DEPARTMENT OF
ECOLOGY
State of Washington

Port Gardner Bay Regional Background Sediment Characterization

Everett, WA

Sampling and Analysis Plan

DRAFT

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Port Gardner Bay
Regional Background Sediment Characterization

Sampling and Analysis Plan DRAFT

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List of Acronyms

COPC	chemicals of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	contaminant screening level
DGPS	differential global positioning system
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FM	Field Manager
GPC	gel permeation chromatography
GPM	Government Project Manager
HSP	Health and Safety Plan
LCS/LCSD	laboratory control sample/laboratory control sample duplicates
MS/MSD	matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act
NAD83	1983 North American Datum
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective clothing
PQL	practical quantitation limit
PSEP	Puget Sound Estuary Program
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SIM	select ion monitoring
SMARM	Sediment Management Annual Review Meetings
SMS	Sediment Management Standards
SOP	standard operating procedure
SQS	Sediment Quality Standard
TCDD	2,3,7,8-Tetrachlorodibenzodioxin
TEF	toxic equivalent factor
TEQ	toxic equivalent quotient
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency
WAAS	Wide Area Augmentation System
WAC	Washington Administrative Code
WHO	World Health Organization

Introduction

The scope of work described in this Sampling and Analysis Plan (SAP) is designed to aid in the establishment of regional background sediment concentrations in Port Gardner Bay to support implementation of the proposed Sediment Management Standards (SMS) rule. During the advisory group process for the SMS rule revisions conducted from 2010 through 2011, and during the public comment period for the proposed rule, Ecology was informed that it should be Ecology's responsibility to establish regional background sediment concentrations for the state. This SAP is designed to collect sufficient surface sediment data to establish regional background concentrations for selected bioaccumulative chemicals of concern in Port Gardner Bay (Figure 1). Port Gardner Bay is one of several embayments identified for focused sediment investigation, cleanup, and source control under the Washington State Department of Ecology (Ecology) Toxics Cleanup Program's Puget Sound Initiative.

Background

For a number of bioaccumulative chemicals, risk-based cleanup levels based on protecting human health fall below natural background, as defined in WAC 173-204-505. Sediments are a sink for typically hundreds of contamination sources, including a mix of permitted and unpermitted stormwater, atmospheric deposition, and historical releases from industrial activities. In urban embayments with developed shorelines, sediment concentrations are frequently higher than natural background. Consequently, an entire embayment could be considered a cleanup site for exceeding natural background concentrations due to numerous sources and potentially liable parties.

The proposed SMS rule includes retaining the two-tiered structure in the original SMS rule to establish sediment cleanup levels. The original SMS rule includes numeric criteria for the protection of benthic invertebrates from the toxic effects of contaminants but does not address background concentrations nor provide detail for assessing human health risk. The proposed SMS rule incorporates human health risk for bioaccumulative contaminants as well as natural background (as the potential Sediment Cleanup Objective) and a new term and concept, regional background (as the potential Cleanup Screening Level).

The proposed SMS rule provides a definition for regional background (WAC 173-204-505; Ecology 2012) and parameters to establish regional background (WAC 173-204-560(5)):

> ***"Regional Background"*** *means the concentration of a contaminant within a department-defined geographic area that is primarily attributable to diffuse sources, such as atmospheric deposition or storm water, not attributable to a specific source or release.* .

However, the proposed SMS rule revisions areintended to provide flexibility to establish regional background on a case by case basis and does not prescribe specifically how regional background shall be established. The approach and methods contained in this SAP serve as an example of how regional background concentrations for selected hazardous substances (arsenic, cadmium, mercury, carcinogenic polycyclic aromatic hydrocarbons [cPAHs], dioxins/furans, and polychlorinated biphenyls [PCBs]) could be established in a particular Ecology-established geographic area.

Port Gardner Bay

Port Gardner Bay is an embayment of Puget Sound's Whidbey Basin, bounded to the east by the City of Everett (Figure 1). The Snohomish River system, the second largest river discharge into Puget Sound, empties into Port Gardner Bay at the City of Everett waterfront and provides approximately 30 percent of the freshwater discharge to the Whidbey Basin. Originating in the Cascade Mountains, tributaries of the Snohomish River drain a variety of forested, agricultural, and industrial properties. The mouth of the Snohomish River's main channel is bounded to the west by Jetty Island, a manmade island composed of sediment from continual maintenance dredging of the river channel.

Port Gardner Bay has a wide variety of commercial and industrial uses, multiple potential point sources of contamination, and an overall history of contamination. Since the early 1900s, the lower Snohomish River has been used for commercial and industrial purposes, often related to timber and maritime industries (saw mills, paper production, boat building, and waste disposal). In the last 25 years, several sediment investigations have detected chlorinated aromatics, polycyclic aromatic hydrocarbons (PAHs), metals, miscellaneous extractables, pesticides, phenols, and phthalates at levels exceeding SMS criteria at numerous locations throughout Port Gardner Bay.

Ten sites within the region have recently been identified as PSI sites for focused sediment cleanup and source control. Currently the lower Snohomish River Estuary is home to numerous sites of environmental remediation projects focused on tideland recovery and habitat restoration. The area of Port Gardner Bay located between Hat (Gedney) Island and the City of Everett is the region of interest in evaluating regional background (Figure 1).

The development of regional background sediment concentrations are intended to facilitate the cleanup of sediment sites in Port Gardner Bay.

Project Scope

The purpose of this SAP is to describe the manner and methods by which data collection efforts and analyses will be performed. The results of this sampling effort will be used in conjunction with previously collected data to aid in the determination of regional background sediment concentrations in Port Gardner Bay. The bioaccumulative contaminants of concern for this investigation include:

- metals (arsenic, cadmium, and mercury)
- carcinogenic polycyclic aromatic hydrocarbons (cPAHs),
- dioxins/furans congeners, and
- polychlorinated biphenyls congeners (PCBs).

The SAP for this study was prepared in accordance with the SMS and SAPA requirements. Sediment sampling procedures correspond to those presented in the Sediment Sampling and Analysis Plan Appendix (Ecology 2008b; WAC 173-204). Analytical procedures and methods are also identified in the SAP in accordance with WAC 173-340-830 and WAC 173-204 (Ecology 2008b).

Project Team and Responsibilities

NewFields and associated subcontractors will implement the SAP under the direction of Ecology. The following sections describe the key roles and responsibilities of the project team.

Project Planning and Coordination

Chance Asher of Ecology will serve as the Government Project Manager (GPM) who will oversee the overall project coordination, supply government-furnished data and services, review reports, and coordinate with contractors. Tim Hammermeister will serve as the NewFields project manager and be responsible for executing the approved SAP, overseeing the collection and analysis of field samples, and reporting analytical results.

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Sample Collection

Dr. Will Hafner of NewFields will serve as field manager (FM) responsible for collecting and processing samples in accordance with the SAP, and transporting samples to the analytical and biological laboratory for analysis and testing. The FM will ensure accurate station positioning and reporting.

Laboratory Sample Preparation and Analysis

Dr. Will Hafner of NewFields will serve as laboratory coordinator responsible for subcontracting state-certified laboratories, delivering samples to the analytical and biological laboratories, and ensuring observation of established protocols for decontamination, sample preservation, holding times, chain-of-custody documentation, and laboratory reporting.

QA/QC Management

Dr. Will Hafner will serve as the NewFields quality assurance/quality control (QA/QC) manager providing quality assurance oversight for the laboratory programs ensuring that the laboratory analytical and QA/QC data are considered valid, and that procedures meet the required analytical quality control limits.

Health and Safety Manager

Preston Martin will serve as the designated NewFields Health and Safety Manager. The Health and Safety Manager is responsible for ensuring that all personnel are properly trained, fully aware of potential site hazards, conduct all work in a safe manner, wear appropriate personal protective clothing (PPE), and abide by the conditions set forth in the site-specific Health and Safety Plan (HSP).

Subcontractor Support

The NewFields project team will consist of the following subcontractors and external support to assist in the data collection activities and provide analytical laboratory services:

- Sampling Vessel

  Bio-Marine Enterprise
  R/V Kittiwake
  Charles Eaton
  2717 3rd Ave. N
  Seattle, WA 98109
  Phone: (206) 714-1055
  cmeaton@msn.com

- Analytical Chemistry (metals, cPAHs, sediment conventionals)

  Analytical Resources, Incorporated
  Cheronne Oreiro
  4611 South 134th Place
  Tukwila, WA 98166
  Phone: (206) 695-6214
  cheronneo@arilabs.com

- Dioxin/Furan and PCB Congener Analysis

  Axys Analytical Services, Ltd.
  Devin Mitchell
  2045 Mills Road
  Sidney, BC V8L 3S8
  CANADA
  Phone: (250) 655-5812
  Fax: (250) 655-5811
  dmitchell@axys.com

- Statistical Guidance

  TerraStat Consulting Group
  Lorraine Read
  323 Union Avenue
  Snohomish, WA 98290
  Phone: (425) 344-6875
  lorraine@premier1.net

Schedule

The proposed schedule for field activities is a 1-week period to be determined by Ecology.

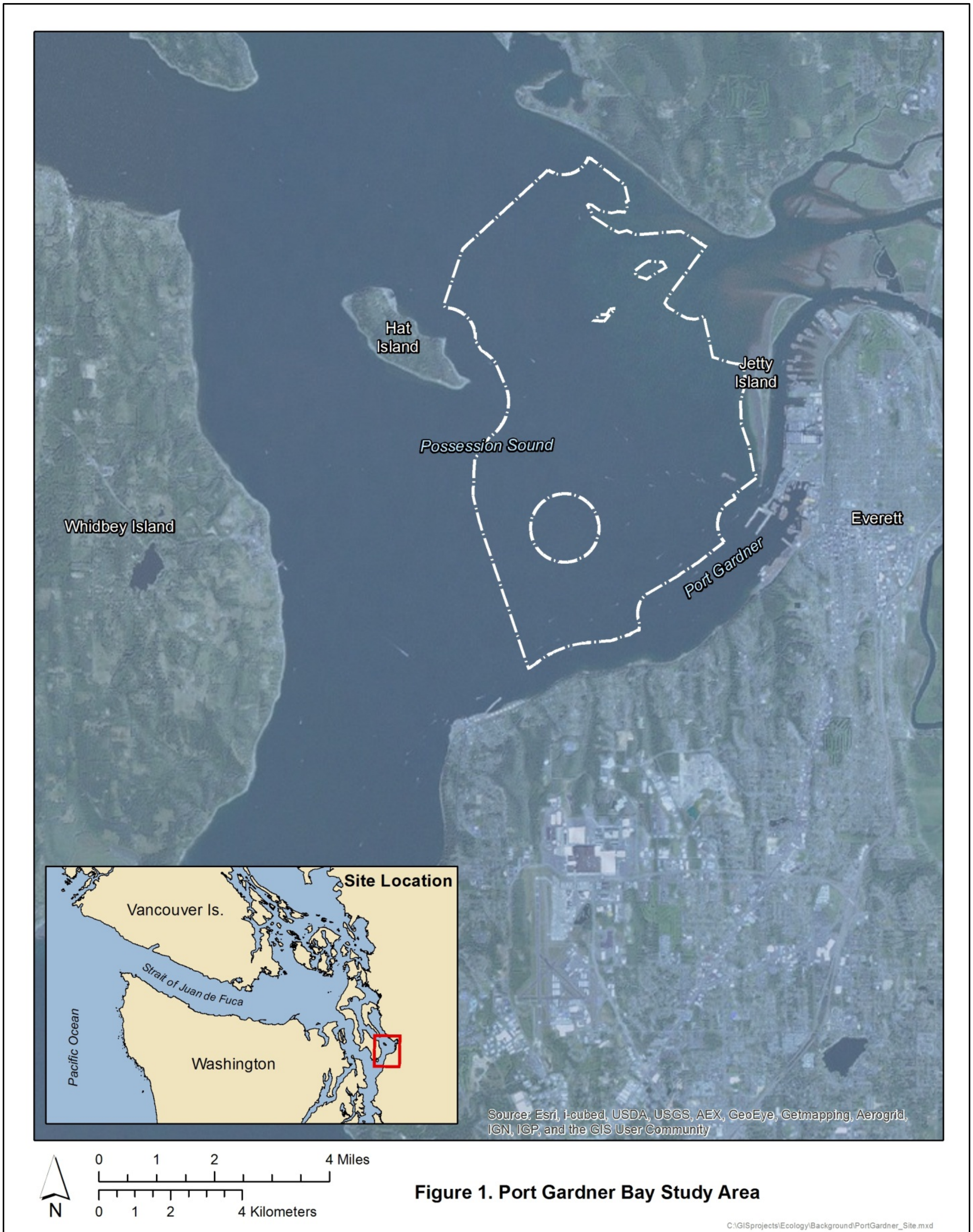

Figure 1. Port Gardner Bay Study Area

Study Design

This section describes the study design for the data collection effort in Port Gardner Bay. Several key study objectives were taken into consideration in the development of the study design:

- Define an area representative of regional background conditions.
- Produce a baseline dataset with temporal consistency.
- Determine the minimum number of baseline samples needed to calculate regional background.
- Define the minimum distance between sampling locations to ensure independent results.
- Assess the quality and usability of existing data for supplementing the baseline dataset.
- Randomly select sediment sampling locations to meet collective study objectives.

The following sections discuss the development and the details of the study design.

Determination of Area Representative of Regional Background

Environmental Systems Research Institute's Geographic Information System ArcGIS was used to allow for the study design to be viewed and developed in context of various geographic layers. First, an area of interest (AOI) polygon within Port Gardner Bay was determined that encompasses a range of conditions bounded by known or suspected source areas, and transitioning through regional background to natural background areas. The AOI defines the extent of the bay where potential sampling locations for this investigation could be placed. The AOI was defined as a hydraulically connected marine environment that excluded areas proximal to potential sources (i.e. active or historical outfalls), developed shoreline, known cleanup sites, dredged disposal sites, shallow areas above -6ft MLLW as well as areas that could be more affected by natural background sediments (as defined in WAC 173-340-200) such as those near the Saratoga Passage.

The minimum spacing between samples for an independent data set was estimated to be 400 meters (m) for Port Gardner Bay. Autocorrelation analyses were used to assess the similarity of sample results within the existing data set (dating from 2004 to 2010). The smallest testable autocorrelation distance was 200m (TerraStat, 2013). The data observations within 200m of each other were determined to be significantly correlated (Pearson's r = 0.74, p=0.048, n=6); observations spaced between 200m and 400m apart were not correlated (Pearson's r = -0.26, n=15). A minimum sampling interval of 400m is expected to be adequate to achieve an independent dataset. An interval of 500m was used as the independent sampling interval. This spacing is sufficient to achieve an independent dataset, yet small enough to allow for a large number of samples to be located within the study AOI.

A minimum of 500m distance was used to buffer the AOI from known or potential point sources including the open-water dredged disposal site and the developed shoreline (eastern and southern boundaries). The northern boundary of the AOI was bounded by a cable crossing between Gedney (Hat) Island and the Tulalip reservation. The western boundary of the AOI was demarcated with a line extending southeast from Gedney (Hat) Island separating Port Gardner from Possession Sound (Figure 2).

Sample Number and Density

The regional background data set will be used to characterize the concentration distributions of target analytes within the AOI. An initial sample size of 25 is expected to provide an indication of the shape of the concentration distributions, and preliminary estimates for the mean and variance of each analyte. In addition to the 25 baseline locations, 20 random secondary sampling locations will be occupied during this investigation to archive sufficient sediment for further analysis as needed, with the exception of mercury. Due to the short holding time, all 20 of the secondary samples will be submitted for mercury analysis.

Following analysis, the baseline dataset may be supplemented with existing data from Port Gardner Bay to determine data sufficiency. Data sufficiency will be determined based on the precision of the mean for this combined data set. A target for these data is to achieve a 95 UCL on the mean that is within 25% of the mean.

The initial 25 samples analyzed from Port Gardner Bay will be combined with any existing data deemed acceptable. From this combined data set, the regional background mean (i.e., 95UCL on the mean) will be estimated from the distribution after excluding any outlier(s), utilizing the most appropriate parametric or non-parametric methods. Graphs depicting the relationship between the 95UCL on the mean and sample size will be constructed for each analyte. From these graphs, the optimal sample size to achieve the desired precision in the mean will be estimated. For any analyte where the desired precision of the mean has not been met, additional samples may be randomly selected from the set of archived samples for analysis. Cost is a limiting factor for this background survey, so available funds will be used to conduct additional analyses where they are deemed to be most appropriate for reducing uncertainty in the dataset.

Once the boundaries for the AOI and the minimum spacing between samples were defined, a spatially-balanced random sampling design was developed using a Reverse Randomized Quadrant-Recursive Raster (RRQRR) algorithm (Theobald et al, 2007). This method requires the use of an inclusion probability raster specifying the probability (0 to 1) that a location (raster cell) will be preferentially selected relative to other locations. To account for the minimum sampling interval, a site sampling grid with a 500m resolution inclusion probability raster was created from the AOI polygon. This ensured the minimum distance between any two sampling locations was at least 500 meters. For this case, all cells were assigned a value of 1, which allows for an equal probability of an individual cell being selected. This allowed for the distribution of proposed sampling locations throughout the AOI while maintaining sample independence.

Through this spatially balanced selection process, the 25 baseline sample locations were randomly placed within the AOI, without regard for existing data (to maintain a completely random distribution). If any of the 25 baseline locations are within 500m of a location with existing data (Figure 2), the new sample results will take precedence (Figure 3). The 20 secondary locations were added separately and randomly placed by the same algorithm used above, but to maximize sample size and spatial coverage a 500m buffer was maintained between the 25 baseline sample locations (Figure 4). This allows for the use of secondary locations to be used for further analysis, as needed, to supplement the combined baseline and historical dataset. In the case where existing data for a given analyte are within 500m of a selected secondary location, the existing data may be used and the next randomly selected secondary location will be submitted for analysis.

Summary of Existing Data

The chemistry results from four previous studies were reviewed and determined to have existing data that may be usable, in part, to supplement the regional background data set. The description of the data screening process and the existing data results are provided in Appendix A. There was a significant number of samples collected in the nearshore areas of Port Gardner Bay and within the Snohomish River Estuary that were excluded for being outside the AOI. The locations of the existing data results are provided in Figure 2. A brief description of each study, including the study name and Study_ID as identified in EIM, are provided herein.

National Coastal Condition Assessment Data (EIM Study_ID: NCCA) - The National Coastal Condition Assessment (NCCA) was one of a series of water assessments conducted by states, tribes, the U.S. Environmental Protection Agency (EPA), and other partners. The purpose of these assessments was to generate statistically-valid reports on the condition of our Nation’s water resources and identify key stressors to these systems. All results were validated at QA1. The NCCA sample is CEW-04480-016 in Figure 2.

2010 Tiered-Full Monitoring at the Port Gardner Non-Dispersive Unconfined Open-Water Dredged Material Disposal Site (Not present in EIM) - This report presented the results of the 2010 tiered-full monitoring program conducted at the Port Gardner non-dispersive unconfined open-water dredged material disposal site in Puget Sound, Washington. The Washington State Department of Natural Resources (DNR) conducted this study through a contract with Science Applications International Corporation (SAIC 2010). The primary goal of the study was to ensure that disposal activities comply with federal Clean Water Act guidelines. Several samples were analyzed for an extended suite of chemicals of concern including dioxin/furan congeners, polybrominated diphenyl ethers (PBDEs), and PCB congeners. All metals and cPAH results were validated at QA1. Dioxin/furan and PCB congeners were validated at Level 4.

Dioxin/Furan Concentrations at the Non-Dispersive Open-Water Dredged material Disposal Sites in Puget Sound (EIM Study_ID: DMMP_Dioxin_2005-07) – The results compiled in this study provided a summary of dioxin/furan concentrations in sediments and tissues measured at the DMMP non-dispersive, open-water dredged material disposal sites in Puget Sound. All results were validated at QA1 (SAIC 2008).

The Puget Sound Assessment and Monitoring Program's Spatial/Temporal Monitoring 2002-Present (EIM Study_ID: PSAMP_SP) – The objectives of the PSAMP spatial and temporal monitoring were similar in scope to the long term monitoring. Chiefly, the goals of this monitoring that were relevant to the current background study were to determine the incidence and severity of toxicity and chemical contamination of sediments, identify spatial patterns, and estimate the spatial extent of contamination. All data were validated at EPA Level 4.

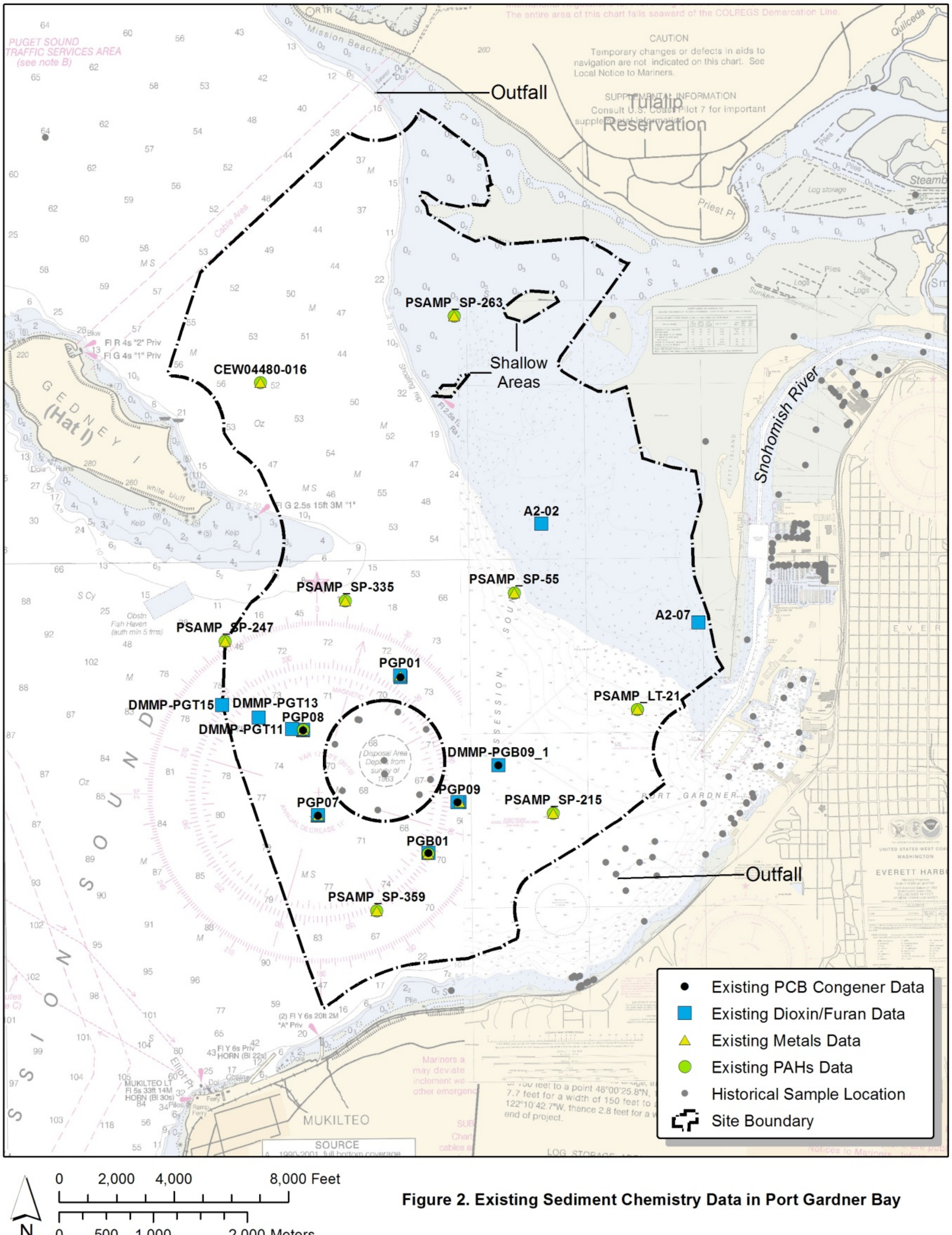

Figure 2. Existing Sediment Chemistry Data in Port Gardner Bay

Sediment Sampling Locations

A total of 45 sediment sampling locations, including 25 baseline locations and 20 secondary locations will be occupied sequentially as part of this investigation.

Baseline Sediment Sample Locations

The purpose of baseline sediment sample locations is to provide a minimum number of randomly placed sampling locations, at least 500 m apart, and to provide reasonable spatial coverage for an area pre-determined to be representative of regional background conditions. The following data collection activities have been identified and are summarized in Table 1:

- Collect 25 surface sediment (0-10 cm) grab samples using a spatially-balanced random design placed within the perimeter of an area designated as representing regional background conditions.
- Submit sediment samples for analysis of the following bioaccumulative contaminants:
    - Metals (arsenic, cadmium, and mercury)
    - Dioxin/furan congeners
    - PCB congeners
    - cPAHs
- Submit sediment samples for analysis of sediment conventionals (grain size distribution, total solids, total volatile solids, total sulfides, and total organic carbon).
- Archive sediment from each location for additional analysis or re-analysis as needed.

The proposed baseline sediment sample locations are presented in Figure 3. Target coordinates are provided in Table 3.

Table 1. Baseline Sediment Sample Locations and Analyses for Port Gardner Bay.

Sampling Location	Sediment Conventionals[1]	Metals[2]	cPAH	Dioxin/Furan Congeners	PCB Congeners	Archive[3]
PG-01	X	X	X	X	X	X
PG-02	X	X	X	X	X	X
PG-03	X	X	X	X	X	X
PG-04	X	X	X	X	X	X
PG-05	X	X	X	X	X	X
PG-06	X	X	X	X	X	X
PG-07	X	X	X	X	X	X
PG-08	X	X	X	X	X	X
PG-09	X	X	X	X	X	X
PG-10	X	X	X	X	X	X
PG-11	X	X	X	X	X	X
PG-12	X	X	X	X	X	X
PG-13	X	X	X	X	X	X
PG-14	X	X	X	X	X	X
PG-15	X	X	X	X	X	X
PG-16	X	X	X	X	X	X
PG-17	X	X	X	X	X	X
PG-18	X	X	X	X	X	X
PG-19	X	X	X	X	X	X
PG-20	X	X	X	X	X	X
PG-21	X	X	X	X	X	X
PG-22	X	X	X	X	X	X
PG-23	X	X	X	X	X	X
PG-24	X	X	X	X	X	X
PG-25	X	X	X	X	X	X

Notes

cPAH-carcinogenic polycyclic aromatic hydrocarbons **SMS-**Washington State Sediment Management Standards **PCB-**polychlorinated biphenyls

1-sediment conventionals include total organic carbon (TOC), total volatile solids (TVS), total solids, total sulfides, and grain size distribution

2-metals include arsenic, cadmium, and mercury

3-sediment archived for potential analysis or reanalysis

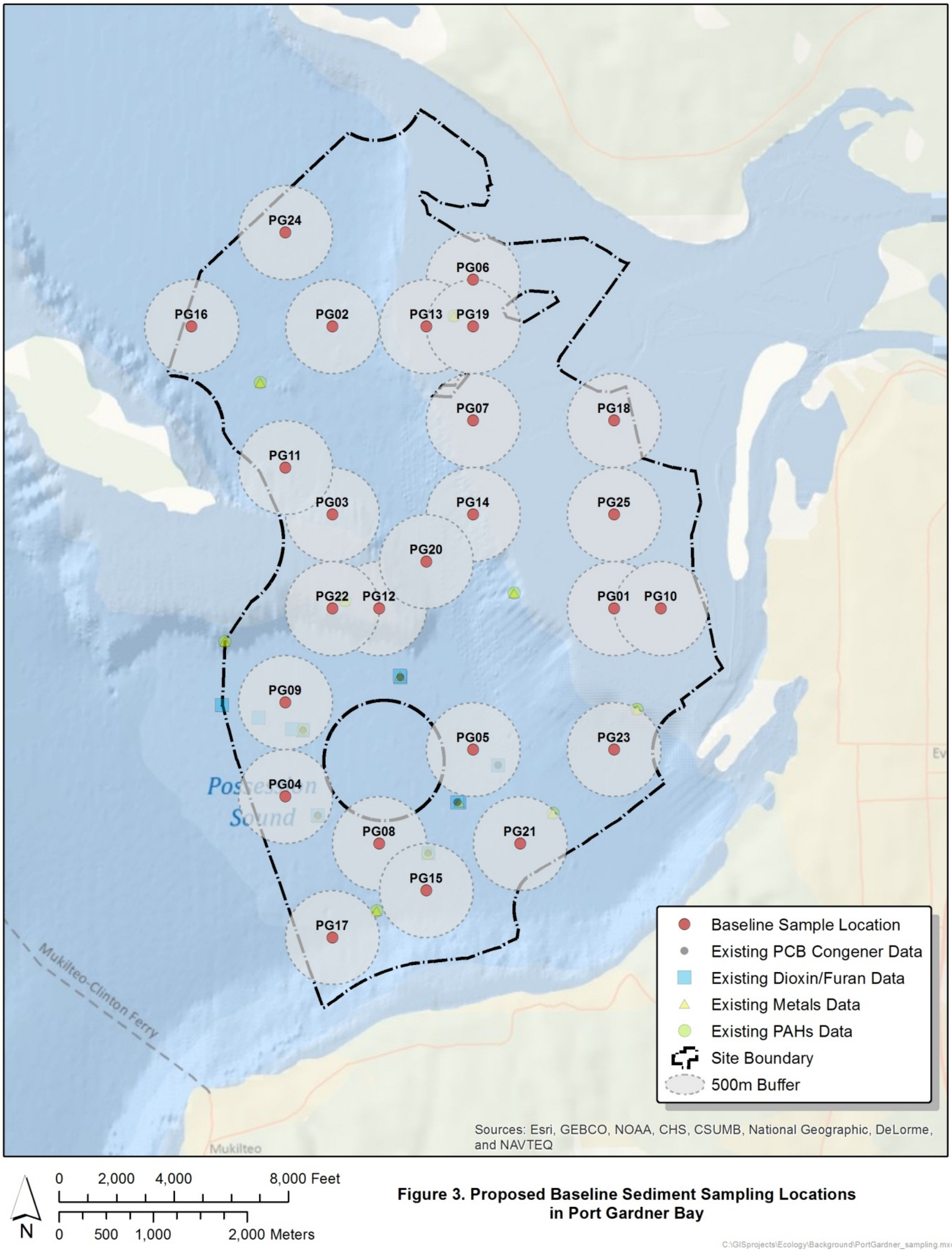

Figure 3. Proposed Baseline Sediment Sampling Locations in Port Gardner Bay

C:\GISprojects\Ecology\Background\PortGardner_sampling.mxd

Secondary Sediment Sample Locations

The purpose of the secondary sediment sample locations is to archive additional samples from randomly placed sampling locations that meet the minimum of 500 m apart from the nearest baseline location, and provide probability-based spatial balance for an area pre-determined to be representative of regional background conditions. These archived samples would then be available, as needed, for chemical analysis to ensure a sufficient number of usable data are available for calculation of regional background concentrations. If a randomly selected secondary location is within 500m of an existing data location for the needed analyte, then the next randomly selected archived sample not within 500m of an existing data location would be analyzed for that analyte. The following data collection activities have been identified and are summarized in Table 2:

The secondary sediment data collection activities include:

- Collect 20 surface sediment (0-10 cm) grab samples using a spatially-balanced random design placed within the perimeter of the area designated as representing regional background conditions.
  - Analyze all 20 samples for mercury due to short holding time.
  - Analyze all 20 samples for sulfides due to the short holding time.
  - Archive sediment for all other analyses.

The proposed secondary sediment sample locations are presented in Figure 4. Target coordinates are provided in Table 4.

Table 2. Secondary Sediment Sample Locations and Analyses for Port Gardner Bay.

Sampling Location	Sediment Conventionals[1]	Metals[2,3]	cPAH	Dioxin/Furan Congeners	PCB Congeners	Archive[4]
PG-26	X[5]	X[3]	-	-	-	X
PG-27	X[5]	X[3]	-	-	-	X
PG-28	X[5]	X[3]	-	-	-	X
PG-29	X[5]	X[3]	-	-	-	X
PG-30	X[5]	X[3]	-	-	-	X
PG-31	X[5]	X[3]	-	-	-	X
PG-32	X[5]	X[3]	-	-	-	X
PG-33	X[5]	X[3]	-	-	-	X
PG-34	X[5]	X[3]	-	-	-	X
PG-35	X[5]	X[3]	-	-	-	X
PG-36	X[5]	X[3]	-	-	-	X
PG-37	X[5]	X[3]	-	-	-	X
PG-38	X[5]	X[3]	-	-	-	X
PG-39	X[5]	X[3]	-	-	-	X
PG-40	X[5]	X[3]	-	-	-	X
PG-41	X[5]	X[3]	-	-	-	X
PG-42	X[5]	X[3]	-	-	-	X
PG-43	X[5]	X[3]	-	-	-	X
PG-44	X[5]	X[3]	-	-	-	X
PG-45	X[5]	X[3]	-	-	-	X

Notes

cPAH-carcinogenic polycyclic aromatic hydrocarbons

SMS-Washington State Sediment Management Standards

PCB-polychlorinated biphenyls

1-sediment conventionals include total organic carbon (TOC), total volatile solids (TVS), total solids, and grain size distribution

2-metals include arsenic, cadmium, and mercury

3-only mercury to be analyzed

4-sediment archived for potential analysis or reanalysis

5-only total sulfides to be analyzed

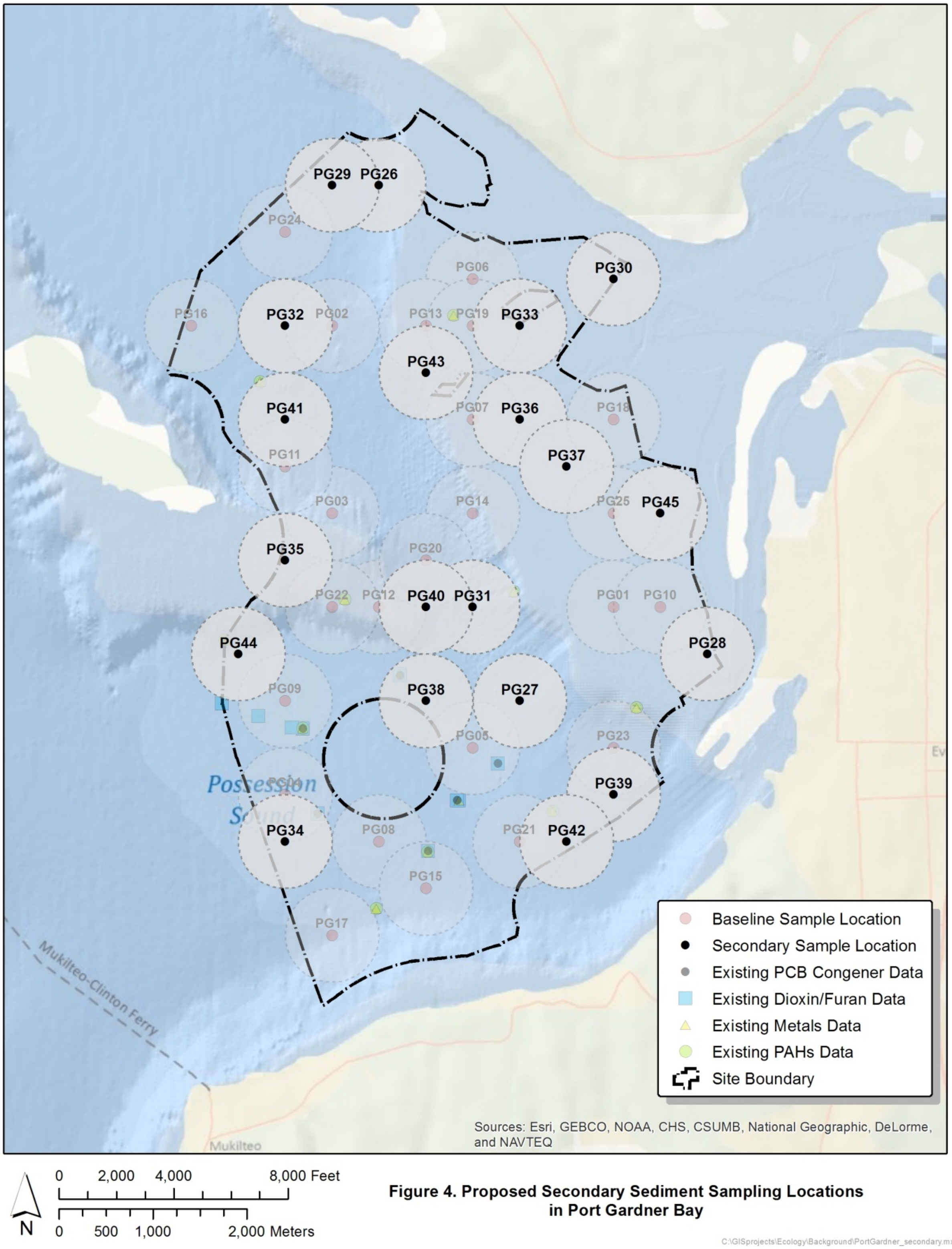

Figure 4. Proposed Secondary Sediment Sampling Locations in Port Gardner Bay

Sample Collection and Handling Methods

This section describes the methodology for positioning, sample collection, processing, identification, documentation, equipment decontamination, and waste handling for the proposed field investigation. Section 4.0 presents the laboratory methods for chemical analysis.

Sampling Platforms

The R/V *Kittiwake*, owned and operated by Mr. Charles Eaton of Bio-Marine Enterprises will be used for the surface sediment grabs in Port Gardner Bay.

Station Positioning and Navigation

NewFields will ensure that vessel navigation provides accurate station positioning, and that sample locations and water depths are recorded. A differential global positioning system (DGPS) will be used aboard the R/V *Kittiwake* for station positioning. A U.S. Coast Guard differential correction signal will be utilized to obtain a minimum accuracy of ± 3 meters. The DGPS receiver will be placed above the block on the sampling device deployment boom to accurately record the position of the sampling device.

Sampling location coordinates will be calculated in advance and programmed into the R/V *Kittiwake*'s navigation system. Upon sampling device deployment, the actual position will be recorded once the device reaches the seafloor and the deployment cable is in a vertical position. Latitude and longitude station coordinates will be recorded in degrees decimal minutes using the 1983 North American Datum (NAD83). Water depths will be measured using the winch meter wheel and verified by the ship's fathometer. Tables 3 and 4 provide the target coordinates for the baseline and secondary sample locations, respectively.

Table 3. Target Coordinates for Baseline Sampling Locations.

StationID	Easting (SPN NAD83)	Northing (SPN NAD83)	Latitude (NAD83)	Longitude (NAD83)
PG-01	1294561.12	366180.67	47.995166	-122.245975
PG-02	1284996.50	376299.29	48.022412	-122.285813
PG-03	1284811.82	369738.20	48.004420	-122.286061
PG-04	1282894.56	359942.70	47.977471	-122.293133
PG-05	1289501.83	361398.34	47.981802	-122.266271
PG-06	1289963.48	377801.05	48.026784	-122.265633
PG-07	1289824.97	372880.24	48.013289	-122.265825
PG-08	1286128.96	358210.11	47.972890	-122.279796
PG-09	1282986.89	363223.26	47.986468	-122.293010
PG-10	1296201.39	366134.50	47.995122	-122.239274
PG-11	1283217.71	371424.64	48.008959	-122.292702
PG-12	1286359.77	366411.48	47.995381	-122.279483
PG-13	1288277.04	376206.95	48.022328	-122.272402
PG-14	1289732.64	369599.70	48.004293	-122.265953
PG-15	1287723.08	356523.67	47.968350	-122.273161
PG-16	1280075.67	376437.81	48.022536	-122.305928
PG-17	1284396.37	354975.71	47.963935	-122.286619
PG-18	1294745.78	372741.74	48.013159	-122.245713
PG-19	1289917.31	376160.78	48.022286	-122.265697
PG-20	1288046.20	368005.59	47.999837	-122.272719
PG-21	1291049.78	358071.63	47.972762	-122.259700
PG-22	1284719.49	366457.65	47.995423	-122.286185
PG-23	1294422.64	361259.86	47.981671	-122.246172
PG-24	1283448.57	379626.01	48.031450	-122.292395
PG-25	1294653.45	369461.20	48.004163	-122.245844

Notes

SPN NAD83: Washington State Plane North, North American Datum 1983

NAD83: North American Datum 1983

Table 4. Target Coordinates for Secondary Sampling Locations.

StationID	Easting (SPN NAD83)	Northing (SPN NAD83)	Latitude (NAD83)	Longitude (NAD83)
PG-26	1286775.28	381173.94	48.035865	-122.278919
PG-27	1291188.26	362992.45	47.986257	-122.259507
PG-28	1297795.50	364448.07	47.990579	-122.232639
PG-29	1285135.01	381220.11	48.035907	-122.285626
PG-30	1294884.29	377662.54	48.026654	-122.245516
PG-31	1289640.31	366319.15	47.995296	-122.266080
PG-32	1283356.22	376345.46	48.022454	-122.292518
PG-33	1291557.58	376114.61	48.022243	-122.258992
PG-34	1282848.40	358302.42	47.972973	-122.293194
PG-35	1283125.38	368144.09	47.999963	-122.292825
PG-36	1291465.24	372834.07	48.013246	-122.259121
PG-37	1293059.35	371147.64	48.008705	-122.252482
PG-38	1287907.71	363084.77	47.986342	-122.272908
PG-39	1294376.48	359619.59	47.977173	-122.246237
PG-40	1288000.04	366365.32	47.995339	-122.272782
PG-41	1283263.88	373064.91	48.013457	-122.292641
PG-42	1292690.05	358025.47	47.972719	-122.253001
PG-43	1288230.87	374566.68	48.017830	-122.272466
PG-44	1281392.77	364909.70	47.991007	-122.299649
PG-45	1296293.72	369415.04	48.004118	-122.239141

Notes

SPN NAD83: Washington State Plane North, North American Datum 1983

NAD83: North American Datum 1983

Sediment Sample Collection

Surface sediment samples will be collected at 45 locations in Port Gardner Bay. Table 5 lists the sediment samples to be collected and analyzed, the number of QA/QC samples, sample container, volume, and preservation requirements.

Table 5. Sediment Sample Collection, Analysis, Containers, and Holding Times

Analyses	Grain Size	Total Solids, TOC, TVS	Total Sulfides	SIM cPAH	Dioxin/Furan &/or PCB Congeners	Metals	Mercury	Archive
Container(s)	16 oz HDPE	8 oz glass	2 oz glass	16 oz glass	8 oz amber glass	4 oz glass		16 oz glass[4,5]; 16 oz HDPE[5]; 8 oz amber glass[5]
Preservative	4°C	4°C/-18°C[2]	4°C; zinc acetate	4°C/-18°C	4°C/-18°C	4°C/-18°C	-18°C	-18°C
Holding Time	6 months	14 days[3]/ 6 months	7 days	14 days/ 1year	14 days/ 1year	14 days/ 1year	28 days	1year
Baseline	25X	25X	25X	25X	25X	25X	25X	25A[5]
Secondary	-	-	20X	-	-	-	20X	20A[6]
QA/QC Samples								
Duplicates[1]	2X	2X	3X	2X	2X	2X	3X	-
Triplicates[1,2]	2X	2X	3X	-	-	-	-	-
Equipment Rinseate[3]	-	-	-	2X	-	2X	3X	-
Rinseate Blank[3]	-	-	-	X	-	X	X	-
Sample Totals	**29**	**29**	**51**	**30**	**27**	**30**	**52**	**45**

Notes

X: sample to be collected and submitted for analysis/testing;

A: sample to be archived **-**: no sample will be collected at this location;

HDPE: high density polyethylene

1. Frequency of analysis is one per 20 samples (5%).

2. Triplicate analysis for sediment conventional parameters only.

3. Equipment rinseate and rinseate blanks conducted for organics and metals only.

4. One 16-oz glass jar to be collected for archive at baseline sampling locations.

5. Two 16-oz glass jars, one 16-oz HDPE jar, and one 8-oz amber glass jar to be collected for archive at secondary sampling locations.

Surface Sediment Grabs

Surface sediment grabs will be collected for chemical analysis from the R/V *Kittiwake* using a stainless steel 0.2 m^2 dual van Veen (0.1m^2 per bucket) .

Established deployment and recovery procedures for the grab sampling gear, described in PSEP, will be followed to ensure recovery of the best possible samples and minimize risks to personnel and equipment (PSEP 1997a). Once a grab sample is retrieved, the overlying water will be carefully siphoned off one side of the sampler. If the sample is judged to be acceptable according to PSEP specifications, the penetration depth will be measured with a decontaminated stainless steel ruler, and sample quality, color, odor, and texture will be described in the sample log (Appendix B).

If needed, multiple grab samples will be collected and composited for each sampling location to provide sufficient volume for chemical analysis. The general procedure for collecting sediment using a grab sampler is as follows:

1. Make logbook and field form entries as necessary throughout the sampling process to ensure accurate and thorough record-keeping.
2. Position the sampling vessel at the targeted sampling location.
3. Set the sampler jaws in the open position, place the sampler over the edge of the boat, and lower the sampler to the bottom.
4. Record the location using the DGPS; measure and record the water depth.
5. Retrieve the sampler and place it securely in the sampling vessel.
6. Examine the sample for the following sample acceptance criteria:
    a. The sampler is not overfilled with sample so that the sediment surface is pressing against the top of the sampler.
    b. The sample does not contain large foreign objects (i.e., trash or debris). A sample that is rock/gravel fill will be rejected in favor of depositional material (i.e., sand/silt/clay).
    c. Overlying water is present indicating minimal leakage.
    d. Overlying water is not excessively turbid indicating minimal sample disturbance.
    e. Sediment surface is relatively flat and/or intact without any indications of disturbance or winnowing.
    f. A penetration depth has been achieved that allows the collection of the upper 10 cm of sediment.
    g. If sample acceptance criteria are not achieved, the sample will be rejected and another sample collection attempt will be made.
7. Siphon off any overlying surface water.
8. Collect samples for total sulfides analysis directly from the grab sampler and place the sediment aliquots in appropriate, pre-cleaned, labeled sample containers (Table 3–3).

Add approximately 2 mL of zinc acetate preservative to the jar, fasten the lid and shake until mixed.

9. Measure and collect the top 10 cm with a stainless steel spoon, avoiding any sediment that is in contact with the inside surface of the grab sampler, then place the sediment into a stainless steel bowl and cover with aluminum foil.
10. Record the following observations of sediment sample characteristics on the field form (Appendix B); repeat steps 4 through 11 if more sample volume is required.
    a. Texture
    b. Color
    c. Biological organisms or structures (i.e., shells)
    d. Presence of debris (i.e., natural or anthropogenic objects)
    e. Presence of oily sheen or obvious contamination
    f. Odor (e.g., hydrogen sulfide, petroleum)
11. Wash excess sediment back into the water away from any areas remaining to be sampled.
12. If needed, percent fines will be determined by rinsing 100 ml of sediment through a 63.5 micron sieve until the water is clear. Percent fines are equal to 100 minus the volume of remaining sediment.
13. Once sufficient sediment volume has been collected, samples should be placed in the appropriate, pre-cleaned, labeled sample containers, placed in a cooler maintained at 4ºC, and prepared for shipment to the analytical laboratory.
14. Confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed.
15. Decontaminate all sampling equipment before proceeding to the next sampling location.

A single replicate sample will be collected from each target sampling location, with the exception of field duplicates and QA/QC samples to be collected randomly at the field supervisor’s discretion.

Sample Identification, Containers, and Labels

Samples will be identified based on the project, sampling area, location, and sample type. All samples collected during will be labeled clearly and legibly. Each sample will be labeled with a unique alphanumeric sample identification number that identifies characteristics of the sample as follows:

Project	Study Area	Location Number	Sample Type
RB12-	PG-	01-	S

Project consists of four characters describing the project (RB12 = Regional Background 2012).

Study Area consists of two characters describing the sampling area (PG=Port Gardner Bay)

Location Number consists of two characters identifying the station location number

Sample Type consists of one to two characters indicating the sample type. S denotes a sediment sample. Sediment QA/QC samples are further identified with D = duplicate, T = triplicate, ER = equipment rinseate, RB = rinseate blank.

Sample labels will be self-adhering, waterproof material. An indelible pen will be used to fill out each label. Each sample label will contain the project name (Port Gardner Bay Regional Background Sediment Characterization), sample identification, date and time of collection, analyses, preservative (as applicable), and the initials of the person preparing the sample. In addition, a unique, sequentially numbered jar tag will be placed on each sample container for tracking purposes. Jar tag numbers will be recorded in a Sample Container Logbook (Appendix B). Sample labels and jar tags will be protected by packaging tape wrapped around the entire jar to prevent loss or damage of the labels during handling and storage.

Sample Storage and Delivery

All samples will be stored in insulated coolers and preserved by cooling to a temperature of 4ºC or as required by analytical methods. Maximum sample holding and extraction times will be strictly adhered to by field personnel and the analytical and testing laboratories.

Preparation of jars for shipment will be performed in the following manner:

1. Wipe or decontaminate the outside of filled, capped sample bottles to ensure there is no sample residual on the outside of the container. Secure sample lid jars with electrical tape to prevent leakage.
2. Label jars with prepared labels. Each set of samples will have a unique sample ID and jar tag number.
3. Secure labels with clear packaging tape.
4. Record the samples in Sample Container Logbook (see Appendix B) and the Chain of Custody forms.
5. Place sample containers in plastic zip-loc bubble-pack bags, or wrap in bubble pack and secure with packaging tape.
6. Prepare an empty insulated cooler by placing three to four ice packs in a garbage bag at the bottom of the cooler. Place sample containers in a garbage bag and fill with the sample bottles. Add additional bags of ice as needed to surround the bag containing the samples.
7. Seal the cooler with strapping tape and a custody seal. Samples for chemical analyses will be shipped via overnight courier to the analytical laboratory once per day or whenever a cooler is filled, and accompanied by the chain-of-custody record, which identifies the shipment contents. The chain-of-custody will be signed by the individual relinquishing samples to the onsite laboratory representative. The field personnel will be responsible for:
    a. Packaging the samples;

b. Signing the chain-of-custody before placing inside the cooler to be sealed;
c. Applying a shipping label, an air bill, a custody seal, and strapping tape to the cooler; and
d. Shipping the samples in accordance with the maximum holding time allowed for the analyses to be performed.

A separate chain-of-custody form will be filled out for each analytical laboratory. The chain-of-custody will be signed by the individuals relinquishing the samples and will be placed inside the cooler before it is sealed.

All sediment samples will be retained for a minimum of 6 months from the time they were received using standard laboratory handling procedures. They may be removed from the laboratory prior to the end of the 6-month period only at the direction of the contractor project manager in consultation with Ecology.

Field Documentation

A complete record of field activities will be maintained. Documentation necessary to meet QA objectives for this project include field notes and field forms (Appendix B), sample container labels, and chain-of-custody forms. The field documentation will provide descriptions of all sampling activities, sampling personnel, and weather conditions, and will record all modifications, decisions, and/or corrective actions to the study design and procedures identified in this work plan.

Field Notebooks

All handwritten documentation must be legible and completed in permanent waterproof ink. Corrections must be marked with a single line, dated, and initialed. All documentation, including voided entries, must be maintained within project files.

The Field Manager will keep the field logbook(s) on site during field operations. Daily activities will be recorded in a bound field logbook of water-resistant paper. Separate logbooks consisting of bound, paginated field forms will be kept for surface sediment grab descriptions, and an inventory of sample containers (separate from constituent of concern [COC] documentation). Examples of the various field forms to be used are presented in Appendix B. All entries will be made legibly, in indelible ink, and will be signed and dated. Information recorded will include the following:

- Date, time, place, and location of sampling;
- Onsite personnel and visitors;
- Daily safety discussion and any safety issues;
- Quality control samples (e.g., duplicate samples, field blanks, etc.);

- Calibration of field equipment (including make and model of equipment);
- Field measurements and their units;
- Observations about site, location, and samples (i.e., weather, current, odors, appearance); and
- Equipment decontamination verification.

Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occur during project field activities. Entries should be factual, detailed, and objective. Unless restricted by weather conditions, all original data recorded in field logbooks and on sample identification tags, chain-of-custody records, and field forms will be written in waterproof ink. If an error is made, the individual responsible may make corrections simply by crossing out the error and entering the correct information. The erroneous information should not be obliterated. All corrections must be initialed and dated.

Chain-of-Custody Procedures

The field crew will retain samples at all times until contractor personnel deliver samples to the appropriate laboratory. All samples will be held and transported in coolers with ice or frozen gel-packs at approximately 4°C.

Chain–of-custody forms will be initiated at the time of sample collection to ensure that all collected samples are properly documented and traceable through storage, transport, and analysis. When all line items on the form are completed or when the samples are relinquished, the sample collection custodian will sign and date the form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the sample will sign the chain-of-custody form and provide the reason for assuming custody. The field chain-of-custody terminates when the laboratory receives the samples. The FM should retain a copy of the completed, signed, chain-of-custody form(s) for project files.

Equipment Decontamination

Sample processing equipment (i.e., spoons, bowls, and reusable containers from which samples are transferred to sample jars) will be washed with a laboratory-grade detergent (e.g., Liquinox) and water solution, rinsed with site or tap water, and will undergo a final distilled water rinse prior to field operations. Decontaminated equipment will be wrapped or covered with aluminum foil. Sub-sampling and processing equipment will be decontaminated before use at each station in order to prevent cross-contamination of samples. Any deviations from these procedures will be documented in the field notebook.

Personal non-disposable field equipment (i.e., boots, waterproof gloves, and garments) will be rinsed with water and brushed clean prior to leaving the immediate vicinity of the sample collection area. Special attention will be given to removing mud that may adhere to boot treads.

Waste Disposal

During the field investigation, field personnel will be responsible for securing appropriate waste containers, and placing wastes in labeled storage containers, performing appropriate testing, preparing wastes for disposal, and proper disposition of wastes.

Excess sediment sample not submitted to the laboratories, and disposable protective clothing, sampling equipment, and packaging are the two types of waste the activities described in this work plan will generate.

Sediment Samples

Small quantities of excess sediment and rinseate water generated during sample processing will be returned to the site. Care will be taken to not dispose of sediment and/or rinseate at locations targeted for subsequent sampling.

Disposable Protective Clothing and Sampling Equipment

Used PPE, such as protective Tyvek suits or gloves, and sampling equipment, such as aluminum foil and paper towels, and any packaging material that cannot be recycled, will be placed in plastic storage bags and disposed of as municipal waste.

Laboratory Analytical Methods

All of the analytical methods used in this program will be performed in accordance with the PSEP guidelines. The laboratory analysis will be consistent with PSEP guidelines (PSEP 1997a, b, c), any recent modifications proposed during the SMARM, and/or the most current laboratory recommendations. Each laboratory participating in this program will institute internal QA/QC plans. Analyses will be required to conform to accepted standard methods and internal QA/QC checks prior to final approval.

Chemical Analyses

Analytical Resources, Inc., and AXYS Analytical Services will conduct the chemical analysis. Table 6 presents the sample preparation methods, analytical methods, and practical quantitation limits (PQL) for the target conventionals, metals, cPAH compounds, and dioxin/furan congeners. Each sample will also be analyzed for the full list of PCB congeners. The congeners and congener pairs obtainable by EPA method 1668A are presented in Table 7.

The analytical results from this supplemental investigation will be used for the determination of regional background concentrations. As a result, the PQLs required for analysis in this study are lower than most standard methods provide. Efforts were made for many of the analytes to find methods that provide lower PQLs.

cPAH will be analyzed in select ion monitoring (SIM) mode. An additional low end point will be added to the calibration standard for dioxin/furan and PCB congener analysis to provide for lower reporting limits. The PQL values listed for dioxin/furan and PCB congeners in Tables 6 and 7 are lower method calibration limits (LMCL), which is defined by the lower limit of the calibration curve. The LMCL is functionally equivalent to the PQL. Metals will be analyzed by inductively coupled plasma-mass spectrometry (ICP-MS) for sediment samples to achieve lower PQLs for arsenic and cadmium.

The PQLs listed may be subject to modification due to elevated sample concentrations, heterogeneous samples (sediment), and potential matrix interferences that may preclude obtaining the desired quantification limit. Specifically:

- Two possible ions are used for the quantification of arsenic. The specific ion used is dependent upon the matrix and interferences. As a result, two reporting limits are listed for arsenic in Table 6.
- The standard reporting limit for cPAH compounds is 5.0 µg/kg using EPA method 8270 SIM. If necessary, ARI can achieve a PQL as low as 0.5 µg/kg using a low level version of 8270 SIM, but only in samples where the concentration is below the standard reporting limit.

ARI will prescreen a solvent shake-out of the sample for potential high concentrations and analyze using the appropriate method.

In the event either laboratory is unable to meet the PQLs additional clean-up measures may be used. If the PQLs still cannot be met, the reasons for the deviation will also be reported.

Table 6. Target Analytes, Methods, and Practical Quantitation Limit.

Analyte	Preparation Method	Analytical Method	PQL
Conventional Parameters			
Grain size	---	PSEP	---
Total Solids (%)	---	PSEP	0.1
Total Sulfides	---	PSEP	1.0
Total organic carbon (%)	---	PSEP	0.10
Total Volatile Solids (%)	---	PSEP	0.1
Metals (mg/kg DW)			
Arsenic	EPA 3050B/3051	EPA 200.8	0.2/0.5†
Cadmium	EPA 3050B/3051	EPA 200.8	0.1
Mercury	EPA 7471A	EPA 7471A	0.025
cPAHs (µg/kg DW)			
Benzo(a)pyrene	EPA 3546	8270-SIM PAH*	5.0
Benz(a)anthracene	EPA 3546	8270-SIM PAH*	5.0
Benzo(b)fluoranthene	EPA 3546	8270-SIM PAH*	5.0
Benzo(k)fluoranthene	EPA 3546	8270-SIM PAH*	5.0
Chrysene	EPA 3546	8270-SIM PAH*	5.0
Dibenz(a,h)anthracene	EPA 3546	8270-SIM PAH*	5.0
Indeno(1,2,3-cd)pyrene	EPA 3546	8270-SIM PAH*	5.0
Dioxin/Furan Congeners (ng/kg DW)‡			
2,3,7,8-TCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	0.2
1,2,3,7,8-PeCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,4,7,8-HxCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,6,7,8-HxCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,7,8,9-HxCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,4,6,7,8-HpCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
OCDD	EPA 1613B/3540C	EPA 1613B (CS-0.2)	2.0
2,3,7,8-TCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	0.2
1,2,3,7,8-PeCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
2,3,4,7,8-PeCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,4,7,8-HxCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,6,7,8-HxCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,7,8,9-HxCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
2,3,4,6,7,8-HxCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,4,6,7,8-HpCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
1,2,3,4,7,8,9-HpCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	1.0
OCDF	EPA 1613B/3540C	EPA 1613B (CS-0.2)	2.0

Notes

SIM-select ion monitoring **PQL**-practical quantitation limit **DW**-dry weight

CS-0.2-additional low level calibration point **cPAH-**carcinogenic polycyclic aromatic hydrocarbons

† PQL for arsenic dependent on the quantified ion, which is in turn dependent on the matrix and interferences

* Samples will undergo a prescreening process at ARI and low concentration samples will be analyzed by a low level variant of 8270-SIM with a reporting limit of 0.5 µg/kg.

‡ Values listed for dioxin/furan congeners are the lower method calibration limits (LMCL) defined by the lowest concentration on the calibration curve. The LMCL is functionally equivalent to the PQL.

Table 7. PCB Congener Methods and Practical Quantitation Limits (PQL).

Analyte	Preparation Method	Analytical Method	PQL
*PCB-156/157	EPA 1668A	EPA 1668A (CS-0.2)	0.8
see below	EPA 1668A	EPA 1668A (CS-0.2)	0.4
PCB Congeners and Congener Pairs (ng/kg DW) for Prep Method EPA 1668A and PQL of 0.4			
PCB-1	PCB-48	PCB-110/115	PCB-164
PCB-2	PCB-50/53	PCB-111	PCB-165
PCB-3	PCB-52	PCB-112	PCB-167
PCB-4	PCB-54	PCB-113/90/101	PCB-169
PCB-5	PCB-55	PCB-114	PCB-170
PCB-6	PCB-56	PCB-117/116/85	PCB-171/173
PCB-7	PCB-57	PCB-118	PCB-172
PCB-8	PCB-58	PCB-120	PCB-174
PCB-9	PCB-59/62/75	PCB-121	PCB-175
PCB-10	PCB-60	PCB-122	PCB-176
PCB-11	PCB-61/70/74/76	PCB-123	PCB-177
PCB-12/13	PCB-63	PCB-126	PCB-178
PCB-14	PCB-64	PCB-127	PCB-179
PCB-15	PCB-66	PCB-128/166	PCB-180/193
PCB-16	PCB-67	PCB-130	PCB-181
PCB-17	PCB-68	PCB-131	PCB-182
PCB-19	PCB-69/49	PCB-132	PCB-183/185
PCB-21/33	PCB-72	PCB-133	PCB-184
PCB-22	PCB-73	PCB-134/143	PCB-186
PCB-23	PCB-77	PCB-136	PCB-187
PCB-24	PCB-78	PCB-137	PCB-188
PCB-25	PCB-79	PCB-138/163/129/160	PCB-189
PCB-26/29	PCB-80	PCB-139/140	PCB-190
PCB-27	PCB-81	PCB-141	PCB-191
PCB-28/20	PCB-82	PCB-142	PCB-192
PCB-30/18	PCB-83/99	PCB-144	PCB-194
PCB-31	PCB-84	PCB-145	PCB-195
PCB-32	PCB-88/91	PCB-146	PCB-196
PCB-34	PCB-89	PCB-147/149	PCB-197/200
PCB-35	PCB-92	PCB-148	PCB-198/199
PCB-36	PCB-94	PCB-150	PCB-201
PCB-37	PCB-95/100/93/102/98	PCB-151/135/154	PCB-202
PCB-38	PCB-96	PCB-152	PCB-203
PCB-39	PCB-103	PCB-153/168	PCB-204
PCB-41/40/71	PCB-104	PCB-155	PCB-205
PCB-42	PCB-105	PCB-156/157*	PCB-206
PCB-43	PCB-106	PCB-158	PCB-207
PCB-44/47/65	PCB-107/124	PCB-159	PCB-208
PCB-45/51	PCB-108/119/86/97/125/87	PCB-161	PCB-209
PCB-46	PCB-109	PCB-162	--

Notes

PQL-practical quantitation limit **DW-**dry weight **CS-0.2-**additional low level calibration point

Analytical Laboratory Reporting

Analytical laboratory reports will be accompanied by sufficient backup data and QC results to enable independent reviewers to evaluate the quality of the data results. Analytical data will be reported in the units specified by the PQLs listed in Tables 6 and 7.

All PQLs will be met. If matrix interferences exist that prevent meeting the listed PQL, the reason will be listed in the laboratory narrative. All non-detect sample results for cPAH will be reported to the method detection limit and detected results less than the target PQL will be qualified. All non-detect results for metals will be reported at the PQL. Metals data are not qualified below the PQL.

Non-detect results for dioxin/furan and PCB congeners will be reported at the sample specific detection limit (SDL). All detected congener results less than the LMCL/PQL will be qualified.

The analytical laboratory deliverables will include the following:

- Case narrative (including any problems encountered, protocol modifications, and/or corrective actions taken);
- Sample analytical and QA/QC results with units;
- All protocols used during analyses;
- Any protocol deviations from the approved sampling plan;
- Surrogate recovery results;
- MS/MSD results;
- Laboratory duplicate/triplicate results;
- Blank results;
- Sample custody records (including original chain-of-custody forms); and
- Electronic analytical results in Ecology's Environmental Information Management (EIM) format.

Quality Assurance Project Plan

The purpose of the project QA/QC is to provide confidence in the project data results through a system of quality control performance checks with respect to data collection methods, laboratory analysis, data reporting, and appropriate corrective actions to achieve compliance with established performance and data quality criteria. This section presents the QA/QC procedures to ensure that the investigation data results are defensible and usable for their intended purpose.

Measurements of Data Quality

The tolerable limits for the data reported by the laboratory will be measured with regard to precision, accuracy, representativeness, completeness, and comparability.

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed conditions. Precision will be assessed by the analysis of matrix spike/matrix spike duplicates (MS/MSDs), field duplicate and triplicates, and laboratory control sample/laboratory control sample duplicates (LCS/LCSD). The calculated relative percent differences (RPDs) for field duplicates and triplicates and MS/MSD pairs will provide information on the precision of sampling and analytical procedures, and the RPDs for LCS/LCSD pairs will provide information on precision of the analytical procedures.

Accuracy is the degree to which an observed measurement agrees with an accepted reference or true value. Accuracy is a measure of the bias in the system and is expressed as the percent recoveries of spiked analytes in MS/MSD and LCS/LCSD samples. Accuracy will also be evaluated through the surrogate spikes in each sample. The laboratory control limits for surrogates will be used for the project.

Representativeness expresses the degree to which data accurately and precisely represent an actual condition or characteristic at a particular sampling point. Representativeness is achieved by collecting samples representative of the matrix at the time of collection. Representativeness can be evaluated using replicate samples, additional sampling locations, and blanks.

Completeness refers to the amount of measurement data collected relative to that needed to assess the project's technical objectives. It is calculated as the number of valid data points achieved divided by the total number of data points requested by virtue of the study design. For this project, completeness objectives have been established at 95 percent.

Comparability is based on the use of established USEPA-approved methods for the analysis of the selected parameters. The quantification of the analytical parameters is based on published methods, supplemented with well-documented procedures used in the laboratory to ensure reproducibility of the data.

Quality Assurance and Quality Control for Chemistry Sediment Samples

Field and laboratory QA/QC samples will be used to evaluate the data precision, accuracy, representativeness, and comparability of the analytical results.

Field QA/QC for Sediment Chemistry

Field QC samples will be collected during sampling to quantitatively measure and ensure the quality of the sampling effort and the analytical data. Field QC samples include field duplicates, equipment rinseate, and rinseate blanks. QC samples are to be handled in the same manner as the environmental samples collected. Brief descriptions of the field QC samples are provided below.

Field Duplicates and Triplicates

Field duplicates and triplicates are collected at the same time as the original sample using identical sampling techniques. Field duplicate sample results (triplicates for sediment conventional parameters) are used to assess the precision of the sample collection process and to help determine the representativeness of the sample. Field duplicates/triplicates will be collected at a five percent frequency. The duplicates/triplicates will be designated for the same analysis as the original samples. The field duplicates/triplicates will be collected from the same homogenate as the original sample.

Equipment Rinseate and Rinseate Blanks

The equipment rinseate blank and decontamination water (rinseate) blank provide a quality control check on the potential for cross contamination by measuring the effectiveness of the sampling and processing decontamination procedures. The equipment rinseate sample consists of de-ionized water rinsed across sample collection and processing equipment after they have been used to collect a sample and have been decontaminated for use at the next sampling location. The decontamination water blank is an unadulterated sample of the de-ionized water used to create the rinseate blank, analyzed to ensure no contaminants were present in the rinse water. Equipment blank samples will not be required when using disposable sample equipment.

Laboratory QA/QC for Sediment Chemistry

One laboratory matrix spike and matrix spike duplicate will be analyzed for every 20 samples submitted or for each analytical batch of samples (if less than 20 submitted) for the analysis of cPAHs, metals, and TOC. The combination of these spiked samples will provide information on the accuracy and precision of the chemical analysis, and to verify that the extraction and measured concentrations are acceptable. The MS/MSDs will be analyzed in accordance with USEPA methods for each respective analyte.

One laboratory replicate will be analyzed for all constituents (except grain size, TOC, and total solids) for every 20 samples submitted or for each analytical batch of samples (if less than 20 submitted). Laboratory triplicates will be analyzed for grain size, TOC, and total solids. These QA/QC samples will be analyzed in accordance with the respective USEPA method and will be used to evaluate the precision of the analytical method.

One laboratory method blank and LCS will be analyzed for all constituents (except grain size and total solids) for each analytical batch of 20 samples to assess potential laboratory contamination and accuracy. An LCSD will be analyzed if required by the method, or if the laboratory does not have enough sample volume to prepare an MS/MSD.

Laboratory control samples, certified reference material, and surrogate spikes will be used as defined by the analytical methods and equipment calibration requirements.

Data Validation

The data generated as part of this investigation will undergo an independent quality assurance review and data validation. A QA2 (Stage 4) chemistry data review will be conducted that examines the complete analytical process from calculation of instrument and method detection limits, practical quantification limits, final dilution volumes, sample size, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples (PTI 1989a).

The QA2 data validation will be conducted by EcoChem, Inc. of Seattle, WA.

Data Analysis and Reporting

This section describes the data analysis and reporting requirements for the data collection activities described in this SAP.

Analysis of Sediment Chemistry Data

The sediment chemistry data will be summarized and presented in tables indicating sediment locations, detected contaminants, detection limits that exceed target PQLs, and data qualifiers assigned by the laboratory or during the data validation efforts. Concentrations of relevant COCs may be mapped to better demonstrate the spatial distributions.

For reporting, dioxin/furan and PCB congeners will be normalized to the toxicity of 2,3,7,8-TCDD (Tetrachlorodibenzo-p-Dioxin) using toxic equivalent factors (TEFs) updated by the WHO in 2005 (Van den Berg et al. 2006). TEQs for dioxin/furan congeners and PCB congeners will be reported separately. The toxic equivalent quotient (TEQ) is equivalent to the sum of the concentrations of individual congeners multiplied by their TEF (potency relative to 2,3,7,8-TCDD). Non-detected values will be assessed as zero, half of the sample specific detection limit, and at the sample specific detection limit for data reporting purposes. TEQ values will also be calculated using Kaplan-Meier analysis to estimate concentrations for non-detected congeners (Helsel 2010). The final TEQ sums will be qualified to indicate the level of censoring within each sample.

PCB congeners will also be reported as total PCBs. Total PCBs is the sum of all detected congeners.

The concentrations for cPAH will be determined by normalizing individual cPAH to the toxicity of benzo(a)pyrene using TEFs present in Ecology's guidance document *Evaluating the Toxicity and Assessing the Carcinogenic Risk of Environmental Mixtures Using Toxicity Equivalency Factors* (Ecology 2007). Non-detected values will be reported and assessed as zero, half of the method detection limit, and at the method detection limit for data reporting purposes.

TEQ values will also be calculated using Kaplan-Meier analysis to estimate concentrations for non-detected PAH compounds (Helsel 2010). The final TEQ sums will be qualified to indicate the level of censoring within each sample.

Calculation of the Regional Background Concentration

The regional background statistics of interest are the 95UCL on the mean for risk-based exposure estimates, and an upper tolerance limit (UTL) as a cleanup screening level. These summary statistics should be calculated on a single data distribution, excluding outliers.

The distribution of the data will be evaluated for the presence of potential outliers, or for a mixture of distinct populations using graphical tools (e.g., boxplots and Q-Q plots) in conjunction with formal outlier tests (e.g., Dixon's or Rosner's test) for identifying samples with extreme concentrations for a single analyte or TEQ. Some samples may not have extreme concentrations for individual analytes, but may still exhibit very different patterns within the suite of PCBs, cPAHs, or dioxin/furan congeners. The presence of samples with very different congener patterns may signify unique contaminant sources. Once identified these samples, along with their surrounding areas, may be excluded from the regional background distribution. Multivariate outlier investigations will use Mahalanobis distances. Mahalanobis distance is a metric very similar to Euclidean distance (i.e., the familiar metric used to calculate the distance between two points on a line). To identify multivariate outliers, the Mahalanobis distance is calculated as the distance between each observation and the center of mass for the remaining observations, scaled to the covariance among congeners in the direction of that observation. A large distance in a direction of high covariance is more likely than a moderate distance in a direction of very low covariance. An observation that doesn't fall within the "cloud" of other data points is identified as a potential multivariate outlier.

Outliers will contaminate a distribution, producing higher variance estimates and subsequently greater uncertainty in the tolerance limit. Any outliers identified will be discussed with the project team, and the regional background will be calculated both with and without the outlier(s) to determine their impact. Any concentrations deemed likely to be from outside of regional background will be excluded from the calculations of the cleanup standards.

After the removal of any outliers, goodness-of-fit tests and graphical displays (e.g., Q-Q plots) will be used to identify the best-fit distributional form for the data. For the calculation of the 95UCL on the mean and UTLs, if the assumption of a particular parametric distribution is not deemed appropriate for the data, non-parametric methods such as the bootstrap or order statistics will be used, as appropriate. In all cases where concentrations are present below detection, methods appropriate for left-censored data will be used. All of the statistical tools required are available in ProUCL 4.1.00 (US EPA 2010), with the exception of the multivariate pattern analysis. The multivariate analysis tools are available in Scout version 1.00.01 (US EPA 2008, runs only up to Windows 98), and R (R Development Core Team 2011); as well as in other commercially available statistical software.

Reporting Procedures

A written data report documenting all activities associated with collection, transportation, and chemical analyses of sediment samples will be prepared. The chemical and QA/QC reports will be included as appendices. At minimum, the Final Report will include:

- A summary of the purpose of the investigation;
- Description of sampling and analysis activities;
- Protocols used during sampling and testing, and an explanation of any deviations from the sampling plan protocols or the approved work plan;
- Methods used for station positioning, sample collection locations reported in latitude and longitude to the nearest tenth of a second (NAD83);
- Maps showing actual locations of sampling stations;
- Maps and data tables of sediment chemistry (results in mg/kg organic carbon, and dry weight);
- Chain-of-custody records;
- Analytical laboratory reports;
- Copies of field and sampling logs as appendices; and
- QA/QC summary; and
- Data validation reports.

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Appendices

Appendix A. Existing Chemistry Data

A1: Screening of Existing Data

Ecology provided NewFields with an Excel file containing EIM data relevant to Port Gardner Bay. There were some caveats to the data available from EIM. The level of QAQC on the studies was variable, though most were thought to be above a level QA1 data validation. There was no consistent reporting for non-detect results. Some results were reported at the MDL, while some were at the PQL.

The data provided were already filtered by date (see first bullet point). Several additional steps were taken to filter the existing data so as to match the sampling methodologies and data quality objectives of the current study. The following steps were not analyte specific:

- **Sample Date.** Samples collected within the last decade (2002 through 2012) were extracted from EIM.
- **Sample Depth.** Only samples from the top 0 to 12 cm were retained. A sample was excluded if the Field_Activity_Lower_Depth and Field_Activity_Upper_Depth were either both zero or both left blank.
- **Field Replicates.** Field replicates were marked in the Sample_Field_Replicate_ID, Sample_Replicate_Flag , and occasionally in the Sample_Sub_ID columns. Use of these columns to mark field replicates was not always consistent. If any of these columns indicated a replicate, and the same parameter was analyzed multiple times at a location, the samples marked as replicates were excluded.
- **Laboratory Replicates.** All laboratory replicates marked in the Result_Lab_Replicate_ID column were excluded.
- **Disposal Site Monitoring Replicates.** A, B, and C replicates were collected from select locations during disposal site monitoring and other projects. These samples were differentiated in the Sample_ID column. Rather than averaging the results, only the A-sample was retained. The B and C replicates were excluded.
- **Multiple Samples at One Location.** Occasionally, multiple samples with the same Location_ID were collected at the same location. These samples were usually PSAMP samples and could be differentiated by Field_Activity_Start_Date. Only the most recent samples were retained.
- **Miscellaneous Replicates.** If the same parameter was analyzed multiple times at a location and no explanation for the reason, the sample was excluded.

Data from two studies were not included with the provided EIM file and were independently queried and filtered using the steps listed above. The first was from 2010 Tiered-Full Monitoring at the Port Gardner Non-Dispersive Unconfined Open-Water Dredged Material Disposal Site (SAIC 2010), and the second was from Sediment Characterization Study in Port Gardner and Lower Snohomish Estuary Port Gardner, WA (SAIC 2009).

Results for specific analytes were further reduced after the preliminary data screening. The full suite of PCB congeners were only available for four samples collected and analyzed as part of the 2010 open water disposal site monitoring. Two of these samples were removed during the spatial screening process summarized below (Table A-2).

Metals were first filtered by method. If the Result_Method column was marked UNKNOWN or left blank, the result was excluded. The remaining analytical methods were consistent with those presented in the Sediment Sampling and Analysis Plan Appendix (Ecology 2008) or those used in the current study.

All non-detects for metals were excluded. The majority of the values associated with metals non-detects were above the PQLs listed in Table 6. These deletions affected one sample in the spatially screened dataset in Table A-1 (cadmium in sample PSAMP_SP-247 was deleted).

TEQ values were calculated for cPAH compounds and dioxin/furan congeners using Ecology guidance (Ecology 2007). A concentration of one half the reported MDL/PQL was used for non-detected results. A separate TEQ was calculated using the same process, but only incorporated the non-detected results. If the non-detect TEQ made up ≥10 percent of the total TEQ, the sample was excluded. cPAH and dioxin/furan congener samples were also screened by method. Samples with methods marked UNKNOWN were excluded. For cPAH, only samples analyzed by derivations of EPA method 8270 were retained. For dioxin/furan congeners, only samples analyzed by EPA method 1613 were retained.

The final criteria for excluding data were based on the spatial distribution of existing data and the random placement of the baseline and secondary sampling locations. Existing data within 500 meters of a new baseline location were excluded. Although these samples are not presented in Tables A-1 and A-2, they may be incorporated at a later date for evaluating uncertainty in regional background concentrations in light of small-scale (<500m) field variability. Existing data within 500 meters of a secondary location were included and marked with the existing and nearby secondary location IDs. If necessary, archived sediment from the secondary location may be submitted for analysis of analytes not present at the nearby existing data location. Existing data greater than 500 meters from baseline and secondary locations were also included.

Two samples from the 2008 Port Gardner Sediment Investigation (SAIC 2009) were excluded from use as existing data despite meeting some of the above criteria. For sample A2-02, the only usable result was arsenic. For sample A2-07, the only usable result was for mercury. The remaining metals, cPAH, and the majority of dioxin/furan congeners from these samples were not detected at PQLs higher than those in Table 6.

Table A-1 presents the available existing data for arsenic, cadmium, cPAH, and dioxin/furan congeners. Table A-2 presents the existing PCB congener data.

Table A-1. Screened existing data for arsenic, cadmium, mercury, cPAH, and dioxin/furan congeners.

LocationID	CEW04480-016		PSAMP_SP-247		PSAMP_SP-55		PGP01		PGPO9		PSAMP_SP-359		DMMP-PGT15	
Date	7/21/2004	Q	6/7/2007	Q	6/12/2007	Q	6/23/2010	Q	6/24/2010	Q	6/7/2007	Q	6/29/2006	
Metals (mg/kg DW)														
Arsenic	9.35		10.4		6.93		12		10.4		9.5		--	
Cadmium	0.21		--		0.19		0.6		0.6		0.21		--	
Mercury	0.087		0.035		0.066		0.12		0.1		0.094		--	
Carcinogenic Polycyclic Aromatic Hydrocarbons (µg/kg DW)														
Benzo(a)pyrene	37		13		18		--		12	J	45		--	
Benzo(a)anthracene	32		12		18		--		10	J	33		--	
Benzo(b)fluoranthene	36		18		25		--		11	J	56		--	
Benzo(k)fluoranthene	42		6.6		10		--		11	J	23		--	
Dibenzo(a,h)anthracene	10	U	1.5	J	1.7	J	--		6	U	6.5		--	
Indeno(1,2,3-cd)pyrene	29		11		14		--		20	U	41		--	
Chrysene	46		18		28		--		15	J	51		--	
cPAH TEQ (1/2 DL)	51.86		18.09		25.15		--		16.65		61.46		--	
Dioxin/Furan Congeners (ng/kg DW)														
2,3,7,8-TCDD	--		--		--		0.352	J	0.414	J	--		0.375	J
1,2,3,7,8-PeCDD	--		--		--		0.98	J	0.806	J	--		1.08	J
1,2,3,4,7,8-HxCDD	--		--		--		1.28	BJ	0.929	BJ	--		1.01	J
1,2,3,6,7,8-HxCDD	--		--		--		4.51	BJ	3.72	BJ	--		5.4	
1,2,3,7,8,9-HxCDD	--		--		--		3.44	BJ	3.3	BJ	--		3.74	J
1,2,3,4,6,7,8-HpCDD	--		--		--		54.9	B	41.8	B	--		64.9	
OCDD	--		--		--		452	B	332	B	--		484	
2,3,7,8-TCDF	--		--		--		2.77	B	2.46	B	--		3.6	B
1,2,3,7,8-PeCDF	--		--		--		0.792	BJ	0.616	BJ	--		0.723	J
2,3,4,7,8-PeCDF	--		--		--		1.41	BJ	1.39	BJ	--		1.33	J
1,2,3,4,7,8-HxCDF	--		--		--		1.37	BJ	1.24	BJ	--		1.36	J
1,2,3,6,7,8-HxCDF	--		--		--		0.82	BJ	0.741	BJ	--		0.805	J
1,2,3,7,8,9-HxCDF	--		--		--		0.105	BJ	0.208	BJ	--		0.0868	U
2,3,4,6,7,8-HxCDF	--		--		--		0.9	BJ	0.802	BJ	--		0.944	J
1,2,3,4,6,7,8-HpCDF	--		--		--		11.3	B	8.59	B	--		14.9	
1,2,3,4,7,8,9-HpCDF	--		--		--		0.661	BJ	0.756	BJ	--		0.777	J
OCDF	--		--		--		25	B	19	B	--		29.6	
Dioxin/Furan TEQ (1/2 DL)	--		--		--		4.11		3.61		--		4.53	

U- the analyte was analyzed for but not detected **B**- analyte found in the sample and the associated blank **TEQ** – toxicity equivalency
J – the analyte was positively identified, the associated numerical value is the approximate concentration of the analyte in the sample

Table A-2. Screened existing data for PCB congeners.

LocationID		PGP01		PGP09	
Date		6/23/2010	Q	6/24/2010	Q
PCB Congeners (ng/kg DW)					
2-MOCB	PCB-001	8.53	B	9.07	B
3-MOCB	PCB-002	3.2	B	2.99	B
4-MOCB	PCB-003	5.45	B	5.86	B
2,2'-DICB	PCB-004	14.8		14.3	
2,3-DICB	PCB-005	0.349	J	0.368	KJU
2,3'-DICB	PCB-006	4.65		4.29	
2,4-DICB	PCB-007	2.1	B	1.97	BJ
2,4'-DICB	PCB-008	33.1	B	28.8	B
2,5-DICB	PCB-009	1.12	J	1.04	J
2,6-DICB	PCB-010	0.609	KDJU	0.69	UD
3,3'-DICB	PCB-011	17.5	B	14.8	B
3,4-DICB	PCB-012	4	CJ	4.05	CDJ
3,4'-DICB	PCB-013	C12		C12	
3,5-DICB	PCB-014	0.237	J	0.222	KJU
4,4'-DICB	PCB-015	30.4		24.7	
2,2',3-TRICB	PCB-016	11	D	9.95	DJ
2,2',4-TRICB	PCB-017	17	D	15.3	D
2,2',5-TRICB	PCB-018	23.9	CBD	21.4	CBD
2,2',6-TRICB	PCB-019	3.35	DJ	2.66	DJ
2,3,3'-TRICB	PCB-020	119	CBD	111	CBD
2,3,4-TRICB	PCB-021	36.7	CD	33.2	CD
2,3,4'-TRICB	PCB-022	27.2	D	25.5	D
2,3,5-TRICB	PCB-023	1.06	UD	1.07	UD
2,3,6-TRICB	PCB-024	0.463	UD	0.556	UD
2,3',4-TRICB	PCB-025	7.89	DJ	7.49	DJ
2,3',5-TRICB	PCB-026	13.6	CDJ	12.6	CDJ
2,3',6-TRICB	PCB-027	2.58	DJ	2.31	DJ
2,4,4'-TRICB	PCB-028	C20		C20	
2,4,5-TRICB	PCB-029	C26		C26	
2,4,6-TRICB	PCB-030	C18		C18	
2,4',5-TRICB	PCB-031	67.9	BD	66.3	BD
2,4',6-TRICB	PCB-032	24.8	D	22.4	D
2',3,4-TRICB	PCB-033	C21		C21	
2',3,5-TRICB	PCB-034	1.01	UD	1.02	UD
3,3',4-TRICB	PCB-035	2.74	DJ	2.22	DJ
3,3',5-TRICB	PCB-036	1.02	UD	1.03	UD
3,4,4'-TRICB	PCB-037	33.5		29.9	
3,4,5-TRICB	PCB-038	1.01	UD	1.02	UD
3,4',5-TRICB	PCB-039	1.02	UD	1.03	UD
2,2',3,3'-TECB	PCB-040	41.7	C	46.6	C
2,2',3,4-TECB	PCB-041	C40		C40	
2,2',3,4'-TECB	PCB-042	22.9		23.6	
2,2',3,5-TECB	PCB-043	2.49		2.72	
2,2',3,5'-TECB	PCB-044	79.2	CB	87.9	CB
2,2',3,6-TECB	PCB-045	10.6	C	10.5	C
2,2',3,6'-TECB	PCB-046	3.5		3.55	

LocationID		PGP01		PGP09	
Date		6/23/2010	Q	6/24/2010	Q
PCB Congeners (ng/kg DW)					
2,2',4,4'-TECB	PCB-047	C44		C44	
2,2',4,5-TECB	PCB-048	12.6		14.2	
2,2',4,5'-TECB	PCB-049	57.6	CB	61.1	CB
2,2',4,6-TECB	PCB-050	9.21	C	9.16	C
2,2',4,6'-TECB	PCB-051	C45		C45	
2,2',5,5'-TECB	PCB-052	87.3	B	96.4	B
2,2',5,6'-TECB	PCB-053	C50		C50	
2,2',6,6'-TECB	PCB-054	0.178	KJU	0.181	J
2,3,3',4-TECB	PCB-055	0.124	U	0.263	U
2,3,3',4'-TECB	PCB-056	50.9		65.3	
2,3,3',5-TECB	PCB-057	0.466	KJU	0.511	J
2,3,3',5'-TECB	PCB-058	0.61	KJU	0.604	J
2,3,3',6-TECB	PCB-059	7	C	8.03	C
2,3,4,4'-TECB	PCB-060	26.7		33.6	
2,3,4,5-TECB	PCB-061	194	CB	227	CB
2,3,4,6-TECB	PCB-062	C59		C59	
2,3,4',5-TECB	PCB-063	4.45		5.25	
2,3,4',6-TECB	PCB-064	32.5		38	
2,3,5,6-TECB	PCB-065	C44		C44	
2,3',4,4'-TECB	PCB-066	118		145	
2,3',4,5-TECB	PCB-067	3.52		3.73	
2,3',4,5'-TECB	PCB-068	1.22	J	1.09	J
2,3',4,6-TECB	PCB-069	C49		C49	
2,3',4',5-TECB	PCB-070	C61		C61	
2,3',4',6-TECB	PCB-071	C40		C40	
2,3',5,5'-TECB	PCB-072	1.63	J	1.75	J
2,3',5',6-TECB	PCB-073	0.082	U	0.0676	U
2,4,4',5-TECB	PCB-074	C61		C61	
2,4,4',6-TECB	PCB-075	C59		C59	
2',3,4,5-TECB	PCB-076	C61		C61	
3,3',4,4'-TECB	PCB-077	17.2		15.9	
3,3',4,5-TECB	PCB-078	0.112	U	0.248	U
3,3',4,5'-TECB	PCB-079	2.52	KU	2.48	
3,3',5,5'-TECB	PCB-080	0.115	U	0.249	U
3,4,4',5-TECB	PCB-081	0.585	J	0.533	KJU
2,2',3,3',4-PECB	PCB-082	18.7		20.5	
2,2',3,3',5-PECB	PCB-083	110	C	122	C
2,2',3,3',6-PECB	PCB-084	33		36	
2,2',3,4,4'-PECB	PCB-085	28.2	C	32.4	C
2,2',3,4,5-PECB	PCB-086	105	CB	115	CB
2,2',3,4,5'-PECB	PCB-087	C86		C86	
2,2',3,4,6-PECB	PCB-088	21.3	C	22.5	C
2,2',3,4,6'-PECB	PCB-089	2.09		2.1	
2,2',3,4',5-PECB	PCB-090	155	CB	172	CB
2,2',3,4',6-PECB	PCB-091	C88		C88	
2,2',3,5,5'-PECB	PCB-092	29.7		32.8	
2,2',3,5,6-PECB	PCB-093	106	CB	113	CB

LocationID		PGP01		PGP09	
Date		6/23/2010	Q	6/24/2010	Q
PCB Congeners (ng/kg DW)					
2,2',3,5,6'-PECB	PCB-094	0.694	KJU	0.779	J
2,2',3,5',6-PECB	PCB-095	C93		C93	
2,2',3,6,6'-PECB	PCB-096	0.899	J	0.815	J
2,2',3',4,5-PECB	PCB-097	C86		C86	
2,2',3',4,6-PECB	PCB-098	C93		C93	
2,2',4,4',5-PECB	PCB-099	C83		C83	
2,2',4,4',6-PECB	PCB-100	C93		C93	
2,2',4,5,5'-PECB	PCB-101	C90		C90	
2,2',4,5,6'-PECB	PCB-102	C93		C93	
2,2',4,5',6-PECB	PCB-103	2.19		2.08	J
2,2',4,6,6'-PECB	PCB-104	0.0951	U	0.067	U
2,3,3',4,4'-PECB	PCB-105	91.7	B	102	B
2,3,3',4,5-PECB	PCB-106	0.438	U	0.763	U
2,3,3',4',5-PECB	PCB-107	7.45	C	7.96	C
2,3,3',4,5'-PECB	PCB-108	C86		C86	
2,3,3',4,6-PECB	PCB-109	19.5		18.4	
2,3,3',4',6-PECB	PCB-110	167	CB	185	CB
2,3,3',5,5'-PECB	PCB-111	0.175	J	0.176	KJU
2,3,3',5,6-PECB	PCB-112	0.107	U	0.131	U
2,3,3',5',6-PECB	PCB-113	C90		C90	
2,3,4,4',5-PECB	PCB-114	4.05		4.49	
2,3,4,4',6-PECB	PCB-115	C110		C110	
2,3,4,5,6-PECB	PCB-116	C85		C85	
2,3,4',5,6-PECB	PCB-117	C85		C85	
2,3',4,4',5-PECB	PCB-118	229	B	233	B
2,3',4,4',6-PECB	PCB-119	C86		C86	
2,3',4,5,5'-PECB	PCB-120	1.11	J	1.06	J
2,3',4,5',6-PECB	PCB-121	0.121	U	0.144	U
2',3,3',4,5-PECB	PCB-122	2.66		2.67	
2',3,4,4',5-PECB	PCB-123	3.07		4.34	
2',3,4,5,5'-PECB	PCB-124	C107		C107	
2',3,4,5,6'-PECB	PCB-125	C86		C86	
3,3',4,4',5-PECB	PCB-126	0.948	J	1.02	J
3,3',4,5,5'-PECB	PCB-127	0.483	U	0.814	U
2,2',3,3',4,4'-HXCB	PCB-128	50.6	C	52.4	C
2,2',3,3',4,5-HXCB	PCB-129	292	CB	308	CB
2,2',3,3',4,5'-HXCB	PCB-130	20.3		20	
2,2',3,3',4,6-HXCB	PCB-131	3.12		3.01	
2,2',3,3',4,6'-HXCB	PCB-132	90.5		90.2	
2,2',3,3',5,5'-HXCB	PCB-133	5.1		4.52	
2,2',3,3',5,6-HXCB	PCB-134	12.8	C	13	C
2,2',3,3',5,6'-HXCB	PCB-135	78	C	78	C
2,2',3,3',6,6'-HXCB	PCB-136	25.4		25.1	
2,2',3,4,4',5-HXCB	PCB-137	8.99		8.73	
2,2',3,4,4',5'-HXCB	PCB-138	C129		C129	
2,2',3,4,4',6-HXCB	PCB-139	5.3	C	5.46	C
2,2',3,4,4',6'-HXCB	PCB-140	C139		C139	

LocationID		PGP01		PGP09	
Date		6/23/2010	Q	6/24/2010	Q
PCB Congeners (ng/kg DW)					
2,2',3,4,5,5'-HXCB	PCB-141	27.2		36.9	
2,2',3,4,5,6-HXCB	PCB-142	0.53	U	0.643	U
2,2',3,4,5,6'-HXCB	PCB-143	C134		C134	
2,2',3,4,5',6-HXCB	PCB-144	8.79		9.93	
2,2',3,4,6,6'-HXCB	PCB-145	0.136	U	0.112	U
2,2',3,4',5,5'-HXCB	PCB-146	46.9		52	
2,2',3,4',5,6-HXCB	PCB-147	207	CB	214	CB
2,2',3,4',5,6'-HXCB	PCB-148	0.692	J	0.613	J
2,2',3,4',5',6-HXCB	PCB-149	C147		C147	
2,2',3,4',6,6'-HXCB	PCB-150	0.749	J	0.586	J
2,2',3,5,5',6-HXCB	PCB-151	C135		C135	
2,2',3,5,6,6'-HXCB	PCB-152	0.193	J	0.154	KJU
2,2',4,4',5,5'-HXCB	PCB-153	271	CB	266	CB
2,2',4,4',5,6'-HXCB	PCB-154	C135		C135	
2,2',4,4',6,6'-HXCB	PCB-155	0.116	U	0.0902	U
2,3,3',4,4',5-HXCB	PCB-156	28.4	C	29.4	C
2,3,3',4,4',5'-HXCB	PCB-157	C156		C156	
2,3,3',4,4',6-HXCB	PCB-158	23.1		25.4	
2,3,3',4,5,5'-HXCB	PCB-159	2.42		2.23	
2,3,3',4,5,6-HXCB	PCB-160	C129		C129	
2,3,3',4,5',6-HXCB	PCB-161	0.365	U	0.421	U
2,3,3',4',5,5'-HXCB	PCB-162	0.892	KJU	0.804	KJU
2,3,3',4',5,6-HXCB	PCB-163	C129		C129	
2,3,3',4',5',6-HXCB	PCB-164	17.3		19.8	
2,3,3',5,5',6-HXCB	PCB-165	0.425	U	0.504	U
2,3,4,4',5,6-HXCB	PCB-166	C128		C128	
2,3',4,4',5,5'-HXCB	PCB-167	11		10.9	
2,3',4,4',5',6-HXCB	PCB-168	C153		C153	
3,3',4,4',5,5'-HXCB	PCB-169	0.36	U	0.405	U
2,2',3,3',4,4',5-HPCB	PCB-170	49.9		49.8	
2,2',3,3',4,4',6-HPCB	PCB-171	18.7	C	17.9	C
2,2',3,3',4,5,5'-HPCB	PCB-172	8.3		8.83	
2,2',3,3',4,5,6-HPCB	PCB-173	C171		C171	
2,2',3,3',4,5,6'-HPCB	PCB-174	48.4		52.1	
2,2',3,3',4,5',6-HPCB	PCB-175	2.9		2.69	
2,2',3,3',4,6,6'-HPCB	PCB-176	7.66		7.87	
2,2',3,3',4',5,6-HPCB	PCB-177	39.1		40.2	
2,2',3,3',5,5',6-HPCB	PCB-178	16.2		15.9	
2,2',3,3',5,6,6'-HPCB	PCB-179	26.9		26.4	
2,2',3,4,4',5,5'-HPCB	PCB-180	95.8	C	104	C
2,2',3,4,4',5,6-HPCB	PCB-181	0.476	J	0.637	KJU
2,2',3,4,4',5,6'-HPCB	PCB-182	0.22	U	0.146	U
2,2',3,4,4',5',6-HPCB	PCB-183	42.6	C	40.1	C
2,2',3,4,4',6,6'-HPCB	PCB-184	0.187	KJU	0.115	U
2,2',3,4,5,5',6-HPCB	PCB-185	C183		C183	
2,2',3,4,5,6,6'-HPCB	PCB-186	0.183	U	0.125	U
2,2',3,4',5,5',6-HPCB	PCB-187	101		103	

LocationID		PGP01		PGP09	
Date		6/23/2010	Q	6/24/2010	Q
PCB Congeners (ng/kg DW)					
2,2',3,4',5,6,6'-HPCB	PCB-188	0.35	KJU	0.25	KJU
2,3,3',4,4',5,5'-HPCB	PCB-189	2.63		2.32	
2,3,3',4,4',5,6-HPCB	PCB-190	9.64		9.92	
2,3,3',4,4',5',6-HPCB	PCB-191	2.23		2.13	
2,3,3',4,5,5',6-HPCB	PCB-192	0.2	U	0.125	U
2,3,3',4',5,5',6-HPCB	PCB-193	C180		C180	
2,2',3,3',4,4',5,5'-OCCB	PCB-194	30.5		35.9	
2,2',3,3',4,4',5,6-OCCB	PCB-195	13.8		13.7	
2,2',3,3',4,4',5,6'-OCCB	PCB-196	18.9		19.6	
2,2',3,3',4,4',6,6'-OCCB	PCB-197	7.85	CDJ	8.18	CDJ
2,2',3,3',4,5,5',6-OCCB	PCB-198	51.2	C	58.5	C
2,2',3,3',4,5,5',6'-OCCB	PCB-199	C198		C198	
2,2',3,3',4,5,6,6'-OCCB	PCB-200	C197		C197	
2,2',3,3',4,5',6,6'-OCCB	PCB-201	6.14		7.55	
2,2',3,3',5,5',6,6'-OCCB	PCB-202	12.7		15.5	
2,2',3,4,4',5,5',6-OCCB	PCB-203	28		32.7	
2,2',3,4,4',5,6,6'-OCCB	PCB-204	0.126	U	0.0993	U
2,3,3',4,4',5,5',6-OCCB	PCB-205	1.84	J	1.82	J
2,2',3,3',4,4',5,5',6-NOCB	PCB-206	29.2		46.8	
2,2',3,3',4,4',5,6,6'-NOCB	PCB-207	4.24	KDJU	10.2	DJ
2,2',3,3',4,5,5',6,6'-NOCB	PCB-208	11	D	24.4	D
2,2',3,3',4,4',5,5',6,6'-DECB	PCB-209	29.5		267	
PCB Total TEQ (1/2 DL)	--	0.113		0.121	
Total PCBs	--	4390		4911	

C/C180 – the C indicates the congener co-elutes as a congener pair, if the C is followed by a number the results are reported with the congener pair
U- the analyte was analyzed for but not detected
J – the analyte was positively identified, the associated numerical value is the approximate concentration of the analyte in the sample
B- analyte found in the sample and the associated blank
K – identifies a target that could not be confirmed by virtue of not satisfying all method required criteria, the reported value may be interpreted as an estimated maximum analyte concentration
TEQ – toxicity equivalency

Appendix B. Field Forms

Appendix C. Health and Safety Plan

Port Gardner Bay Regional Background Sediment Characterization, Everett, WA

Health and Safety Plan

Prepared for:

Washington State Department of Ecology
Toxics Cleanup Program
300 Desmond Drive
Lacey, Washington 98504

Prepared by:

NewFields
115 2nd Avenue North, Suite 100
Edmonds, Washington 98020

February 2013

1.0 Introduction

This Site-Specific Health & Safety Plan (HASP) has been developed as part of the Port Gardner Bay Regional Background Sediment Characterization. This plan is intended to incorporate sampling activities in support of the bay-wide sediment collection effort, and should be revised if the scope of work is changed.

The procedures and protocols in this plan have been established to ensure that a mechanism is in place to address project personnel in the event that hazards from field work or site contamination are encountered during the project. This plan addresses typical on-site activities such as collection of contaminated sediment samples and marine vessel use. This HASP is not designed to replace existing procedures or to address all health and safety procedures that could be required during typical emergency response activities.

Compliance with this HASP is required from all authorized NewFields project personnel, project support personnel, and visitors who enter the work areas of this project. No field work will be conducted without meeting the requirements of this HASP.

The content of this HASP may change or undergo revision based upon unexpected field conditions, modifications to the technical scope of work or additional information made available to health and safety (H&S) personnel. Any proposed changes must also be reviewed and approved by designated NewFields personnel.

1.1 Project Location

Project field work will be conducted in Port Gardner Bay, WA. All sediment sampling activities will be conducted aboard the R/V *Kittiwake*, embarking and disembarking from the Everett marina area.

1.2 Personnel and Emergency Contact Information

Table 1 lists relevant project personnel and local emergency contact information. Additional detailed emergency information is found in Section 6.0 along with written hospital directions and accompanying maps.

All project personnel, project support personnel, and visitors present during field work must sign in the space provided in Table 1 prior to initiating project work. A signature below indicates commitment to implement this plan and to ensure that project fieldwork is conducted safely. A signature below also indicates review and approval of the plan and agreement that the anticipated hazards are correct and that planned hazard controls are sufficient.

Table 4. Project Personnel and Local Emergency Contact Information

Project Personnel		
Project Manager, Tim Hammermeister		(206) 890-8667
Field Manager, Will Hafner		(425)-318-0420
Health and Safety Officer, Preston Martin		(206) 962-0214
WDOE, Chance Asher		(360) 407-6914
Emergency Contact Information		
Emergency or Everett Police Department		911 or (425) 257-8700
Fire Department Everett Fire Department (EFD)		911 or (425) 257-8700
Ambulance		911
Hospital: Providence Regional Medical Center Everett 1800 13th Street Everett, WA 98201		(425) 261-2000
U.S. Coast Guard		(360) 417-5800
National Response Center (NRC) for Oil/Chemical Spills		(800) 424-8802
Poison Control Center		(800) 222-1222
Name	Signature	Date

2.0 Health and Safety Personnel

The following briefly describes the health and safety designations and general responsibilities for this project.

2.1 Project Manager – NewFields

The Project Manager or designee has overall executive responsibility for all activities and personnel on the site during all project activities described in this HASP.

2.2 On-Site Health and Safety Officer

The HSO is responsible for the development of safety protocols and procedures, pursuant to the all hazardous aspects of this project, implementation and enforcement of this HASP. The HSO has the authority to modify this HASP based on actual site working conditions and procedures. The HSO will also be responsible for the resolution of any outstanding health and safety issues which arise during the conduct of site work.

Health and safety-related duties and responsibilities will be assigned only to qualified individuals by the HSO. The HSO has stop-work authorization, which will be executed upon determination of an imminent safety hazard, emergency situation, or other potentially dangerous situation, such as extreme weather conditions. An Authorization to Proceed with work will be issued by the HSO after such action. The HSO or designee will initiate and execute contact with support facilities and personnel when this action is appropriate. The HSO may periodically conduct QA/QC surveys of the health and safety procedures implemented onsite.

3.0 Site and Project Description

Port Gardner Bay is an approximately 18 square mile coastal embayment located within Possession Sound, an extension of Puget Sound near Everett, WA. The bay is protected from oceanic swells entering from the Strait of Juan de Fuca, while limited fetch and terrain restricts the growth of local wind waves to less than 3 feet for all but gale conditions. Local weather patterns are generally characterized by daily sea breeze formation throughout the summer months, which transition to southerly wind and the passage of frontal systems from late-fall through spring. Water depths within the bay range from intertidal near the mouth of the Snohomish River, to ~600 feet along the SW extent of the embayment. Circulation within the bay is generally weak and variable, with mixed semi-diurnal tides having a mean diurnal range of 11 feet. The Snohomish River delta is a dominant feature within the bay, acting as a large source of sand and suspended sediment north of the Port of Everett. Distributary channels and shoaling areas of the delta may represent navigational hazards, but are not being targeted for this study.

The current investigation will involve sediment chemistry collection throughout the Bay to determine regional background concentrations of the analytes of concern.

3.1 Scope of Work

Under direction of the Washington Department of Ecology (Ecology), NewFields will conduct a sediment chemistry evaluation at several locations throughout the bay. The objective of the study is to evaluate the Regional Background sediment concentrations of selected bioaccumulative contaminants for Port Gardner Bay. Sediment sampling is proposed at 45 locations in Port Gardner Bay. A more detailed description of the scope of work and maps of the sample locations can be found in the Sampling and Analysis Plan (SAP).

3.1.1 Sediment Sampling

Surface sediment samples will be collected for chemical analyses using a dual van Veen grab sampler deployed from the R/V *Kittiwake*, operated by Charles Eaton of Bio-marine enterprises. Hazards associated with grab sampling are primarily physical in nature. Slipping/tripping hazards are present on the sampling vessel when the deck is wet. There are numerous pinch points on the sampling equipment as well as the vessel itself. All personnel will be trained in the operation and deployment of the field gear, and will receive a vessel-specific safety briefing from Charles Eaton, owner and operator of the R/V *Kittiwake*. All members of the sampling crew will wear slip-resistant boots, safety glasses, nitrile gloves, personal flotation devices (PFDs).

Sediment samples will be processed on deck once the vessel is repositioned to minimize pitch and roll. The sediment will be subsampled for chemistry analysis using a stainless steel spoon and pre-cleaned laboratory jars. All sampling equipment will be cleaned according to decontamination procedures outlined in the SAP. Sampling and decontamination includes potential contact with bottom sediments and decontamination chemicals.

4.0 Hazard Assessment

This section summarizes hazards that may exist during project related tasks.

4.1 Task Specific Hazard Assessment

For the field sampling tasks described in Section 3, the overall hazard level is low. Hazards encountered during this sampling program are due to physical safety hazards associated with the field operations. Types of potential hazards associated with the field sampling effort are summarized in Table 2. Potential hazards while working at the site include, but are not limited to, the following:

- Physical hazards from use of sampling equipment and operations on a vessel and beach areas
- Physical hazards from working conditions (e.g., slips/trips/falls, drowning, hypothermia).
- Physical hazards from operating a motor vehicle to transit to and from the work site.

As described below, protective equipment and safe working procedures will help prevent accidents caused by these hazards. Exposure to harmful microbial organisms or other organisms in the sediments is not expected during this program.

Table 2. Sediment Sampling – Types of Potential Hazards

Physical Hazards			
Name of Physical Hazard	**Source**	**Exposure Level/ Potential**	**Exposure Limit**
Boating Operations	boat deck	Likely	N/A
Heat (ambient)	sun	Unlikely	N/A
Cold Weather Operations	boat deck area	Likely	N/A
Heavy Manual Lifting/Moving	van Veen grab	Likely	N/A
Slips/Trips/Falls	boat deck area	Likely	N/A
Inclement Weather – Snow, rain	boat deck area	Likely	N/A
Material Handling	sediment	Likely	N/A
Vehicular Travel	van shuttle	Likely	N/A
Working Over Water	boat deck area	Likely	N/A
Biological Hazards			
Name of Biological Hazard	**Source**	**Exposure Level/ Potential**	**Exposure Limit**
Insect bites and stings	Boat launch area	Unlikely	N/A

Control Measures Used	
Engineering Controls:	
Level of PPE: D	
Location: on boat deck, stream/intertidal	**PPE Equipment:** Chemical-resistant steel toe boots or waders, PVC Bib-style overalls (and jacket with hood as necessary), splash-proof safety goggles, nitrile gloves, PFD Type III. Cold-weather clothing and insulated gloves are recommended.
Work Practices:	Frequent changes of disposable nitrile gloves Wash hands and face with soap and water after each sampling event Take shower at end of workday

NA = Not applicable.

4.2 Physical Hazards

The following is a general discussion of the hazards that may be encountered on site. Information on any contaminants encountered during this project may be found in standard health and safety references, such as the NIOSH "Pocket Guide to Chemical Hazards." Internet site: http://www.cdc.gov/niosh/npg/npg.html

4.2.1 Sampling Vessel Operations

The physical hazards associated with the deployment and retrieval of sampling equipment result from their weight and the method of deployment. Only appropriate personnel whose presence is required will be deploying and retrieving sampling gear. Under circumstances of potentially dangerous waves or winds, the sampling leader will employ best professional judgment to ensure safe field operations.

To avoid injuries from slipping on wet surfaces, rubber boots or waders with appropriate tread will be worn when working on the work deck or loading/unloading heavy equipment from the vessel. No overhead gear will be deployed, however, hard hats will be worn if overhead hazards exist. Sample handling equipment, containers, and deck lines, not in immediate use will be kept clear of walkways and work areas until needed. Each time operations at a given location have been completed, excess sediment on the deck will be washed overboard to prevent slipping, minimize personnel exposure to potentially contaminated sediment, and limit cross-contamination between sample locations.

Life vests will be provided for and worn by all personnel working on the deck, or as directed by the Site Safety Officer or vessel operator.

In a man overboard situation, sampling personnel will immediately notify the captain, while a designated person maintains constant visual contact with the victim. A life ring will be available to throw to the victim, while other buoyant materials may be thrown into the water to assist with the return and recovery of the victim. The captain will inform the sampling crew of vessel-specific hazards and safety procedures on the first day of sampling operations.

4.2.2 Motor Vehicle Operation

Motor vehicles will be used to transport field personnel, equipment, and supplies to the sampling sites or laboratories. Only sampling team personnel with valid driver’s licenses and liability insurance (per local state laws) will operate motor vehicles required for work activities. All field staff will use best professional judgment at all times to ensure safe operation of motor vehicles, including:

- Operators are to practice defensive driving and drive in a courteous manner
- Be aware of pedestrians and give them the right-of-way
- All vehicles are to be operated in a safe manner and in compliance with statutory traffic regulations and ordinances
- Verifying safety seat belts are in proper operating order
- Seat belts are to be worn by the driver and all passengers whenever the vehicle is in motion
- No persons are allowed to ride in the back of any vehicles, unless equipped with seatbelts
- Vehicles are to be driven in conformance with local speed limits
- Avoid excessively long driving periods

- Personnel who are impaired by fatigue, illness, alcohol, illegal or prescription drugs, or who are otherwise physically unfit, are not allowed to drive
- Personnel are to avoid using cellular phones or engaging in other distractions while driving
- Motor vehicle accidents are to be reported to the responsible law enforcement agency, the NewFields manager, and the NewFields HSO.

4.2.3 Weather

If severe weather occurs that may affect the safety of site workers, the NewFields PM or their designee shall stop affected field operations. The PM or their designee will resume operations when weather conditions improve to acceptable levels.

4.2.4 Heat and Cold Stress

Depending on the time of year and weather conditions, cold or heat stress may be a potential problem. The PM will ensure that the heat and cold stress programs are implemented and that adequate rest breaks and liquid (i.e., water, Gatorade) consumption occur.

Proposed work/rest schedules will be dependent upon the weather conditions encountered and the level of personal protective equipment being utilized by on-site personnel. The PM or designee will establish work/rest schedules prior to the commencement of the project tasks and will adjust as needed.

4.2.5 Illumination

If work activities occur before sunrise and/or after sunset, lighting will be provided at each work area to meet the requirements of 29 CFR 1910.120(m). The Standard states that while any work is in progress, the general site areas shall be lighted to not less than 5 foot-candles; excavation, waste areas, access ways, active storage areas, loading platforms, and field maintenance areas shall be lighted to not less than 3 foot-candles; and first aid stations not less than 30 foot-candle.

4.2.6 Slip, Trip and Fall Hazards

As in any work area, it is expected that the ground may be uneven, the surface may be unreliable due to surface evenness, debris may be present, work is being performed on poly sheeting, and wet or muddy areas may exist. Therefore, the potential for slipping, tripping, and falling is present, especially considering that encapsulating suits and respiratory protection will which can impede vision. Severe trip hazards will be identified prior to commencement of project activities and demarcated by flags or caution tape.

4.2.7 Manual Lifting

Manual lifting of heavy objects such as coolers with samples may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers will be instructed to use power equipment to lift heavy loads whenever possible and to evaluate loads before trying to lift them (i.e. they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques, 1) make sure footing is solid, 2) make back straight with no curving or slouching, 3) center body over feet, 4) grasp the object firmly and as close to your body as possible, 5) lift with legs, and 6) turn with your feet, don't twist, will be stressed. Back injuries are a serious concern as they are the most common workplace injury, often resulting in lost or restricted work time, and long treatment and recovery periods. In addition, hand digging for pipes may present lifting/ergonomic hazards.

4.2.8 Other Physical Hazards

Incorporating the following basic safety procedures can prevent many of the most common causes of injury or accident during field sampling:

- Implement good housekeeping practices, including immediate cleanup of spills and safe storage of all materials. All equipment or materials not in immediate use will be removed from the immediate work area.
- Use proper lifting and moving techniques to prevent back or muscle strain or injury. Any heavy equipment, boxes, coolers etc. should be tested before lifting and if it is too heavy, the equipment should be broken into smaller components or assistance requested. Lifting should be done with the legs, not the back.
- Use extra caution when handling sharp tools or sampling devices and when possible, wear protective gloves.

4.2.9 Biological Hazards

The project location and timing of proposed fieldwork is such that risks from biological hazards are low.

5.0 Work Clothing and Levels of Personnel Protection

The PM or designee will recommend appropriate levels of protective clothing to be worn in the event that hazardous materials are encountered The sediment and water field sampling activities described in this site-specific HASP will be performed in Level D or modified Level D PPE, as specified in Table 2. If site conditions include hazards that exceed the protection of Level D or modified Level D PPE, work will be halted and personnel will immediately exit the area while site conditions and PPE levels are re-evaluated by the Site Supervisor and HSO.

Definition of Levels of Protection:

Level D:
Work coveralls
Gloves
Appropriate work boots
Hardhat (if overhead gear is present)
Safety glasses with side shields or splash goggles as needed
A respirator is not required.

Level C:
Chemical-resistant disposable coveralls
Chemical-resistant outer gloves
Chemical-resistant inner gloves
Appropriate leather work boots with chemically resistant outer boots or chemically resistant rubber boots
Hardhat
Full or Half face, Air Purifying Respirator (APR) with combination HEPA - P,O,N 100 (dusts, fumes, aerosols) and chemical cartridge as appropriate for hazard.

Level B:
Chemical-resistant disposable coveralls
Chemical-resistant outer gloves
Chemical-resistant inner gloves
Appropriate leather work boots with chemically resistant outer boots or chemically resistant rubber boots
Hardhat
Supplied air - air line or self-contained breathing apparatus (SCBA).

Level A:
Fully encapsulating chemical-resistant/gas tight suit
Attached chemical-resistant outer gloves
Chemical-resistant inner gloves
Attached chemical-resistant boots.
Self-contained breathing apparatus.

5.1 Donning and Doffing

Manufacturers procedures for donning and removing PPE ensembles will be followed in order to prevent damage to PPE, reduce and eliminate migration from the work area and a transfer of contaminants to the wearer's body or others.

5.2 Storage and Inspection

Protective equipment will be stored and maintained in the company vehicles on site or in the work trailer. Items such as gloves, protective suits, and hearing protection will be kept within a suitable storage area. Table 3 lists PPE storage and cleaning procedures.

Employees are responsible for inspecting personal protective equipment prior to donning, during use and at the end of the shift. Defective equipment shall be removed from service and reported to the PM. All reusable equipment will be maintained in a sanitary condition, in accordance with the manufacturer's recommendations.

Table 3. Level D Storage and Cleaning Procedures.

Level D Storage Procedures: In the Field laboratory, decontamination solutions such as nitric acid, methanol and acetone will be stored in dedicated cabinets and the outside doors labeled with flammable and acid labels respectively. Alconox soap powder does not require special storage and will be placed on a shelf. Any plastic containers containing Alconox will be labeled as such.
Level D Cleaning Procedures: Cleaning procedures for PPE require that hard hats, nitrile gloves, rain gear, boots, and personal floatation devices be brushed thoroughly with a solution of Alconox and rinsed with tap water after each sampling event.

6.0 Emergency Plan

Emergency situations can be characterized as an accident or injury to the field personnel. Emergency phone numbers are listed in Section 1 of this Health and Safety Plan. In case of emergency, it is important that the following Incident Reporting Procedure be observed:

It is important to assure the rapid and accurate transfer of information appropriate personnel in the event of an emergency situation. To simplify the procedure, emergency situations can be reported by dialing 911. This includes incidents requiring police assistance, fire department, or medical emergencies.

Be sure to provide the following information to the dispatcher:

1. Caller full name
2. The nature of the incident (i.e. "Fire")
3. The location of the incident (i.e., "Street location and nearest intersection”), the more specific the better.
4. What you need (i.e. "Fire Department and First Aid")
5. If you are able, where you will meet emergency responders (i.e. At end of West Street, near train tracks)
6. If applicable, a call back number or your cell phone number (e.g., "I'll be at the scene; my cell phone number is 123-4567").
7. Status of the situation. (e.g., is the situation stabilized or “I have the fire under control”)
8. If anyone is injured or in need of emergency assistance (e.g., "A mechanic working on a pump was burned.")

6.1 Site Emergency Coordinator

Site Emergency Coordinator: Preston Martin (HSO)

6.2 Personnel Injury

In the event of an emergency situation, the local emergency response group will be called. In case of a life-threatening situation, emergency first aid may be applied on-site as deemed necessary. The individual should be cleaned up and/or decontaminated and then transported to the nearest medical facility if needed.

The local rescue squad shall be contacted for transport as necessary in an emergency. Since some situations may require transport of an injured party by other means, transportation by automobile may be required.

6.3 Personnel Exposure Treatment

SKIN CONTACT: Use copious amounts of soap and water. Wash and/or rinse affected area thoroughly, then provide appropriate medical attention. Eyes should be thoroughly rinsed with water for at least 15 minutes.

INHALATION: Move to fresh air and, if necessary, decon/transport to hospital.
INGESTION: Decontaminate and transport to emergency medical facility.
PUNCTURE WOUND OR LACERATION: Decontaminate, if possible, and transport to emergency medical facility.

6.4 Hospitals

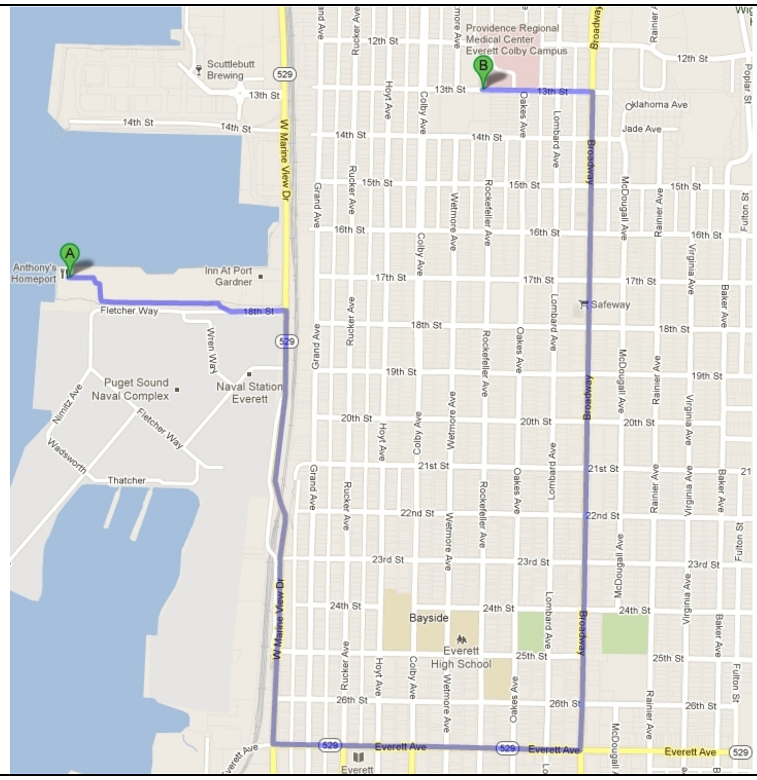
The following map and table show the location and driving directions to the nearest hospital.

Table 5. Nearest Hospital to Port Gardner Bay moorage site.

Providence Regional Medical Center
1726 W Marine View Dr.
Everett, WA 98201

General: (425) 261-2000
Emergency: (425) 261-3024

1) From Anthony's Homeport parking lot, head east on 18th St.
2) Turn right onto W Marine View Dr.
3) Take the 3rd left onto Everett Ave.
4) Turn left onto Broadway.
5) Turn left at WA-303S/NW Waaga Way.
6) Turn left onto 13th St.
7) The Cymbaluk Medical Tower will be on the left.



Note: For non-emergency treatment, an urgent care walk-in clinic is located nearby:

The Everett Clinic (Gunderson Building)
3927 Rucker Ave.
Everett, WA 98201

Appendix D. Background Memo

To be provided under separate cover by February 19, 2013.