diss. Poly	/ /	:			250, 500, 1L HNO_3	YES	YES		
	/ /	:			250, 500, 1L	YES			
	Total Bottles (include duplicate count):								

Analysis Allowed per Bottle Type

BOTTLE TYPE	TYPICAL ANALYSIS ALLOWED PER BOTTLE TYPE (Circle applicable or write non-standard analysis below)
VOA - Glass	(8021) (8260B) (BTEX) (NWTPH-G)
AMBER - Glass	(PAH) (TPH-HCID) (NWTPH-Dx) (TPH-418.1) (Oil &Grease) (8081A)
WHITE - Poly	(pH) (Conductivity) (TDS) (TSS) (BOD) (Turbidity) (Alkalinity) (HCO_3/CO_3) (Cl) (SO_4) (NO_3) (NO_2) (F)
YELLOW - Poly	(COD) (TOC) (Total PO_4) (Total Keldahl Nitrogen) (NH_3) (NO_3/NO_2)
GREEN - Poly	(Cyanide)
RED TOTAL - Poly	(As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na)
RED DISSOLVED - Poly	(As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na) (Hardness) (Silica)

WATER QUALITY DATA Purge Start Time: : Pump/Bailer Inlet Depth:

Meas.	Method §	Purged (gal)	Sal (ppt)	E Cond (mS)	°F Temp °C	pH	Diss O_2 (mg/l)	Water Quality
4		.	.		.	.	.	
3		.	.		.	.	.	
2		.	.		.	.	.	
1		.	.		.	.	.	
0		**0.00**	.		.	.	.	

[Casing] [Select A-G] [Cumulative Totals] [Circle units] [Clarity, Color]

SAMPLER: _____ _____

(PRINTED NAME) (SIGNATURE)

Sediment Core Collection Log

Job: | **Station ID:**

Job No: | **Attempt No.**

Field Staff: | **Date:**

Contractor: | **Logged By:**

Vertical Datum: | **Horizontal Datum:**

Field Collection Coordinates:

Lat/Northing: | Long/Easting:

A. Water Depth	**B. Tide Measurements**	**C. Mudline Elevation**
DTM Depth Sounder:	Time:	(-A+B=C)
DTM Lead Line:	Height:	

Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length:

Drive Penetration:

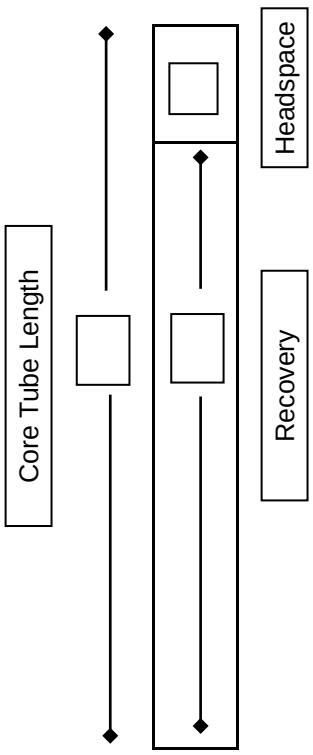
Headspace Measurement:

Recovery Measurement:

Recovery Percentage:

Total Length of Core To Process:

Drive Notes:



Core Field Observations and Description:	Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Samples Collected (i.e. rinsate blank)

Sediment Core Processing Log

COC ID #

ANCHOR QEA

Job:	Date Logged:
Job No.:	Core Pushed By:
Station ID:	Core Logged By:
	Type of Core: ☐ Vibracore ☐ Piston Core ☐ Other
No. of Sections:	Diameter of Core (inches):
Water Depth/Elevation of Core:	Core Quality: ☐ Good ☐ Fair ☐ Poor ☐ Disturbed
Cored Length (feet; from log):	Average % Compaction =
Core Recovery (feet):	Internal Composite Received on:

Theoretical Depth in ( ) Actual Core Sections	Size % G	Size % S	Size % F	Summary Sketch	Classification and Remarks (Moisture content, density/consistency/ color, minor contituent, MAJOR constituent, amount, shape of minor constituent, sheen, odor)

ANCHOR QEA

Fish Log

Job:	Trawl start coordinates:
Job No:	
Station ID:	Trawl start time:
Field Staff:	Trawl end coordinates:
Species:	
Total # of fish collected at station:	Trawl end time:

Fish ID	Date	Time	Fish Length (cm)	Whole fish wet weight (blotted, grams)	Notes

Sample Containers:
Analyses: