Sediment Characterization Study in Port Gardner and Lower Snohomish Estuary Port Gardner, WA

Combined Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP)

FINAL

Prepared for

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Toxics Cleanup Program
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List of Acronyms

COC	constituent of concern
CSL	contaminant screening level
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FM	Field Manager
GPC	gel permeation chromatography
GPM	Government Project Manager
HPAH	high molecular polynuclear aromatic hydrocarbon
HSP	Health and Safety Plan
LAET	lowest apparent effects threshold
LCS/LCSD	laboratory control sample/laboratory control sample duplicates
LPAH	low molecular polynuclear aromatic hydrocarbon
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
NAD83	1983 North American Datum
OSI	organism-sediment index
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pg	picogram
PPE	personal protective clothing
PSEP	Puget Sound Estuary Program
PSI	Puget Sound Initiative
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
REMOTS	Remote Ecological Monitoring of the Seafloor
RPD	redox potential discontinuity
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SMARM	Sediment Management Annual Review Meetings
SMS	Sediment Management Standards
SPI	sediment profile imaging
SOP	standard operating procedure
SQS	Sediment Quality Standard
SVOC	semi-volatile organic compound
TCDD	2,3,7,8-Tetrachlorodibenzo-p-Dioxin
TEF	toxic equivalent factor
TEQ	toxic equivalent quotient
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
WAC	Washington Administrative Code
WHO	World Health Organization

1.0 Introduction

Port Gardner and the lower Snohomish River Estuary (referred to as Port Gardner) are identified under the Toxics Cleanup Program's Puget Sound Initiative (PSI) for focused sediment cleanup and source control (Figure 1–1). Previous environmental investigations in the area have measured sediment chemical concentrations that have exceeded Sediment Management Standards (SMS), according to Chapter 173-204 Washington Administrative Code (WAC). However, much of the data are outdated and many areas of suspected contamination are not well characterized (Science Applications International Corporation [SAIC] 2008a). The purpose of this combined Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) is to present a work plan for conducting a sediment investigation to characterize the current sediment quality of Port Gardner. The objectives of the study are to:

1. Determine the overall nature and extent of sediment contamination in Port Gardner,

2. Evaluate the potential sources of contaminants in sediments, including potential source identification, and

3. Provide a scale of priority for areas providing the greatest return in restored ecological values and function upon cleanup.

The SAP/QAPP for this study was prepared in accordance with the requirements outlined in WAC 173-340-820. Analytical procedures are also identified in the SAP/QAPP in accordance with WAC 173-340-830.

1.1 Site Description

Port Gardner is an embayment of Puget Sound's Whidbey Basin, bounded to the east by the City of Everett (Figure 1–1). 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. The Snohomish River estuary additionally consists of a series of interconnected sloughs that flow through the lowlands east and north of the river's main channel. These waterways can experience tidal influence as far as 20 miles upstream.

The fluvial sediment load of the Snohomish River maintains mudflats and tidal marshlands in the estuarine delta and is deposited throughout the deeper portions of Port Gardner Bay. The extensive tide flats and sloughs provide important habitat for the spawning and rearing of forage fish (e.g., Pacific herring, surf smelt, and sand lance) and the migration of juvenile salmonids. However, dikes and other forms of tidally-restrictive structures emplaced for agricultural development caused the loss of considerable wetland habitat throughout the estuary. The waterfront of the City of Everett is heavily industrialized, and tideland filling, shoreline armoring, and over-water structures are present throughout the region.

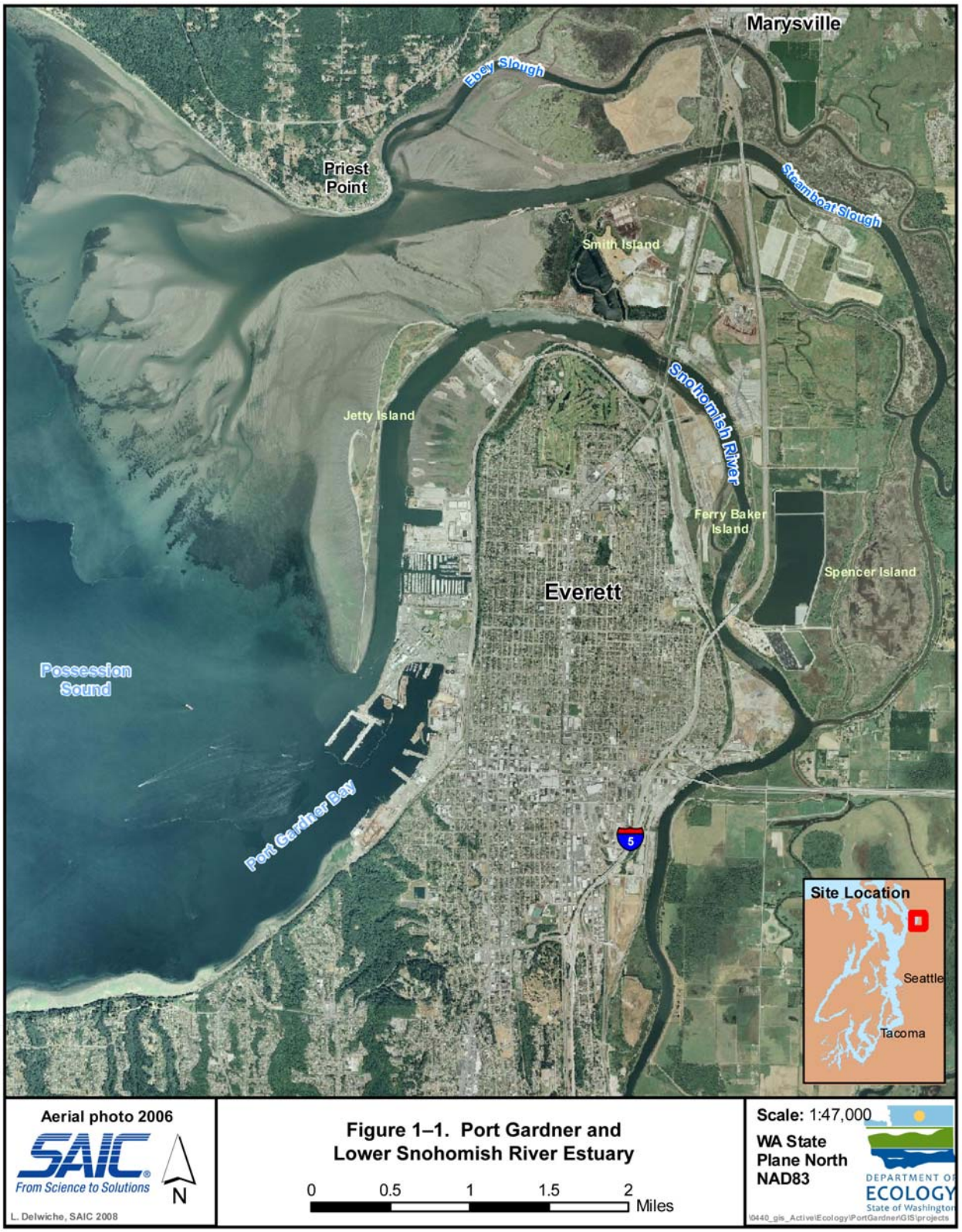

Figure 1–1. Port Gardner and Lower Snohomish River Estuary

1.2 Site History

The Port Gardner Data Gaps Report provides a detailed description of the site, operational history, and summary of previous investigations (SAIC 2008a). Port Gardner 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, polynuclear aromatic hydrocarbons (PAHs), metals, miscellaneous extractables, pesticides, phenols, and phthalates at levels exceeding current SMS criteria at numerous locations throughout Port Gardner. The most extensive contamination has been identified within the East Waterway (Figure 1–2), which has historically been dredged with subsequent sediment disposal at the Dredged Material Management Program (DMMP) open-water dredged material disposal site in Port Gardner Bay. Only sediments that are determined suitable for open-water disposal (i.e., pass DMMP screening level criteria; U.S. Army Corps of Engineers [USACE] 2003) are allowed for disposal at the DMMP site.

Ten sites within the region have recently been identified as PSI sites for focused sediment cleanup and source control (Figure 1–3). Currently the lower Snohomish River Estuary is home to numerous sites of environmental remediation projects focused on tideland recovery and habitat restoration (Figure 1–3).

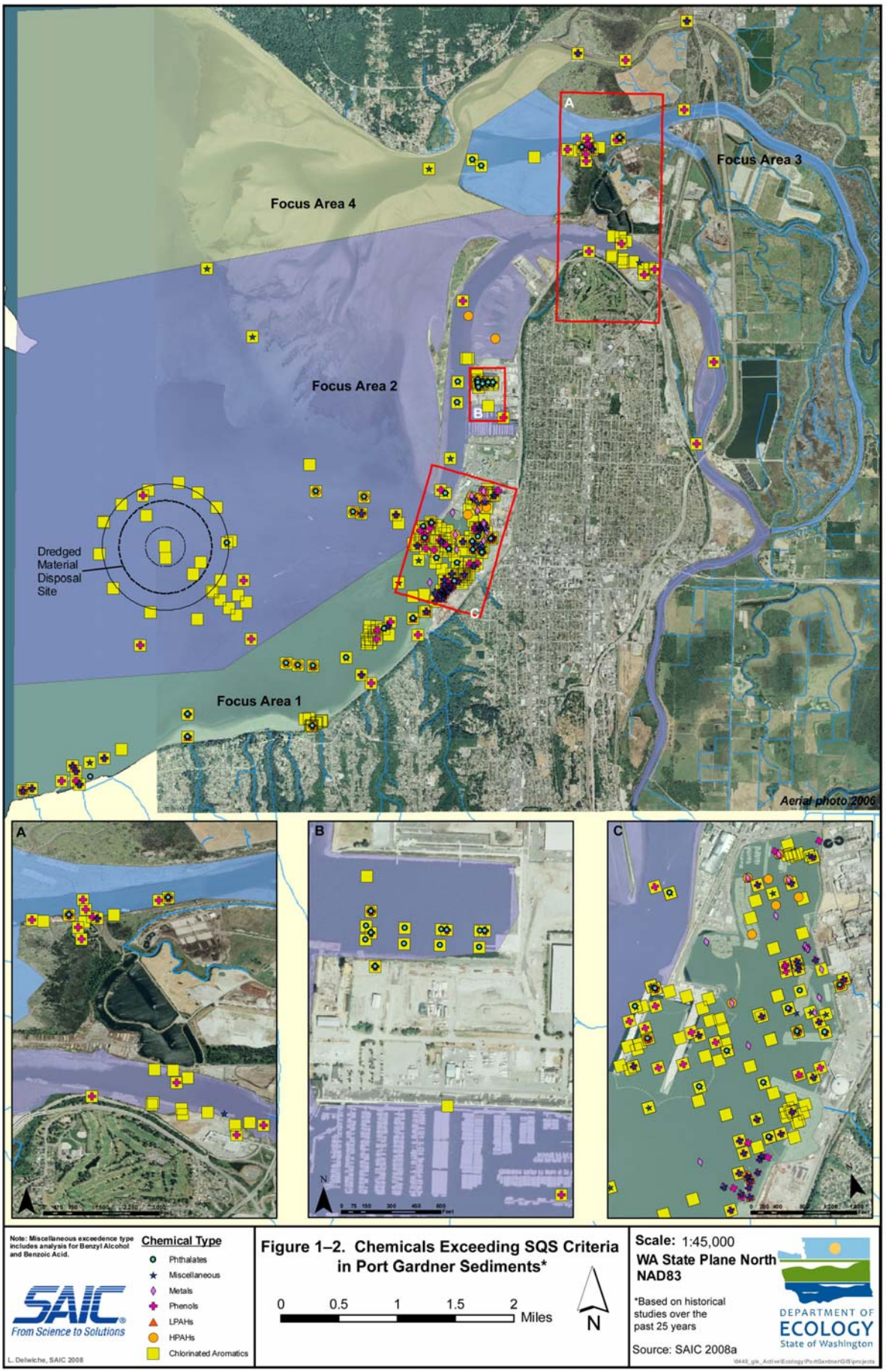
Focus Area 4
Focus Area 3
Focus Area 2
Focus Area 1
Dredged Material Disposal Site
A
B
C
Aerial photo 2006
Note: Miscellaneous exceedence type includes analysis for Benzyl Alcohol and Benzoic Acid.
Chemical Type
Phthalates
Miscellaneous
Metals
Phenols
LPAHs
HPAHs
Chlorinated Aromatics
SAIC
From Science to Solutions
L. Delwiche, SAIC 2008
Figure 1–2. Chemicals Exceeding SQS Criteria in Port Gardner Sediments*
0 0.5 1 1.5 2 Miles
N
Scale: 1:45,000
WA State Plane North
NAD83
*Based on historical studies over the past 25 years
Source: SAIC 2008a
DEPARTMENT OF ECOLOGY
State of Washington

Figure 1–3. Puget Sound Initiative Cleanup and Habitat Restoration Sites in Port Gardner

1.3 Project Scope and Objectives

The scope of this Sediment Investigation SAP/QAPP is limited geographically to the aquatic areas of Port Gardner Bay, the lower Snohomish River, Steamboat Slough, and Ebey Slough. The study area is divided into four Focus Areas as shown in Figure 1–4. Focus Area 1 consists of East Waterway and the southern portion of Port Gardner Bay within approximately 0.7 mile of the southern shoreline. Focus Area 2 comprises the central Port Gardner Bay and the lower Snohomish River's main channel, extending approximately 9 miles upstream from the river mouth. Focus Area 3 encompasses approximately 6 miles of Steamboat Slough, from its divergence from the Snohomish River at the southern tip of Spencer Island to its mouth in northern Port Gardner Bay. Focus Area 4 consists of the lower 5 miles of Ebey Slough and northern Port Gardner Bay.

The purpose of this SAP/QAPP is to describe the manner and methods by which data collection efforts will be performed to characterize the sediment quality of Port Gardner. The results of the sediment characterization will inform the prioritization of cleanup and restoration actions under the PSI. This sediment investigation will encompass the following project objectives:

- Conduct an intensive sampling and analysis effort to characterize the overall nature and extent of sediment contamination in Port Gardner.
- Collect, process, and analyze representative sediment data to characterize the site in accordance with protocols, timing, and quality assurance/quality control (QA/QC) requirements outlined by Washington State SMS protocols, Puget Sound Estuary Program (PSEP) protocols, and subsequent Sediment Management Annual Review Meetings (SMARM) updates.
- Compare the sediment chemistry results to Washington State Sediment Management Standards (SMS), Sediment Quality Standards (SQS), and Cleanup Screening Levels (CSL).
- Analyze for dioxins/furans in sediments so the Washington State Department of Ecology (Ecology) can evaluate the dioxin/furan concentrations relative to human health and ecological health concerns. Analysis of dioxins/furans will follow United States Environmental Protection Agency (USEPA) Method 1613B for 2-, 3-, 7-, 8-substituted chlorinated dioxins and furans. Tissue collection and analysis may also be conducted to assess the uptake of dioxins/furans in ecological receptors, if warranted.
- Conduct a suite of sediment toxicity tests on synoptic surface sediment samples that exceed the SQS chemical criteria. The suite of toxicity tests will include a larval development bioassay, an amphipod mortality bioassay, and a juvenile polychaete growth bioassay.
- Collect subsurface sediment cores to determine the vertical extent of woody debris and potential contamination through chemical analysis.
- Perform a subsurface video probe survey to determine the vertical variation in sediment physical characteristics and the extent of sedimentary woody debris accumulation.
- Conduct a sediment profile imaging survey to determine the physical conditions of the bottom substrate and benthic habitat types.
- Collect fish, shellfish, and plant tissue for archival and residue analysis for bioaccumulative compounds measured in sediments.

Figure 1–4. Port Gardner Sediment Characterization Study Focus Areas

1.4 Project Team and Responsibilities

SAIC and its subcontractors will implement the SAP/QAPP under the direction of Ecology. The following sections describe the key roles and responsibilities of the project team.

1.4.1 Project Planning and Coordination

Russ McMillan 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. John Nakayama will serve as the SAIC project manager and be responsible for executing the approved SAP/QAPP, overseeing the collection and analysis of field samples, and reporting analytical results.

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1.4.2 Sample Collection

Leon Delwiche of SAIC will serve as field manager (FM) responsible for collecting and processing samples in accordance with the SAP/QAPP, and transporting samples to the analytical and biological laboratory for analysis and testing. The FM will ensure accurate station positioning and reporting.

1.4.3 Laboratory Sample Preparation and Analysis

Will Hafner of SAIC 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.

1.4.4 QA/QC Management

Tim Hammermeister will serve as the SAIC 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.

1.4.5 Health and Safety Manager

John Nakayama will serve as the designated SAIC 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).

1.4.6 Subcontractor Support

The SAIC project team will consist of the following subcontractors to support the data collection activities and laboratory analytical services:

- Data Collection and Biological Testing

  NewFields
  Jack Word
  P.O. Box 216
  4729 NE View Drive
  Port Gamble, WA 98364
  Phone: (360) 297-6060
  Fax: (360) 297-7268
  mailto:jqword@newfields.com

- Analytical Chemistry (SMS Parameters)

  Analytical Resources, Incorporated
  Susan Dunnihoo
  4611 South 134th Place
  Tukwila, WA 98166
  Phone: (206) 695-6200
  mailto:sue@arilabs.com

- Dioxin/Furan Congener Analysis

  Axys Analytical Services, Ltd.
  Cynthia Tomey
  2045 Mills Road
  Sidney BC V8L 3S8
  CANADA
  Phone: (250) 655-5801
  Fax: (250) 655-5811
  mailto:ctomey@axys.com

- Sampling Vessels

  Sediment Core Collection and Video Probe Activities

  Marine Sampling Systems
  R/V Nancy Anne
  Bill Jaworski
  Phone: (253) 208-1515
  Fax: (253) 857-3336
  mailto:msampling@aol.com

Sediment Profile Imaging, Bottom Trawling, and Surface Sediment Grab Collection

Bio-Marine Enterprise
R/V Kittiwake
Charles Eaton
2717 3rd Ave. N
Seattle, WA 98109
Phone (206) 282-4945
cmeaton@msn.com

1.4.7 Schedule

The proposed schedule for field activities is a 3-week period between July 28 and August 15, 2008, for Phase I of the project, and October 6 and 7, 2008, for Phase II (Table 1-1). The draft data report will be submitted to Ecology on January 12, 2009, and the final data report will be completed 14 days following receipt of comments.

Table 1–1. Proposed Port Gardner Sediment Characterization Schedule

Field Activity	Vessel	Date
Phase I Field Program		
SPI Survey	R/V *Kittiwake*	July 28–31, 2008
Surface Sediment Grab Sampling	R/V *Kittiwake*	August 1, 4–7, 2008
Trawl Sampling	R/V *Kittiwake*	August 8, 2008
Video Probe Survey	R/V *Nancy Anne*	August 11–12, 2008
Subsurface Core Sampling	R/V *Nancy Anne*	August 13–14, 2008
Phase II Field Program		
Surface Sediment Grab Sampling	R/V *Kittiwake*	October 6, 2008

2.0 Study Design

This section describes the study design for each data type to be collected for the Port Gardner Sediment Investigation. Figures 2–1 through 2–3 present the proposed sampling locations for each data type. Section 3.0 describes the data collection methods. Port Gardner sampling will be completed during two sampling events. The bulk of sampling will occur during Phase I, including sediment profile imaging, subsurface video probing, surface sediment grab sampling, subsurface sediment coring, and fish and shellfish tissue sampling (Table 2–1). The Phase II sampling event will occur approximately 2 months following the Phase I event. During Phase II, a second set of surface sediment samples will be collected at selected locations for bioassay testing. The location of these samples will be determined based on the chemical results from Phase I (e.g., chemical concentrations exceeding SMS standards). Plant tissues will also be collected in Focus Area 4 in coordination with the Tulalip Tribe.

2.1 Sediment Profile Imaging

The initial component of the investigation will be to conduct an area-wide survey using a digital sediment profile imaging (SPI) camera. SPI photography provides a cross-sectional photograph of the sediment/water interface (in profile) and near-surface sediment. Information from the SPI survey will be used to refine the sampling locations for the other data types (Sections 2.2 through 2.4). A total of up to 101 locations will be surveyed using the SPI camera: 47 locations in Focus Area 1, 38 locations in Focus Area 2, 8 locations in Focus Area 3, and 8 locations in Focus Area 4 (Figure 2–1).

The SPI survey will be used to assess the condition of the benthic habitat and the physical characteristics of the surface sediment. Parameters measured or determined using the images include:

- Infaunal successional stage,
- Calculation of the organism-sediment index (OSI),
- Depth of apparent redox potential discontinuity (RPD),
- Presence and thickness of depositional layers,
- Grain size mode and range, and
- Evidence of erosional and depositional events to identify high- and low-energy layers.

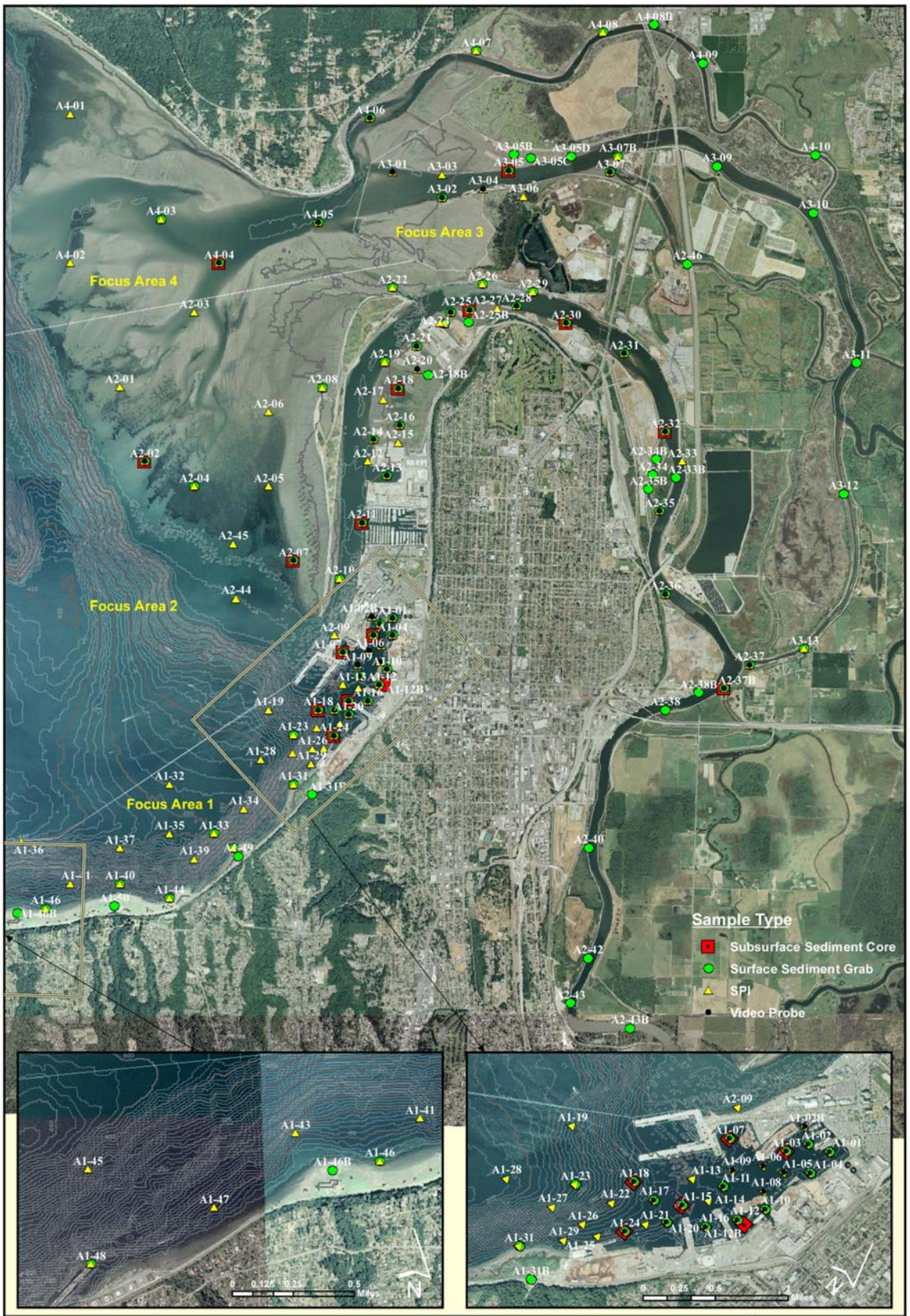
A preliminary review of the SPI photography may be used to help identify or refine proposed grab sampling locations for analyzing conventional and chemical parameters. Surface sediment stations co-located at selected SPI stations will also be used to ground truth observations made from the images.

Table 2–1. Stations and Sample Types for the Port Gardner Sediment Characterization

Station	Sediment Profile Imaging	Video Probing	Grab Sampling	Core Sampling
A1-01	X	X	X	
A1-02	X	X	X	
A1-02B	X	X		
A1-03	X	X	X	X
A1-04	X	X	X	
A1-05	X	X		
A1-06	X	X		
A1-07	X	X	X	X
A1-08	X	X		
A1-09	X	X		
A1-10	X	X	X	
A1-11	X	X	X	
A1-12	X	X	X	
A1-12B				X
A1-13	X			
A1-14	X			
A1-15	X	X	X	X
A1-16	X	X	X	
A1-17	X	X	X	
A1-18	X	X	X	X
A1-19	X			
A1-20	X	X	X	
A1-21	X			
A1-22	X			
A1-23	X		X	
A1-24	X	X	X	X
A1-25	X			
A1-26	X			
A1-27	X			
A1-28	X			
A1-29	X			
A1-31	X		X	
A1-31B			X	
A1-32	X			
A1-33	X		X	
A1-34	X			
A1-35	X			
A1-36	X			
A1-37	X			
A1-38	X		X	
A1-39	X			
A1-40	X		X	
A1-41	X			
A1-43	X			
A1-44	X		X	
A1-45	X			
A1-46	X		X	

Station	Sediment Profile Imaging	Video Probing	Grab Sampling	Core Sampling
A1-46B			X	
A1-47	X			
A1-48	X		X	
A1-49			X	
A1-50			X	
A2-01	X			
A2-02	X	X	X	X
A2-03	X			
A2-04	X		X	
A2-05	X			
A2-06	X			
A2-07	X	X	X	X
A2-08	X		X	
A2-09	X			
A2-10	X		X	
A2-11	X	X	X	X
A2-12	X			
A2-13	X	X	X	
A2-14	X	X	X	
A2-15	X			
A2-16	X	X	X	
A2-17	X			
A2-18	X	X	X	X
A2-18B			X	
A2-19	X		X	
A2-20	X	X		
A2-21	X	X	X	
A2-22	X		X	
A2-23	X		X	
A2-23B	X			
A2-24	X	X	X	
A2-25	X	X	X	X
A2-25B			X	
A2-26	X		X	
A2-27	X			
A2-28	X	X	X	
A2-29	X		X	
A2-30	X	X	X	X
A2-31	X	X	X	
A2-32	X	X	X	X
A2-33	X			
A2-33B			X	
A2-34			X	
A2-34B			X	
A2-35	X	X	X	
A2-35B			X	
A2-36	X	X	X	
A2-37	X	X	X	

Station	Sediment Profile Imaging	Video Probing	Grab Sampling	Core Sampling
A2-37B		X	X	X
A2-38			X	
A2-38B			X	
A2-40			X	
A2-42			X	
A2-43			X	
A2-43B			X	
A2-44	X			
A2-45	X			
A2-46			X	
A3-01	X	X		
A3-02	X	X	X	
A3-03	X			
A3-04	X	X		
A3-05	X	X	X	X
A3-05B			X	
A3-05C			X	
A3-05D			X	
A3-06	X			
A3-07	X	X	X	
A3-07B	X		X	
A3-09			X	
A3-10			X	
A3-11			X	
A3-12			X	
A3-13	X		X	
A4-01	X			
A4-02	X			
A4-03	X		X	
A4-04	X	X	X	X
A4-05	X	X	X	
A4-06	X	X	X	
A4-07	X		X	
A4-08	X		X	
A4-08B			X	
A4-09			X	
A4-10			X	



SAIC
From Science to Solutions

L. Delwiche, SAIC 2008

N

Figure 2–1. Proposed Sample Types and Locations in Port Gardner

0 0.5 1 1.5 2 Miles

0 0.25 0.5 1 1.5 2 Kilometers

Scale: 1:37,000

WA State Plane North NAD83

DEPARTMENT OF ECOLOGY State of Washington

2.2 Subsurface Video Probe

Subsurface sediment video probing is proposed to determine the vertical variation in sediment characteristics and the extent of sedimentary woody debris accumulation. This device allows for real-time observations of the sediment as the video probe is advanced into the sediment column (SAIC 2008b). The physical characteristics of the sediment are determined with depth, up to a maximum depth of 7 feet. Co-located with SPI sampling locations, video probing efforts will focus on areas where woody debris accumulation may be present (Figure 2–1). Due to equipment limitations, video probing is proposed only for water depths of less than 100 feet. The results of the survey may be used to refine the locations originally identified for sediment core sampling.

2.3 Surface Sediment Samples

Collections of surface sediment (0 to 10 cm) samples are proposed using a 0.2 m^2 dual van Veen or 0.25 m^2 hydraulic van Veen grab sampler. Sampling locations were selected based on the results of previous investigations, and to provide broad spatial coverage to define the overall extent of sediment contamination in Port Gardner. A total of 82 locations are proposed: 25 in Focus Area 1, 37 locations in Focus Area 2, 11 locations in Focus Area 3, and 9 locations in Focus Area 4. A total of 38 samples will be initially analyzed with the remaining samples archived for potential future analysis (Figure 2–2).

Table 2–2 lists surface sediment samples selected for analysis. These samples will be analyzed for conventional parameters (ammonia, total sulfides, total organic carbon [TOC], total volatile solids, total solids, and grain size) and the Washington State SMS chemicals of concern. Chemistry results will be compared to Sediment Quality Standards (SQS) and Cleanup Screening Levels (CSL). These standards provide a regulatory basis, management goal, and decision process for the characterization and cleanup of contaminated sediments (WAC 173-204). A total of 15 of the samples will be analyzed for dioxin/furan congeners. An additional subset of seven samples will be analyzed for pesticide compounds, eight samples for tributyltin, and nine samples for guaiacols/resin acids. Selection of these samples was based on presence of possible sources as identified by SAIC (2008a) (see Table 2–2).

Based on the results of the surface sediment chemical analyses, Phase II of sampling will be conducted to collect sediments for toxicity testing in areas of concern (e.g., at locations that exceed the SQS chemical criteria). Up to 20 samples will be evaluated for toxicity using the SMS suite of bioassay tests, including the larval development bioassay, amphipod mortality bioassay, and juvenile polychaete growth bioassay. In addition, up to 12 archived sediment samples will be analyzed for the World Health Organization (WHO) list of polychlorinated biphenyl (PCB) congeners during Phase II of the project. The samples selected will be based on the PCB Aroclor results for sediments determined during Phase I.

Table 2–2. Stations and Surface Sediment Sample Chemical Analyses Proposed for the Port Gardner Sediment Characterization

Station	Conventionals	SMS Chemicals[1]	Pesticides	Tributyltin	Guaiacols/ Resin Acids	Dioxin/ Furan Congeners	Archive
A1-01	X	X					
A1-02	X	X			X		
A1-03	X	X		X		X	
A1-04							X
A1-07	X	X					
A1-10	X	X				X	
A1-11							X
A1-12							X
A1-15	X	X					
A1-16	X	X					
A1-17							X
A1-18	X	X				X	
A1-20							X
A1-23	X	X					
A1-24	X	X			X	X	
A1-31							X
A1-31B	X	X				X	
A1-33							X
A1-38	X	X					
A1-40							X
A1-44	X	X					
A1-46							X
A1-46B	X	X				X	
A1-48							X
A1-49							X
A1-50							X
A2-02	X	X				X	
A2-04							X
A2-07	X	X					
A2-08	X	X				X	
A2-10	X	X					
A2-11	X	X		X			
A2-13	X	X		X			
A2-14	X	X					
A2-16	X						X
A2-18	X	X	X		X	X	
A2-18B	X	X				X	
A2-19							X
A2-21	X						
A2-22	X	X					
A2-23	X	X					
A2-24							X
A2-25	X	X			X	X	
A2-25B	X	X				X	
A2-26	X	X					

Station	Conventionals	SMS Chemicals[1]	Pesticides	Tributyltin	Guaiacols/ Resin Acids	Dioxin/ Furan Congeners	Archive
A2-28	X	X					
A2-29	X	X					
A2-30	X	X			X	X	
A2-31							X
A2-32	X	X	X	X	X	X	
A2-33B	X	X					
A2-34	X	X					
A2-34B	X	X					
A2-35							X
A2-35B							X
A2-36	X	X			X		
A2-37	X	X	X			X	X
A2-37B	X	X	X			X	
A2-38	X	X					
A2-38B	X	X					
A2-40							X
A2-42	X	X	X				
A2-43							X
A2-43B	X	X					
A2-46	X	X					
A3-02							X
A3-05	X	X		X	X	X	
A3-05B	X						
A3-05C							X
A3-05D	X						
A3-07							X
A3-07B	X	X		X			
A3-09	X	X	X				
A3-10							X
A3-11	X	X	X				
A3-12							X
A3-13	X	X		X			
A4-03							X
A4-04	X	X					
A4-05	X	X					
A4-06							X
A4-07	X	X	X	X	X	X	
A4-08							X
A4-08B	X	X					
A4-09	X	X					
A4-10							X

Notes

1. SMS chemicals include semi-volatile organics, metals, and PCB Aroclors.

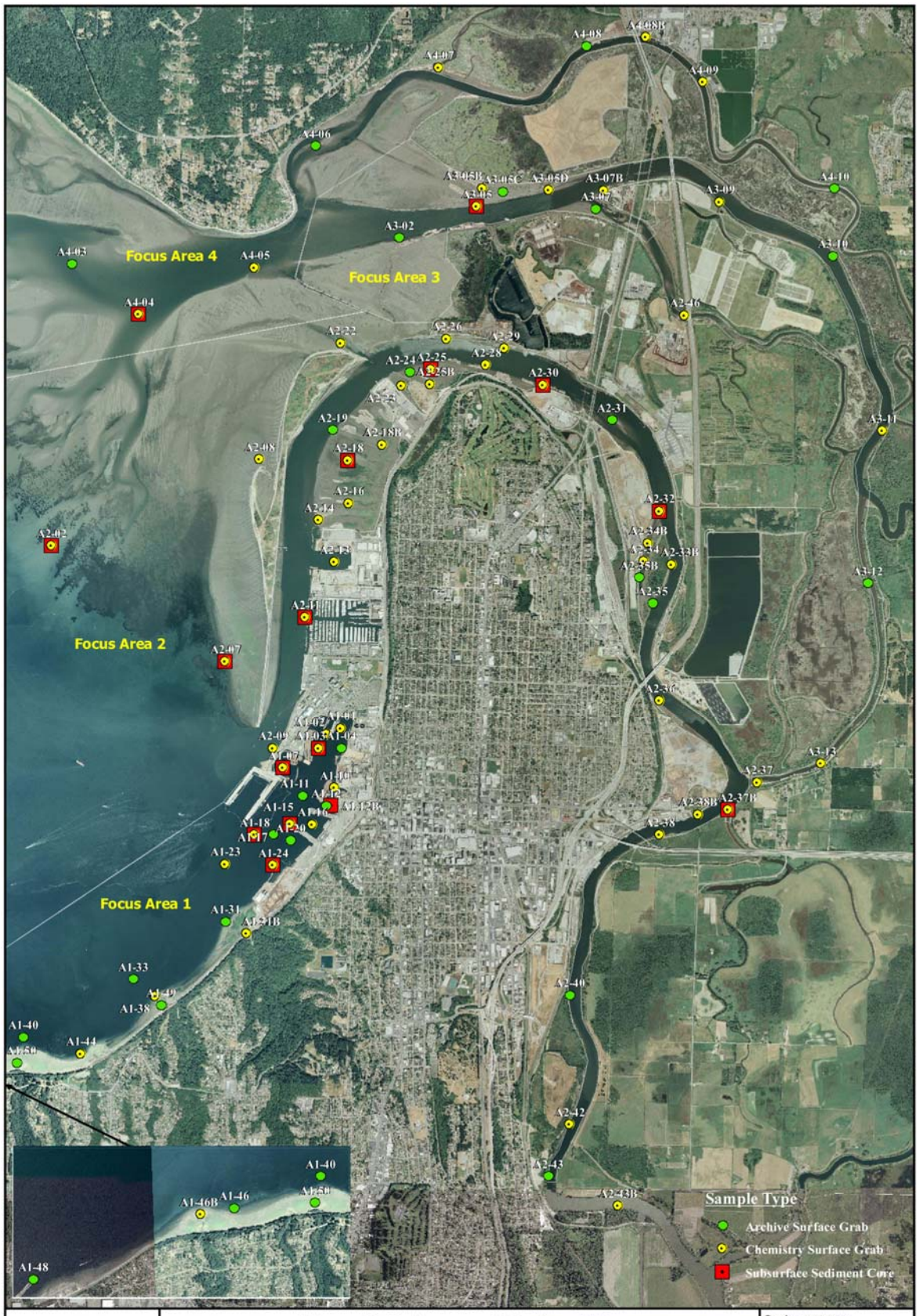


Figure 2–2. Proposed Grab and Core Sample Locations in Port Gardner

Scale: 1:32,000
WA State Plane North NAD83

L. Delwiche, SAIC 2008

2.4 Subsurface Sediment Cores

Subsurface sediment cores are proposed to determine the vertical extent of chemical contamination and woody debris accumulation. The cores will be advanced to 11 feet below the sediment surface using a vibracore sampler. Sediment core processing will include a physical description of the stratigraphy, including presence or absence of wood debris, and the collection of core sediment composites by depth interval (0 to 1, 1 to 3, 3 to 5, 5 to 7, 7 to 9, 9 to 11 feet) for the analysis of conventionals and SMS parameters. The 16 proposed locations for sediment core collection were based on their proximity to potential point sources of contamination and contemporary sediment accumulation (Figure 2–2). Two subsurface intervals will be analyzed at ten of the core locations, and one subsurface interval will be analyzed at five of the core locations (Table 2–3). Five subsurface intervals will be analyzed for dioxin/furan congeners. All sample intervals will be archived at one location (A1-12B). The subsurface interval selected may be modified in the field based on the distribution of sediment contamination (e.g., oily sheen) observed during core processing. The remaining core sample intervals will be archived for potential future analysis.

2.5 Tissue Sampling

The collection of fish, crab, clam, and plant specimens are proposed for tissue residue analysis of bioaccumulative chemicals of concern. Bottom trawling and intertidal hand sampling will be used to collect these specimens (Figure 2–3). If present in abundance at intertidal areas, ghost shrimp and polychaete species may also be collected. Target plant specimens will be identified in coordination with the Tulalip Tribe and collected in Focus Area 4.

Bottom trawling is proposed in three areas, with triplicate flatfish and crab samples proposed for collection. A total of three flat fish, three crab meat, and three hepatopancreas (one replicate sample from each area) are initially proposed for analysis; remaining samples will be archived. For clam specimens, triplicate samples are proposed for six areas. Four clam samples (one replicate sample each from locations A1-31B, A1-46B, A2-18B, and A2-25B) are initially proposed for analysis, with the remaining tissue samples archived (see Table 2–4). Tissues collected from two locations (A1-49 and A1-50) will be archived. At hand sampling locations, co-located sediment samples will also be collected and analyzed for the sediment conventionals, SMS parameters, and dioxin/furan congeners. In addition, up to 12 archived tissue samples will be analyzed for the World Health Organization (WHO) list of PCB congeners (Phase II of project) based on the PCB Aroclor results for Phase I sediments and tissues analyses.

Table 2–3. Chemical Analysis Proposed for Subsurface Sediment Samples

Station	Subsurface Depth Interval					
	0–1 feet	1–3 feet	3–5 feet	5–7 feet	7–9 feet	9–11 feet
A1-03	A	C,S	C,S	A	A	A
A1-07	A	C,S	C,S	A	A	A
A1-12B	A	A	A	A	A	A
A1-15	A	C,S	C,S	A	A	A
A1-18	A	C,S	C,S	A	A	A
A1-24	A	C,S,D	C,S	A	A	A
A2-02	A	C,S	A	A	A	A
A2-07	A	C,S	A	A	A	A
A2-11	A	C,S	A	A	A	A
A2-18	A	C,S,D	C,S	A	A	A
A2-25	A	C,S	C,S	A	A	A
A2-30	A	C,S,D	C,S	A	A	A
A2-32	A	C,S,D	C,S	A	A	A
A2-37	A	C,S	A	A	A	A
A3-05	A	C,S,D	C,S	A	A	A
A4-04	A	C,S	A	A	A	A

A: Archive
C: Conventional Parameters
S: SMS Parameters
D: Dioxin/Furan Congeners
Note: Depth intervals selected for analysis may be modified in the field based on observations during core processing.

Table 2–4. Chemical Analysis Proposed for Tissue Samples

Station	Tissue Type	Replicate	SMS Metals	PCBs (Aroclors)	Dioxin/Furan Congeners
TRAWL1	English Sole	1	X	X	X
	English Sole	2	A	A	A
	English Sole	3	A	A	A
	Dungeness Crab Meat	1	X	X	X
	Dungeness Crab Meat	2	A	A	A
	Dungeness Crab Meat	3	A	A	A
	Dungeness Hepatopancreas	1	X	X	X
	Dungeness Hepatopancreas	2	A	A	A
	Dungeness Hepatopancreas	3	A	A	A
TRAWL2	English Sole	1	X	X	X
	English Sole	2	A	A	A
	English Sole	3	A	A	A
	Dungeness Crab Meat	1	X	X	X
	Dungeness Crab Meat	2	A	A	A
	Dungeness Crab Meat	3	A	A	A
	Dungeness Hepatopancreas	1	X	X	X
	Dungeness Hepatopancreas	2	A	A	A
	Dungeness Hepatopancreas	3	A	A	A
TRAWL3	English Sole	1	X	X	X
	English Sole	2	A	A	A
	English Sole	3	A	A	A
	Dungeness Crab Meat	1	X	X	X
	Dungeness Crab Meat	2	A	A	A
	Dungeness Crab Meat	3	A	A	A
	Dungeness Hepatopancreas	1	X	X	X
	Dungeness Hepatopancreas	2	A	A	A
	Dungeness Hepatopancreas	3	A	A	A
A1-31B	Varnish Clams	1	X	X	X
	Varnish Clams	2	A	A	A
	Varnish Clams	3	A	A	A
A1-46B	Varnish Clams	1	X	X	X
	Varnish Clams	2	A	A	A
	Varnish Clams	3	A	A	A
A1-49	Varnish Clams	1	A	A	A
	Varnish Clams	2	A	A	A
	Varnish Clams	3	A	A	A
A1-50	Varnish Clams	1	A	A	A
	Varnish Clams	2	A	A	A
	Varnish Clams	3	A	A	A
A2-18B	Eastern Softshell Clams	1	X	X	X
	Eastern Softshell Clams	2	A	A	A
	Eastern Softshell Clams	3	A	A	A
A2-25B	Eastern Softshell Clams	1	X	X	X
	Eastern Softshell Clams	2	A	A	A
	Eastern Softshell Clams	3	A	A	A

Figure 2–3. Trawling and Intertidal Tissue Sampling Locations in Port Gardner

3.0 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. Samples will be collected for sediment profile imaging, subsurface video probing, sediment chemistry, toxicity, and tissue residues. When possible, sample locations for each data type are co-located to assist in cross-validation. Section 4.0 presents the laboratory methods for chemical analysis and toxicity testing.

3.1 Sampling Platforms

Several sampling vessels will be used as needed to meet the multiple data collection objectives. The R/V *Kittiwake*, owned and operated by Mr. Charles Eaton of Bio-Marine Enterprises will be used for the SPI survey, bottom trawling, and surface sediment grabs. The R/V *Nancy Anne*, owned and operated by Mr. Bill Jaworski of Marine Sampling Systems, will be used for the subsurface sediment collection and video probing. The R/V *Growler*, owned and operated by SAIC, will be used to sample shallow water locations in Focus Areas 2, 3, and 4, as well as assist in the collection of crab and clam tissue, if needed.

3.2 Station Positioning and Navigation

SAIC 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* and R/V *Nancy Anne* 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 and R/V *Nancy Anne*'s navigation systems. 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).

At subsurface sediment coring and video probing locations, water depths will be measured directly by lead-line and converted to mudline elevations referencing the mean lower low water (MLLW) elevation. At SPI and sediment grab locations, water depths will be measured using the winch meter wheel and verified by the ship's echo sounder.

Figures 2–1 through 2–3 display the sampling locations, and Table 3–1 provides the target sample coordinates.

Table 3–1. Target Station Coordinates

Station	Easting	Northing	Latitude	Longitude
	State Plane WA N - NAD83		NAD83	
A1-01	1301100	363526	47 59.2929 N	122 13.1447 W
A1-02	1300646	363334	47 59.2600 N	122 13.2550 W
A1-02B	1300349	363583	47 59.3000 N	122 13.3290 W
A1-03	1300392	362900	47 59.1879 N	122 13.3154 W
A1-04	1301100	362900	47 59.1900 N	122 13.1419 W
A1-05	1300676	362535	47 59.1287 N	122 13.2442 W
A1-06	1300243	362341	47 59.0955 N	122 13.3494 W
A1-07	1299300	362283	47 59.0832 N	122 13.5801 W
A1-08	1300631	361940	47 59.0307 N	122 13.2526 W
A1-09	1299827	361832	47 59.0105 N	122 13.4490 W
A1-10	1300899	361667	47 58.9866 N	122 13.1857 W
A1-11	1299900	361413	47 58.9419 N	122 13.4293 W
A1-12	1300613	361100	47 58.8925 N	122 13.2533 W
A1-12B	1300781	361124	47 58.8970 N	122 13.2121 W
A1-13	1299300	361100	47 58.8886 N	122 13.5782 W
A1-14	1299877	360981	47 58.8708 N	122 13.4330 W
A1-15	1299516	360531	47 58.7957 N	122 13.5195 W
A1-16	1300200	360523	47 58.7964 N	122 13.3519 W
A1-17	1298986	360200	47 58.7397 N	122 13.6478 W
A1-18	1298400	360200	47 58.7379 N	122 13.7913 W
A1-19	1296600	360200	47 58.7325 N	122 14.2322 W
A1-20	1299510	360022	47 58.7120 N	122 13.5187 W
A1-21	1299206	359694	47 58.6571 N	122 13.5917 W
A1-22	1298352	359545	47 58.6301 N	122 13.8002 W
A1-23	1297500	359300	47 58.5872 N	122 14.0078 W
A1-24	1298974	359271	47 58.5869 N	122 13.6466 W
A1-25	1298609	358803	47 58.5088 N	122 13.7339 W
A1-26	1298204	358775	47 58.5030 N	122 13.8330 W
A1-27	1297464	358612	47 58.3973 N	122 14.0135 W
A1-28	1296312	358400	47 58.4357 N	122 14.2947 W
A1-29	1298130	358242	47 58.4151 N	122 13.8760 W
A1-31	1297500	357500	47 58.2912 N	122 13.9997 W
A1-31B	1298158	357128	47 58.2320 N	122 13.8370 W
A1-32	1293000	357500	47 58.2777 N	122 15.1018 W
A1-33	1294620	355715	47 57.9890 N	122 14.6970 W
A1-34	1295700	356600	47 58.1378 N	122 14.4365 W
A1-35	1293000	355700	47 57.9816 N	122 15.0937 W
A1-36	1287634	355438	47 57.9222 N	122 16.4064 W
A1-37	1291200	355197	47 57.8934 N	122 15.5322 W
A1-38	1295305	355192	47 57.9051 N	122 14.5270 W
A1-39	1293900	354800	47 57.8363 N	122 14.8692 W
A1-40	1291200	353900	47 57.6801 N	122 15.5263 W
A1-41	1289400	353900	47 57.6746 N	122 15.9670 W
A1-42	1284900	353900	47 57.6608 N	122 17.0689 W
A1-43	1286700	353655	47 57.6260 N	122 16.6270 W
A1-44	1293000	353391	47 57.6019 N	122 15.0833 W
A1-45	1282200	353000	47 57.5044 N	122 17.7258 W

Station	Easting	Northing	Latitude	Longitude
	State Plane WA N - NAD83		NAD83	
A1-46	1288500	353000	47 57.5239 N	122 16.1833 W
A1-46B	1287469	352832	47 57.4930 N	122 16.4350 W
A1-47	1284900	352100	47 57.3650 N	122 17.0605 W
A1-48	1282200	350955	47 57.1680 N	122 17.7163 W
A1-49	1295491	354896	47 57.8570 N	122 14.4800 W
A1-50	1290990	353094	47 57.5470 N	122 15.5740 W
A2-01	1291200	371900	48 0.6403 N	122 15.6080 W
A2-02	1292100	369200	48 0.1991 N	122 15.3752 W
A2-03	1293900	374600	48 1.0926 N	122 14.9585 W
A2-04	1293900	368300	48 0.0565 N	122 14.9300 W
A2-05	1296600	368300	48 0.0646 N	122 14.2684 W
A2-06	1296600	371000	48 0.5087 N	122 14.2805 W
A2-07	1297500	365600	47 59.6233 N	122 14.0359 W
A2-08	1298550	371889	48 0.6607 N	122 13.8066 W
A2-09	1298985	362900	47 59.1837 N	122 13.6600 W
A2-10	1299182	364953	47 59.5220 N	122 13.6210 W
A2-11	1299986	366982	47 59.8580 N	122 13.4330 W
A2-12	1300200	369200	48 0.2234 N	122 13.3903 W
A2-13	1300887	368687	48 0.1411 N	122 13.2196 W
A2-14	1300410	369996	48 0.3549 N	122 13.3423 W
A2-15	1301298	369878	48 0.3382 N	122 13.1242 W
A2-16	1301344	370526	48 0.4449 N	122 13.1158 W
A2-17	1300765	371447	48 0.5946 N	122 13.2617 W
A2-18	1301311	371856	48 0.6635 N	122 13.1297 W
A2-18B	1302371	372345	48 0.7470 N	122 12.8720 W
A2-19	1300817	372800	48 0.8173 N	122 13.2550 W
A2-20	1302000	372550	48 0.7797 N	122 12.9639 W
A2-21	1301964	373371	48 0.9146 N	122 12.9764 W
A2-22	1301100	375500	48 1.2622 N	122 13.1975 W
A2-23	1302985	374185	48 1.0515 N	122 12.7297 W
A2-23B	1302807	374208	48 1.0548 N	122 12.7733 W
A2-24	1303216	374600	48 1.1204 N	122 12.6769 W
A2-25	1303900	374683	48 1.1361 N	122 12.5076 W
A2-25B	1303858	374233	48 1.0620 N	122 12.5160 W
A2-26	1304373	375630	48 1.2932 N	122 12.3958 W
A2-27	1304895	374733	48 1.1202 N	122 12.2639 W
A2-28	1305600	374822	48 1.1639 N	122 12.0915 W
A2-29	1306177	375336	48 1.2501 N	122 11.9522 W
A2-30	1307389	374210	48 1.0681 N	122 11.6503 W
A2-31	1309511	373106	48 0.8931 N	122 11.1253 W
A2-32	1311000	370279	48 0.4324 N	122 10.7257 W
A2-33	1311599	369200	48 0.2567 N	122 10.5968 W
A2-33B	1311380	368606	48 0.1583 N	122 10.6480 W
A2-34	1310519	368709	48 0.1728 N	122 10.8594 W
A2-34B	1310654	369277	48 0.2666 N	122 10.8287 W
A2-35	1310772	367400	47 59.9583 N	122 10.7918 W
A2-35B	1310363	368194	48 0.0878 N	122 10.8954 W
A2-36	1311000	364382	47 59.4626 N	122 10.7230 W

Station	Easting	Northing	Latitude	Longitude
	State Plane WA N - NAD83		NAD83	
A2-37	1314042	361834	47 59.0522 N	122 9.9670 W
A2-37B	1313131	360980	47 58.9093 N	122 10.1864 W
A2-38	1311000	360200	47 58.7744 N	122 10.7051 W
A2-38B	1312209	360827	47 58.8814 N	122 10.4117 W
A2-40	1308211	355211	47 57.9463 N	122 11.3667 W
A2-42	1308200	351200	47 57.2866 N	122 11.3521 W
A2-43	1307543	349575	47 57.0173 N	122 11.5059 W
A2-43B	1309711	348663	47 56.8737 W	122 10.9712 W
A2-44	1295414	364227	47 59.3913 N	122 14.5408 W
A2-45	1295311	366205	47 59.7162 N	122 14.5748 W
A2-46	1311788	376362	48 1.4351 N	122 10.5811 W
A3-01	1301100	379685	48 1.9504 N	122 13.216 W
A3-02	1302900	378777	48 1.8064 N	122 12.7707 W
A3-03	1302900	379596	48 1.9411 N	122 12.7743 W
A3-04	1304397	379078	48 1.8603 N	122 12.4050 W
A3-05	1305304	379752	48 1.9738 N	122 12.1855 W
A3-05B	1305484	380324	48 2.0684 N	122 12.1438 W
A3-05C	1306112	380212	48 2.0519 N	122 11.9895 W
A3-05D	1307560	380263	48 2.0645 N	122 11.6346 W
A3-06	1305859	378793	48 1.8177 N	122 12.0453 W
A3-07	1308996	379682	48 1.9730 N	122 11.2800 W
A3-07B	1309258	380260	48 2.0690 N	122 11.2180 W
A3-09	1312872	379903	48 2.0206 N	122 10.3305 W
A3-10	1316371	378212	48 1.7524 N	122 9.4654 W
A3-11	1317927	372774	48 0.8621 N	122 9.0611 W
A3-12	1317475	368026	48 0.0803 N	122 9.1519 W
A3-13	1316019	362422	47 59.1546 N	122 9.5069 W
A4-01	1289415	381780	48 2.2597 N	122 16.0907 W
A4-02	1289415	376397	48 1.3740 N	122 16.0660 W
A4-03	1292707	377971	48 1.6433 N	122 15.2662 W
A4-04	1294800	376400	48 1.3913 N	122 14.7459 W
A4-05	1298400	377857	48 1.6417 N	122 13.8699 W
A4-06	1300282	381641	48 2.2697 N	122 13.4253 W
A4-07	1304134	384077	48 2.6817 N	122 12.4914 W
A4-08	1308720	384748	48 2.8054 N	122 11.3695 W
A4-08B	1310583	385022	48 2.8558 N	122 10.9137 W
A4-09	1312348	383623	48 2.6308 N	122 10.4797 W
A4-10	1316424	380309	48 2.0974 N	122 9.4613 W

3.3 SPI Survey Data Collection

SPI photography provides a cross-sectional photograph of the sediment/water interface. An area 20 cm high by 14 cm wide is captured in this "profile" and recorded as a digital image. Images are collected using a Benthos model 3731 sediment profile digital camera. The sediment profile camera consists of a wedge-shaped prism with a Plexiglas faceplate and a back mirror mounted at a 45° angle. Light is provided by an internal strobe. The mirror reflects the image of the profile of the sediment/water interface to a digital camera mounted horizontally on top of the prism. Three replicate images will be collected from each SPI sampling location.

3.4 Subsurface Video Probe Data Collection

The vertical extent of wood debris will be evaluated through the use of a subsurface sediment video probe. This device is similar to a core sampler. A downward-looking video camera is mounted inside the nose of a core barrel. The end of the barrel is capped with a clear Plexiglas cone, which acts as a viewport for the video camera. As the core barrel is advanced into the sediment, the video is observed from the vessel and recorded to a video tape or DVD. Verbal descriptions of the physical characteristics of the sediment, including presence or absence of wood debris, will be recorded with the video feed and transcribed on a core log. The video probe will be advanced to 7 feet below the surface or until refusal is reached.

3.5 Sediment Sample Collection

Surface sediment samples will be collected at 82 subtidal and intertidal sampling locations. Subsurface sediment cores will be collected at 16 locations (Figures 2–1 and 2–2). Sediment samples will be analyzed for SMS and conventional parameters. A subset of samples will be analyzed for pesticides, tributyltin, guaiacols/resin acids, and dioxin/furan congeners. Several samples will be archived for possible future analysis (Tables 2–2 and 2–3). Table 3–2 lists the surface and subsurface sediment samples to be collected and analyzed, the analytical methods, sample container, volume, and preservation requirements. The following sections describe the collection and processing methods.

Table 3–2. Sediment Samples to be Analyzed, Containers, and Holding Times

Sample Locations	Surface and Subsurface Sediment Chemistry										Sediment Toxicity
Analyses	Sediment Conventionals[1]	Total Sulfides	SVOCs, PCBs	Pesticides	Guaiacols/ Resin Acids	Dioxin/Furan Congeners	Metals	Butyltins	Mercury	PCB Congeners (WHO)	Amphipod, Larval, and Polychaete Bioassays
Container(s)	16 oz glass	4 oz glass	16 oz glass		8 oz glass	8 oz glass	8 oz glass			8 oz glass	3 32 oz glass
Preservative	4°C/-18°C[2]	4°C; zinc acetate	4°C/-18°C		4°C/-18°C	4°C/-18°C	4°C/-18°C		18°C	4°C/-18°C	4°C, nitrogen purged headspace
Holding Time	14 days/ 6 months[3]	7 days	14 days/ 1year		14 days/ 1year	14 days/ 1year	14 days/ 1year		28 days	14 days/ 1year	8 weeks
Area 1	24X	24X	24X		2X	7X	24X	1X	24X	TBD	TBD
Area 2	42X	42X	40X	4X	5X	10X	40X	3X	40X	TBD	TBD
Area 3	9X	9X	7X	2X	1X	2X	7X	3X	7X	TBD	TBD
Area 4	6X	6X	6X	1X	1X	1X	6X	1X	6X	TBD	TBD
QA/QC Samples											
Duplicates[6]	3X	3X	3X	-	-	1X	3X	-	3X	-	-
Triplicates[6,7]	3X	3X	-	-	-	-	3X	-	3X	-	-
MS/MSD[6,8]	-	-	3X	-	-	1X	-	-	-	-	-
Equipment Rinseate[6,8]	-	-	X	-	-	-	X	-	X	-	-
Rinseate Blank	-	-	X	-	-	-	X	-	X	-	-
Sample Totals	**88**	**88**	**85**	**7**	**9**	**22**	**85**	**8**	**85**	**TBD**	**TBD**

Notes

X: sample to be collected and submitted for analysis/testing; -: no sample will be collected at this location; TBD: number of samples to be determined under Phase II program

1. Sediment conventional parameters include grain size distribution, total solids, total volatile solids, total organic carbon, and ammonia.
2. Samples for grain size distribution and ammonia analysis should be stored at 4°C only.
3. Holding time for ammonia analysis is 7 days at 4°C; holding time for grain size distribution is 6 months at 4°C.
4. References: chemistry, toxicity testing, and potential benthic community analysis will be conducted at these locations
5. Three candidate reference locations have been identified for the purposes of this work plan. Actual reference locations will be determined in the field based on physical attributes of the site and the results of the wet-sieving. Up to three reference locations will be sampled for chemistry and toxicity to match grain size distribution with site sediments. One reference location will be identified as a sediment quality triad location and will include benthic community analysis.
6. Frequency of analysis is one per 20 samples (5%).
7. Triplicate analysis for sediment conventional parameters only.
8. MS/MSDs, equipment rinseate, and rinseate blanks conducted for organics and metals only.

3.5.1 Surface Sediment Samples

Surface sediment (0 to 10 cm) for chemical and toxicological analysis will be collected using a stainless steel 0.2 m^2 dual van Veen or single Young grab sampler. If accessible during low tide events, surface sediment samples from intertidal areas (i.e., six clam sampling locations) will be collected directly with stainless steel spoons. Established deployment and recovery procedures for the sampling gear, described in PSEP, will be followed to ensure recovery of the best possible samples and minimize risks to personnel and equipment. 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 and texture will be described in the sample log.

If needed, multiple grab samples will be collected and composited for each sampling location to provide sufficient volume for chemical analysis (Phase I program) and toxicity testing (Phase II). 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. Field documentation is described in Section 3.9.
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 3–2).
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. Once sufficient sediment volume has been collected, samples should be placed in the appropriate, pre-cleaned, labeled sample containers as described in Section 3.7, placed in a cooler maintained at 4ºC, and prepared for shipment to the analytical or biological laboratory as described in Section 3.8.
13. Confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed, as described in Section 3.9.
14. Decontaminate all sampling equipment as described in Section 3.10 before proceeding to the next sampling location.

A single replicate sample will be collected from each target sampling location, with the exception of field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples to be collected randomly at the field supervisor's discretion. The sample types collected from each location and samples to be analyzed and archived are presented in Table 3–2. During the Phase II field program, aliquots of homogenized sediment will be collected for toxicity testing at designated locations.

3.5.2 Subsurface Sediment Collection

Subsurface sediment samples will be collected at a total of 16 locations. Surface sediment grabs will also be collected at 15 of the locations. Subsurface sediments will be collected using a vibracore equipped with 12-foot barrels. The cores will be advanced to 11 feet below mudline or until refusal. Each core will be sampled at depth horizons of 0 to 1, 1 to 3, 3 to 5, 5 to 7, 7 to 9, and 9 to 11 feet below mudline.

The general procedure for collecting sediment cores is as follows:

1. Make logbook and field form entries as necessary throughout the sampling process to ensure accurate and thorough record-keeping. Field documentation is described in Section 3.9.
2. Position the sampling vessel at the targeted sampling location.
3. Record the location using the DGPS; measure and record the water depth.
4. Insert pre-cleaned Lexan or aluminum core tubes equipped with an "eggshell" core catcher to retain material in the core barrel for deployment.
5. Position the core-sampler vertically on the bottom and advance it to a sampling depth 11 feet for the vibracorer to include all targeted sampling intervals or until refusal.
6. Once sampling is complete, extract the sampler and remove the core liner from the core barrel or detach core tube from the vibracorer. Examine the core sample at each end to verify sufficient sediment retention. Then inspect the condition and quantity of material within the core to determine acceptability. If sample acceptance criteria are not achieved, reject the sample and attempt another sample collection.
   a. To verify whether an acceptable core sample has been collected, the following criteria must be met:
      i. Target penetration depth (i.e.,11 feet) or refusal was achieved;

ii. Sediment recovery of at least 65 percent of the penetration depth is targeted to deem the core acceptable;
iii. Sample appears undisturbed and intact without any evidence of obstruction or blocking within the core tube or core catcher.

b. The percent sediment recovery will be determined by dividing the length of material recovered in the core tube by the depth of core penetration below mudline. If the sample is deemed acceptable, overlying water will be siphoned from the top of the core tube, and each end of the tube will be capped and sealed with duct tape for storage until processing. The cores will be stored on ice until they are processed. The station number, station coordinates, date and time of collection, sediment description, field crew, and weather conditions will be recorded in the sediment coring log (Appendix B).

7. Record sediment sample characteristics on the field form (Appendix B); if more sample volume is required, repeat steps 4 through 11.
8. Label, cap, and store sediment cores in an upright vertical position in a container packed with ice until processed. Process cores within 2 days following collection.
9. The FM will confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed.
10. Wash excess sediment back into the water away from any areas remaining to be sampled.
11. Decontaminate sample equipment as described in Section 3.10 before proceeding to the next sampling location.

A single acceptable sample for each subsurface interval will be collected. The subsurface intervals proposed for analysis and archiving are provided in Table 3–3. The intervals selected for analysis may be modified in the field, based on visual observations of the sediment cores (e.g., presence of oily residue, woody debris, etc.). SAIC will process all sediment cores on site at a designated processing location (extrusion, documentation, and sample collection for analysis). Disposable nitrile gloves will be worn for all handwork such as sectioning and extruding the core, sub-sampling, mixing samples, and filling sample containers. The gloves will be disposed of between sample composites in order to prevent cross-contamination between samples.

Sampling implements and processing equipment will be decontaminated prior to processing the sediment cores. Sediment cores will be processed in the same order as collected to minimize holding time. Each section comprising a core sample will be extruded onto a stainless steel tray using a core sample removal tool (a plunger style device that pushes the sample through the core tube). Care will be taken to preserve the integrity of the core section stratums by extruding in order from top (e.g., mudline) to bottom (native material). Once the sediment has been extruded, a visual characterization of the sample material will be immediately conducted. The core will then be visually described in the core log including the following information and characteristics:

- Station number
- Date and time of collection
- Station coordinates
- Weather conditions
- Names of persons collecting and logging the sample
- Penetration depth

- Percent sediment recovery
- Physical soil description in accordance with the Unified Soil Classification System (USCS)
- Color
- Odor (e.g. hydrogen sulfide, petroleum)
- Visual stratifications and lenses
- Vegetation and/or woody debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen or obvious contamination
- Any other distinguishing characteristics or features

Representative aliquots of sediment will be collected from the top 1 foot and at 2-foot intervals using decontaminated stainless steel spoons to generate the composite sample that will be used to evaluate the project's technical objectives. Up to six samples will be collected from each core representing a 1-foot or 2-foot vertical horizon (i.e., 0 to 1 feet, 1 to 3 feet,…9 to 11 feet). Sediment will be collected from the center of the core that has not been smeared by, or in contact with, the core tube. The volumes removed will be placed in a decontaminated stainless steel bowl or pan and mixed until homogenous in texture and color. After all sediment for a composite sample is collected and homogenized, representative aliquots will be placed in the appropriate, pre-cleaned, labeled sample containers and prepared for shipment to the analytical laboratory for analysis or archiving.

3.6 Tissue Sampling

Fish and crab will be collected at three trawl sampling locations, and clam tissue samples will be collected at six intertidal locations (Figure 2–3). Triplicate samples of each species will be collected, and only the first replicate sample at each location will be initially analyzed at four of the locations. The methods for collecting and processing the samples are outlined in the following sections.

3.6.1 Trawl Sampling

A 7.6-meter otter trawl will be used to target the collection of Dungeness crab (*Cancer magister*) and English sole (*Parophrys vetulus*). English sole will be the targeted flatfish species; however, if they are not present in abundance, alternate species may include starry flounder (*Platichthys stellatus*) or flathead sole (*Hippoglossoides elassodon*). Likewise, if Dungeness crab is not in abundance, red rock crab (*Cancer productus*) may be collected as an alternate species.

The otter trawl will be towed approximately 900 meters (1/2 nautical mile) at a ground speed of 4.2 to 5.0 kilometers/hour (2.5 to 3.0 knots), which covers an area swept by the net (opening = 6 meters) of approximately 5,400 square meters. Trawl sampling will be conducted in all three target areas in Port Gardner, but with no particular attention to hitting specific stations. Approximately three trawls per area will be performed.

Triplicate English sole and Dungeness crab samples will be collected in each area. English sole with a minimum length of 20 cm will be targeted for collection. Each English sole sample will consist of five fish. The whole bodies of each fish will be homogenized separately. Equal volumes from each fish homogenate will be combined to make a final composite sample for analysis. The laboratory will archive the remaining tissue from each fish as separate samples.

Male Dungeness crabs with a minimum length of 9 cm will be targeted for collection. If males are not in abundance, females will be taken. Each Dungeness crab sample will consist of five crabs. The crabs in each sample will be dissected for crab meat and hepatopancreas tissue samples. Crab pots may also be utilized to supplement the collection of crabs if insufficient numbers are obtained via bottom trawling.

All fish will be immediately collected from the trawl bag upon net retrieval and transferred to a holding tank where they will be identified and enumerated. Non-target species will be promptly and carefully released to the water.

Fish processing will include identification, measurements for length and weight, and a check for obvious external abnormalities or parasites. All fish will be euthanized humanely following collection.

3.6.2 Shellfish Collection

Small shovels and trowels will be used to collect Eastern softshell clams (*Mya arenaria*) and purple varnish clams (*Nuttallia obscurata*) at low tide from publicly accessible beaches at designated locations in Focus Areas 1 and 2 (Figure 2–3).

3.6.3 Tissue Sample Processing

Organisms collected for tissue residue analysis (English sole, Eastern softshell and/or purple varnish clams, Dungeness crab) will be rinsed with site water following collection. Fish will be individually wrapped with heavy duty aluminum foil and placed in pre-labeled polyethylene bags. Crabs will be placed directly in pre-labeled polyethylene bags. All organisms collected for a composite sample will be included in the same polyethylene bag. All clams for a composite sample will be placed directly into pre-cleaned sample jars (one per species). Sample preparations (i.e., whole fish compositing and crab dissections) will be conducted by SAIC. Clam shucking and final tissue homogenization will be conducted by the analytical laboratory. Tissue samples will be immediately placed on ice in coolers in the field. If not submitted immediately (within 24 hours) to the analytical laboratory, the tissue samples will be frozen at -18°C.

Bivalve, Dungeness crab, and English sole tissue samples to be archived will be immediately placed on ice in coolers in the field and archived at -18°C at the SAIC warehouse until a decision is made for analysis.

English sole samples will include five organisms per composite. The composite sample identification number and the total length of each fish included in a composite sample will be recorded on data sheets included as part of the biological sampling log. The whole body (skin on) from each individual fish will be homogenized separately and equal volumes from each fish homogenate will be combined to create a final composite sample for analysis. The laboratory will archive the remaining tissue from each fish as separate samples.

Dungeness crab samples will include five organisms per composite. The carapace width and sex of each crab retained for analysis will be recorded on data sheets in the biological sampling log. Upon receipt by the analytical laboratory, the crabs will be dissected to collect edible meat and hepatopancreas tissue samples. The edible meat and hepatopancreas samples will be homogenized separately and archived for potential future analysis.

Triplicate tissue samples of Eastern softshell and purple varnish clams will be collected at six beach locations in Port Gardner (Figure 2–3). However, a minimum of five clams will be collected per composite. The shell length and weight for each clam retained for analysis will be recorded in the biological sampling log. Upon receipt by the analytical laboratory, the clams will be shucked to collect the edible tissues. The tissue from each sample will be homogenized and analyzed.

3.7 Sample Identification, Containers, and Labels

Samples will be identified based on the project, sampling area, location, and sample type. All samples collected during the investigation 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	**Focus Area**	**Location Number**	**Sample Type**
PG-	A1-	01-	S

Project consists of two characters describing the project (PG = Port Gardner).

Focus Area consists of two characters describing the sampling area (A1 = Focus Area 1; A2 = Focus Area 2; A3 = Focus Area 3; and A4 = Focus Area 4)

Location Number consists of two characters identifying the station location number (Figures 2–1 through 2–3). Tissue samples will be identified by species (ES = English sole; SF = starry flounder; DC = Dungeness crab; RC = red rock crab; MY = Mya [Eastern softshell clam]; VC = varnish clam).

Sample Type consists of one to two characters indicating the sample type. Sample type is indicated for QA/QC samples or toxicity testing, with D = duplicate, T = triplicate, R = Rinseate, RB = Rinseate Blank, TX=toxicity, and S0-1, S1-3, S3-5, etc. for the subsurface sediment intervals 0 to 1 foot, 1 to 3 feet, 3 to 5 feet, etc., respectively.

Sample aliquots submitted to the analytical laboratory will be placed in pre-cleaned sample containers and preserved as identified in Table 3–2. The procedure for sample storage and shipping is provided in Section 3.8.

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 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.

3.8 Sample Storage and Delivery

All samples will be stored in insulated coolers and preserved by cooling to a temperature of 4ºC and 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 bottles 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 (Section 3.9.2).
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.

Samples for toxicological testing will be shipped to the appropriate biological laboratory at the completion of the sample collection effort for archiving. They will be properly labeled, packaged, and preserved with ice in a cooler as described above and temporarily stored under contractor custody. A separate chain-of-custody form will be filled out for the chemistry and the toxicological samples. 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.

3.9 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.

3.9.1 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.

3.9.2 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 4ºC.

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.

3.10 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 and sediments that may adhere to boot treads.

3.11 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 cores 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.

3.11.1 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.

3.11.2 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.

4.0 Laboratory Analytical Methods

All of the chemical analytical and biological testing procedures 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, d), and any recent modifications proposed during the SMARM. 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.

4.1 Chemical Analyses

Laboratories subcontracted to SAIC will conduct the chemical analysis. Table 4–1 presents the specific analyses and conventional parameters to be measured, sample preparation methods, analytical methods, method detection limits (MDLs), and SMS numeric criteria (SQS and CSL). The MDLs 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. In the event the laboratory is unable to meet the MDLs, the reasons for the deviation will also be reported. SMS guidance will be used to compare chemistry data results to determine whether further biological testing is warranted.

In addition to the analytes on the SMS list, pesticides, butyltins, guaiacols/resin acids, and dioxin/furan congeners will also be analyzed in a subset of samples. Pesticides will be analyzed using USEPA Method 8081A, butyltins (bulk) will follow Michelsen et al. (1996), and guaiacols/resin acids analysis will follow USEPA Method 8270 (Table 4–1). Analysis of dioxins/furans will follow USEPA Method 1613B for 2,3,7,8-substituted chlorinated dioxins and furans (Table 4–2). The concentration of dioxin/furan compounds will be normalized to the toxicity of 2,3,7,8-TCDD (Tetrachlorodibenzo-p-Dioxin) using toxic equivalent factors (TEFs) updated by the World Health Organization (WHO) in 2005 (Van den Berg et al. 2006). 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 half of the method detection limit for data evaluation purposes.

Table 4–1. SMS Analytes (parameter, preparation method, analytical method, sediment method detection limit [TDL], SMS SQS, and CSL)

Analyte	Prep Method[1]	Analytical Method[2]	Sediment MDL [3,4]	SQS	CSL
Conventional Parameters					
Total Solids (%)	---	PSEP [5]	0.1	---	---
Total Volatile Solids (%)	---	PSEP [5]	0.1	---	---
Total Organic Carbon (%)	---	PSEP [5]	0.1	---	---
Total Sulfides (mg/kg)	---	PSEP [5]	1	---	---
Ammonia (mg/kg)	---	Plumb 1981	1	---	---
Grain Size	---	Modified ASTM with Hydrometer	---	---	---
Metals			**mg/kg**	**mg/kg**	
Arsenic	PSEP/3050B	6010B/6020	19	57	93
Cadmium	PSEP/3050B	6010B/6020	1.7	5.1	6.7
Chromium	PSEP/3050B	6010B/6020	87	260	270
Copper	PSEP/3050B	6010B/6020	130	390	390
Lead	PSEP/3050B	6010B/6020	150	450	530
Mercury	---	7471A /245.5	0.14	0.41	0.59
Silver	PSEP/3050B	6010B/6020	2	6.1	6.1
Zinc	PSEP/3050B	6010B/6020	137	410	960
Butyltins			**µg/kg**	**µg/kg**	
Bulk butyltins	3550B	Michelsen et al 1996	0.1	---	---
Low Molecular Polycyclic Aromatic Hydrocarbons (LPAH)			**µg/kg**	**mg/kg OC**	
Naphthalene	3540C/3550B	8270C/1625C	20	99	170
Acenaphthylene	3540C/3550B	8270C/1625C	20	66	66
Acenaphthene	3540C/3550B	8270C/1625C	20	16	57
Fluorene	3540C/3550B	8270C/1625C	20	23	79
Phenanthrene	3540C/3550B	8270C/1625C	20	100	480
Anthracene	3540C/3550B	8270C/1625C	20	220	1200
2-Methylnaphthalene	3540C/3550B	8270C/1625C	20	38	64
Total LPAH				370	780
High Molecular Polycyclic Aromatic Hydrocarbons (HPAH)			**µg/kg**	**mg/kg OC**	
Fluoranthene	3540C/3550B	8270C/1625C	20	160	1200
Pyrene	3540C/3550B	8270C/1625C	20	1000	1400
Benzo(a)anthracene	3540C/3550B	8270C[6]/1625C	20	110	270
Chrysene	3540C/3550B	8270C[6]/1625C	20	110	460
Benzofluoranthenes	3540C/3550B	8270C[6]/1625C	20	230	450
Benzo(a)pyrene	3540C/3550B	8270C[6]/1625C	20	99	210
Indeno(1,2,3-c,d)pyrene	3540C/3550B	8270C[6]/1625C	20	34	88
Dibenzo(a,h)anthracene	3540C/3550B	8270C[6]/1625C	20	12	33
Benzo(g,h,i)perylene	3540C/3550B	8270C/1625C	20	31	78
Total HPAH				960	5300

Analyte	Prep Method[1]	Analytical Method[2]	Sediment MDL [3,4]	SQS	CSL
Chlorinated Benzenes			**µg/kg**	**mg/kg OC**	
1,2-Dichlorobenzene	3540C/3550B	8270C[6]/1625C	3.2	2.3	2.3
1,4-Dichlorobenzene	3540C/3550B	8270C[6]/1625C	3.2	3.1	9
1,2,4-Trichlorobenzene	3540C/3550B	8270C[6]/1625C	6	0.81	1.8
Hexachlorobenzene	3540C/3550B	8270C[6]/1625C	12	0.38	2.3
Phthalate Esters			**µg/kg**	**mg/kg OC**	
Dimethyl phthalate	3540C/3550B	8270C/1625C	20	53	53
Diethyl phthalate	3540C/3550B	8270C/1625C	20	61	110
Di-n-butyl phthalate	3540C/3550B	8270C/1625C	20	220	1700
Butyl benzyl phthalate	3540C/3550B	8270C/1625C	20	4.9	64
Bis(2-ethylhexyl)phthalate	3540C/3550B	8270C/1625C	20	47	78
Di-n-octyl phthalate	3540C/3550B	8270C/1625C	20	58	4500
Ionizable Organic Compounds			**µg/kg**	**µg/kg**	
Phenol	3540C/3550B	8270C/1625C	20	420	1200
2 Methylphenol	3540C/3550B	8270C/1625C	6	63	63
4 Methylphenol	3540C/3550B	8270C/1625C	20	670	670
2,4-Dimethylphenol	3540C/3550B	8270C/1625C	6	29	29
Pentachlorophenol	3540C/3550B	8270C/1625C	61	360	690
Benzyl alcohol	3540C/3550B	8270C/1625C	6	57	73
Benzoic acid	3540C/3550B	8270C/1625C	100	650	650
Miscellaneous Compounds			**µg/kg**	**mg/kg OC**	
Dibenzofuran	3540C/3550B	8270C/1625C	20	15	58
Hexachlorobutadiene	3540C/3550B	8270C/1625C	20	3.9	6.2
N-Nitrosodiphenylamine	3540C/3550B	8270C/1625C	12	11	11
Total PCBs	3540C/3550B	8082	67	12	65
Guaiacols and Resin Acids			**µg/kg**	**µg/kg**	
3,4,5-trichloroquaiacol	3540C/3550B	8270C/1625C	1	---	---
Tetrachloroquaiacol	3540C/3550B	8270C/1625C	2	---	---
Abietic acid	3540C/3550B	8270C/1625C	100	---	---
Dehydroabietic acid	3540C/3550B	8270C/1625C	100	---	---
Pimaric acid	3540C/3550B	8270C/1625C	100	---	---

Analyte	Prep Method[1]	Analytical Method[2]	Sediment MDL [3,4]	SQS	CSL
Pesticides			**µg/kg**	**µg/kg**	
Total DDT	3550B	8081A	---	---	---
p,p'-DDE	3550B	8081A	2.3	---	---
p,p'-DDD	3550B	8081A	3.3	---	---
p,p'-DDT	3550B	8081A	6.7	---	---
Aldrin	3550B	8081A	1.7	---	---
Chlordane	3550B	8081A	1.7	---	---
Dieldrin	3550B	8081A	2.3	---	---
Heptachlor	3550B	8081A	1.7	---	---
Lindane	3550B	8081A	1.7	---	---

Notes

1. Recommended sample preparation methods are: PSEP (1997a,b) and USEPA Method 3050B and 3500 series (sample preparation methods from SW-846 [USEPA 1986] and subject to changes by USEPA updates).
2. Recommended sample cleanup methods are: Sample extracts subjected to gel permeation chromatography (GPC) cleanup follow the procedures specified by USEPA SW-846 Method 3640A. Special care should be used during GPC to minimize loss of analytes. If sulfur is present in the samples (as is common in most marine sediments), cleanup procedures specified by USEPA SW-846 Method 3660B should be used. All PCB extracts should be subjected to sulfuric acid/permanganate cleanup as specified by USEPA SW-846 Method 3665A. Additional cleanup procedures may be necessary on a sample-by-sample basis. Alternative cleanup procedures are described in PSEP (1997a,b) and USEPA (1986).
3. MDL, SQS, and CSL are on a dry weight basis.
4. The recommended MDL is based on a value equal to one third of the 1988 dry weight lowest apparent effects threshold (LAET) value (Barrick et al. 1988) except for the following chemicals: 1,2-dichlorobenzene, 1,2,4-trichlorobenzene, hexachlorobenzene, hexachlorabutadiene, n-nitrosodiphenylamine, 2-methylphenol, 2,4-dimethylphenol, and benzyl alcohol, for which the recommended MDL is equal to the full value of the 1988 dry weight LAET.
5. Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples, Puget Sound Estuary Program, April 1997.
6. Selected ion monitoring may improve the sensitivity of USEPA Method 8270C and is recommended in cases when detection limits must be lowered to human health criteria levels or when TOC levels elevate detection limits above ecological criteria levels. See PSEP Organics Chapter, Appendix B – Guidance for Selected Ion Monitoring (1997).

Table 4–2. Dioxin/Furan Analytical Method and Sediment Method Detection Limit

Parameter	Analysis Method[1]	Sediment MDL[2]
2,3,7,8-TCDD	1613B	0.2 to 0.5
1,2,3,7,8-PeCDD	1613B	0.2 to 0.5
1,2,3,4,7,8-HxCDD	1613B	1 to 5
1,2,3,6,7,8-HxCDD	1613B	1 to 5
1,2,3,7,8,9-HxCDD	1613B	1 to 5
1,2,3,4,6,7,8-HpCDD	1613B	1 to 5
OCDD	1613B	10
Total Tetra-Dioxins (TCDD)	1613B	0.2 to 0.5
Total Penta-Dioxins (PeCDD)	1613B	1 to 5
Total Hexa-Dioxins (HxCDD)	1613B	1 to 5
Total Hepta-Dioxins (HpCDD)	1613B	1 to 5
2,3,7,8-TCDF	1613B	1 to 5
1,2,3,7,8-PeCDF	1613B	1 to 5
2,3,4,7,8-PeCDF	1613B	1 to 5
1,2,3,4,7,8-HxCDF	1613B	1 to 5
1,2,3,6,7,8-HxCDF	1613B	1 to 5
1,2,3,7,8,9-HxCDF	1613B	1 to 5
2,3,4,6,7,8-HxCDF	1613B	1 to 5
1,2,3,4,6,7,8-HpCDF	1613B	1 to 5
1,2,3,4,7,8,9-HpCDF	1613B	1 to 5
OCDF	1613B	10
Total Tetra-Furans (TCDF)	1613B	0.2 to 0.5
Total Penta-Furans (PeCDF)	1613B	1 to 5
Total Hexa-Furans (HxCDF)	1613B	1 to 5
Total Hepta-Furans (HpCDF)	1613B	1 to 5

Notes

1. Method 1613 Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division. October 1994.
2. Method detection limit (MDL) is on a dry weight basis in pg/g.

4.2 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 MDLs listed in Tables 4–1 and 4–2.

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
- Analytical results in Environmental Information Management (EIM) format.

4.3 Biological Analyses

This section describes specific procedures for the suite of bioassays used for SMS biological analysis. The decision to conduct confirmatory biological testing will be contingent on the chemistry results for a given location. In order to meet the 56-day holding time limit for sediments, archived sediments will not be used for biological testing. Instead, locations of sedimentary chemical exceedance will be re-sampled before submission for biological testing. This strategy provides ample time for bioassay preparation as well as time for retests if necessary.

Bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out background conditions and sediment grain-size effects on bioassay organisms. These reference sediments will be collected at the same time as other bioassay sediment samples. Wet-sieving in the field is required to find an adequate match between sample and reference sediments. These wet-sieving results will be recorded and submitted with the sample analysis results. The location of the reference sediment sampling location will be recorded to the nearest 0.1 second using NAD83.

All sediment samples collected for bioassays during the re-sampling event will be stored at 4°C, either with no headspace or under a nitrogen atmosphere (i.e., nitrogen-purged headspace), until initiation of the biological testing. All bioassays, including retests, will commence within 56 days from collection. The laboratory will maintain chain-of-custody procedures throughout biological testing.

Collection of sediments for bioassay testing will be initiated as soon as possible after the first chemical results become available. This includes obtaining test organisms and control and reference sediments in a timely manner. This approach will support the opportunity for any additional biological testing within the allowable 56-day holding period, if such need arises. As initial chemistry data become available, the project manager and the bioassay laboratory representative will maintain close coordination with Ecology to expedite biological testing decisions.

The three bioassays (amphipod mortality, larval development, and juvenile polychaete growth) will be conducted on each sample identified for biological testing (Table 4–3). All biological testing will be in strict compliance with Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (PSEP 1995), with appropriate modifications as specified in the annual review process. General biological testing procedures and specific procedures for each sediment bioassay are summarized in the following sections. Section 5.0 discusses the specific QA/QC measures employed as part of the biological analyses.

Table 4–3. Bioassay Tests and Target Organisms

Bioassay Test	Test Organism
10-day Amphipod Mortality Test	*Rhepoxynius abronius;* *Eohaustorius estuarius;* *Ampelisca abdita*
48-hour Larval Development Test[1] (echinoderm or bivalve)	*Dendraster exentricus;* *Mytilus galloprovincialis*
20-day Juvenile Polychaete Growth Test	*Neanthes arenaceodentata*

Notes
1. Actual test length may vary based on larval development stage.

4.3.1 Amphipod Mortality Bioassay

This test involves exposing the amphipods *Rhepoxynius abronius*, *Eohaustorius estuarius*, or *Ampelisca abdita* to test sediment for 10 days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 25 percent mean mortality.

R. abronius is the preferred amphipod species for coarser-grained sediments (less than 60 percent fines). *E. estuarius* is the preferred test organism for sediments with percent fines greater than 60 percent, while testing with *A. abdita* is recommended when sediment clay content exceeds 20 percent.

Ammonia and sulfides toxicity may interfere with test results for this bioassay. If elevated levels of these analytes are suspected, aeration may need to be conducted throughout the test. This action will be coordinated with Ecology. Ammonia reference toxicant tests may be conducted if elevated ammonia concentrations are suspected in test sediments.

4.3.2 Larval Development Bioassay

This test monitors larval development of a suitable echinoderm or molluscan species (e.g., *Dendraster excentricus* or *Mytilus galloprovincialus*) in the presence of test sediment. *D. excentricus* is the preferred species over *M. galloprovincialis*. The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) that is determined by the developmental stage of organisms in a sacrificial seawater control (PSEP 1995). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality. The seawater control has a performance standard of 70 percent mean normal survivorship. Initial counts will be made for a minimum of five 10 mL aliquots. Final counts for seawater control, reference sediment, and test sediment will be made in 10 mL aliquots.

As with the amphipod mortality bioassay, ammonia and sulfides toxicity may interfere with test results for the larval development bioassay. If elevated levels of these analytes are suspected, aeration may need to be conducted throughout the test. This action will be coordinated with Ecology. Ammonia reference toxicant tests may be conducted if elevated ammonia concentrations are suspected in test sediments.

4.3.3 Juvenile Polychaete Growth Bioassay

This sublethal, static-renewal toxicity test can be used to determine the relative toxicity of marine sediments using the juvenile polychaete *Neanthes arenaceodentata*. The test is conducted in accordance with the methods described by PSEP (1995) and modifications to the test approved by the DMMP agencies.

The toxicity test involves a 20-day exposure to sediments and the response of the organisms to test sediments as compared to their response in control (clean) and reference sediment. Following the bioassay, polychaete growth is reported as mean individual growth (expressed as mg/individual/day).

The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 80 percent of the control growth. The DMMP agencies have established a target control growth performance guideline of greater than or equal to 0.72 mg/individual/day. The *N. arenaceodentata* negative control has a target growth rate of greater than or equal to 0.72 mg/individual/day and a performance standard of greater than or equal to 0.38 mg/individual/day (below which the test is considered a QA/QC failure). Use of worms smaller than 0.25 mg (dry weight) at the beginning of the test will also be considered a QA/QC failure.

4.3.4 Bioassay Interpretation

Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. The SMS biological effects criteria are presented in Table 4–4.

Table 4–4. SMS Biological Effect Criteria

Biological Test[1]	Sediment Quality Standards	Cleanup Screening Levels
Amphipod Mortality	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 25% greater, on an absolute basis, than the reference sediment mean mortality.	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30% greater, on an absolute basis, than the reference sediment mean mortality.
Larval Development	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 85% of the mean normal survivorship in the reference sediment.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 70% of the mean normal survivorship in the reference sediment.
Juvenile Polychaete Growth	The mean individual growth rate of polychaetes in the test sediment is less than 70% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P P≤0.05) from the reference sediment mean individual growth rate.	The mean individual growth rate of polychaetes in the test sediment is less than 50% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P P≤0.05) from the reference sediment mean individual growth rate.

Notes

1. Sufficient sediment will be collected to conduct the suite of three laboratory bioassays: amphipod mortality, larval development, and juvenile polychaete growth.

Source: Ecology 2003.

4.3.5 Biological Laboratory Reporting

The biological laboratory responsible for conducting laboratory bioassays will prepare a written report documenting all the activities associated with toxicity testing. At a minimum, the following will be included in the report:

- Results of the laboratory bioassay analyses and QA/QC results for test and reference sediments (raw data will be legible or typed; illegible data may result in the need for a retest if the agencies cannot interpret the data as a result);
- Results of positive and negative controls, including reference toxicant specific laboratory control limits;
- Water quality monitoring results;
- All protocols used during analyses, including explanation of any deviation from the PSEP protocols and the approved sampling plan;
- Chain-of-custody procedures, including explanation of any deviation from the identified protocols;
- Location and availability of data, laboratory notebooks, and chain-of-custody forms;
- Source of test organisms; and
- Source of control sediment and control seawater.

5.0 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.

5.1 Measurements of Data Quality

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

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 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 (%Rs) 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.

5.2 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. The field QA samples to be collected are described in Section 5.2.1. The laboratory QA samples are discussed in Section 5.2.2.

5.2.1 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 Replicates

Field duplicates 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 replicates will be collected at a 5 percent frequency. The replicates will be designated for the same analysis as the original samples and submitted to the laboratory blind (i.e., with no indication of the contents or the associated sample). The field replicates 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.

5.2.2 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 semi-volatile organic compounds (SVOCs), PCBs, 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.

5.3 Biological Testing QA/QC for Sediment Samples

The detailed standard operating procedures (SOPs) for the bioassay tests proposed for this investigation will be provided by the selected biological laboratory upon request. This section summarizes the toxicity test QA/QC procedures to be implemented to ensure the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls, reference sediment samples, laboratory replicates, and daily water quality measurements. In addition, close contact with the biological laboratory will be maintained prior to and during the testing period to resolve any QA/QC problems or testing methodology issues in a timely manner.

5.3.1 Negative Control

The negative control consists of clean, inert material tested in parallel with the test sediments under identical test conditions. The biological testing laboratory provides this clean material, which usually consists of sediment collected from the original location from which the test organisms were harvested. The test acceptability criteria are based on the results of the negative control. A test with at least 90 percent survival (70 percent mean normal survivorship for larval development) in negative control test chambers is considered acceptable.

5.3.2 Positive Control

A positive control will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and which provide an indication of the sensitivity of the particular organisms used in a bioassay. Cadmium chloride or other appropriate reference toxicant will be used for the amphipod mortality, larval development, and juvenile polychaete growth bioassays.

5.3.3 Reference Sediment

Reference sediments are chosen to closely match the grain size distribution of the test sediments. Reference sediments from the approved Carr Inlet reference area are proposed for this study. The reference sediment will be run with each test batch for all three bioassays for comparison and to aid in interpretation. All reference sediments will be analyzed for total solids, total volatile solids, TOC, bulk ammonia, bulk sulfides, and grain-size.

All bioassays have performance standards for reference sediments (see Section 4.2). Failure to meet these standards may result in the requirement to retest.

5.3.4 Laboratory Replication

Five laboratory replicates of each test sediment, reference sediment, negative control, and elutriate concentration will be run for each respective bioassay. The replication of tests provides multiple observations of effects to test organisms so that statistical comparisons can be made between test and reference sediments.

5.3.5 Bioassay Water Quality

Water quality monitoring will be conducted for the amphipod, larval development, and juvenile polychaete growth bioassays. This consists of daily measurements of salinity, temperature, pH, and dissolved oxygen (every third day for juvenile polychaete growth bioassay). Ammonia and sulfides will be determined at test initiation and termination, and interstitial salinity will be determined prior to the test setup. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls). Parameter measurements must be within the limits specified for each bioassay as listed in Table 5–1. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group. In addition, interstitial ammonia measurements at test initiation and test termination will be conducted for the amphipod test.

Table 5–1. Water Quality Control Limits

Test (*Test Species*)	Temperature	Salinity	Dissolved Oxygen	pH[3]
Amphipod Mortality (*E. estuarius; R. abronius*)	15 ± 1 °C	Ambient[1]	NA[2]	---
Larval Development (*Mytilus* sp.)	16 ± 1 °C	28 ± 1 ppt	> 60% saturation	---
Larval Development (*D. excentricus*)	15 ± 1 °C	28 ± 1 ppt	> 60% saturation	---
Juvenile Polychaete Growth (*N. arenaceodentata*)	20 ± 1 °C	28 ± 2 ppt	NA[2]	---

Notes
1. Same as interstitial salinity of test sediment.
2. Continuous aeration is required by the protocol, so the dissolved oxygen should not be a cause of concern.
3. pH is monitored as a water quality parameter. There are generally no control limits for pH; however measurements of pH may be useful in interpreting results (Ecology 2003).

Source: Ecology 2003.

5.4 Data Validation

The data generated as part of this investigation will undergo an independent quality assurance review and data validation. A QA2 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). A QA1 review of bioassay data will be conducted evaluating the acceptability of test results for positive controls, negative controls, reference sediments, replicates, and experimental water quality conditions such as temperature, salinity, pH, and dissolved oxygen (PTI 1989b).

6.0 Data Analysis and Reporting

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

6.1 Analysis of Sediment Profile Imaging Data

SAIC has developed a standardized and formalized technique known as Remote Ecological Monitoring of the Seafloor (REMOTS) for SPI image collection, analysis, and interpretation. Physical and biological parameters are measured directly from the SPI transparencies using a video digitizer and computer image analysis system. The image analysis system can measure up to 256 different tonal color scales so that subtle features can be accurately digitized and measured. The image analysis software allows the measurement and storage of data with 21 different variables for each image. A representative image from each station will undergo full computer image analysis. In addition, a second image from 20 percent of the stations will be analyzed for quality assurance.

SPI imagery will be used to estimate the percent wood waste by volume and evaluate the health of the benthic macroinvertebrate community. Depth of the apparent RPD, infaunal successional stage, and calculation of the Organism-Sediment Index (OSI) are three key REMOTS image analysis parameters used to assess the health of the benthic infaunal community.

6.1.1 Determination of Wood Waste

An estimate of percent wood waste by volume will be determined from SPI images. The percent of total area of wood debris in an SPI image can be estimated by comparing the SPI image to proportional estimate templates of known percent area. Another option is to calculate percent wood debris using the REMOTS image analysis if the color of the wood debris is similar between particles. In addition, visual inspection of surface van Veen and core samples will assist in determining an estimate of wood waste by volume at a particular location.

6.1.2 Apparent Redox Potential Discontinuity

The depth of the apparent RPD, which is the change from oxidized to reduced sediment, will be measured using SPI photography and REMOTS image analysis. The apparent RPD is a sensitive indicator of infaunal succession, sediment bioturbation activity, and sediment oxygen demand. In fine-grained coastal areas where there is oxygen in the overlying water column, surficial sediment has a higher reflectance relative to underlying hypoxic or anoxic sediment. This is because the surface sediment contains oxidized forms of iron (olive in color when associated with organic particles), while iron present in sediments below this oxygenated layer are in electrochemically reduced form (gray to black in color). The visible oxic/anoxic boundary is referred to as the apparent RPD. In general, the depth of the actual RPD is shallower than the apparent RPD because bioturbation mixes oxidized particles downward in the sediment column. As a result, the apparent RPD depth provides an estimate of the degree of biogenic sediment mixing. The cross-sectional area of the aerobic sediment is determined from SPI images by density-slicing its unique reflectance value. This oxidized area can then be digitized, measured to scale, and divided by the prism window width to obtain a mean depth for the apparent RPD.

6.1.3 Infaunal Successional Stages

The mapping of infaunal successional stages from SPI images is based on the theory that organism/sediment interactions follow a predictable sequence after a major seafloor disturbance. Infaunal succession following a major seafloor disturbance initially involves pioneering populations (Primary or Stage I succession) of very small organisms living at or near the sediment/water interface (Pearson and Rosenberg 1978; Rhoads and Germano 1986). In the absence of further disturbance, infaunal deposit feeders eventually replace these early successional assemblages. The start of this "infaunalization" process is designated as Stage II. Large, deep-burrowing infauna (Stage III taxa) represent a high order successional stage typically found in areas of low disturbance. The presence of Stage III feeding voids indicates the presence of Stage III organisms.

6.1.4 Organism-Sediment Index

The OSI provides a measure of benthic habitat quality based on dissolved oxygen conditions, depth of the apparent RPD, infaunal successional stage, and presence or absence of sedimentary methane measured during REMOTS image analysis (Rhoads and Germano 1986). The OSI is a numerical index ranging from -10 to +11. The lowest value is given to bottom sediments with low or no dissolved oxygen in the overlying bottom water, no apparent macrofaunal life, and methane gas present in the sediment. High OSI values are given to aerobic bottom sediments with a deep apparent RPD, mature macrofaunal community, and no methane gas. The numerical values and ranges used in calculating the OSI are provided in Table 6–1. Previous SPI surveys conducted in various coastal regions by SAIC (e.g., Puget Sound, Long Island Sound, Chesapeake Bay, and the Florida and Louisiana coasts) have shown that OSI values less than 7 indicate a stressed or disturbed benthic environment.

6.1.5 Physical Parameters

Physical sediment parameters that will be measured include grain size, TOC, and total sulfides. In addition, SPI photography will also be used to evaluate the grain-size mode and range, sediment bearing capacity, the presence and thickness of depositional layers, and any evidence of erosional or depositional events. The distribution of grain-size major mode in phi sizes (Φ) will be determined from SPI photography using REMOTS image analysis. The grain-size mode and distribution will provide a direct measurement of granular characteristics. The camera prism penetration depth will provide a measure of sediment-bearing capacity. Evidence of erosional and depositional events will be useful for determining the relative energy at a given location, and thus the sediments' potential for redistribution.

Table 6–1. Calculation of the Organism-Sediment Index

Choose One Value:	**Mean RPD Depth Classes**	**Index Value**
	0.00 cm	0
	> 0 - 0.75 cm	1
	0.76 - 1.50 cm	2
	1.51 - 2.25 cm	3
	2.26 - 3.00 cm	4
	3.01 - 3.75 cm	5
	> 3.75 cm	6
Choose One Value:	**Successional Stage**	**Index Value**
	Azoic	- 4
	Stage I	1
	Stage I – II	2
	Stage II	3
	Stage II – III	4
	Stage III	5
	Stage I on III	5
	Stage II on III	5
Choose One or Both if Appropriate:	**Chemical Parameters**	**Index Value**
	Methane Present	- 2
	No/Low Dissolved Oxygen	- 4
Organism-Sediment Index =		Range: -10 to +11

6.2 Analysis of Video Probe Data

The video probe survey will generate a video of sediments with depth, an audio recording describing sediment characteristics and/or wood debris presence/absence with depth, and a written transcription to a core log. Results from the video probe survey will be analyzed to determine the vertical extent of wood debris up to 7 feet below the sediment surface at each location. These results will be verified with analysis of co-located sediment cores.

6.3 Analysis of Surface and Subsurface Sediment Chemistry Data

The analysis of surface and subsurface chemistry data will include the comparison of the results to the SMS numeric criteria and DMMP interim criteria for dioxin/furan concentrations. The sediment chemistry data will be summarized and presented in tables indicating sediment locations, detected contaminants, any detection limits that exceed SQS and/or CSL numeric criteria, and any data qualifiers assigned by the laboratory or during the data validation efforts. The locations with chemistry exceeding numeric criteria will be mapped to delineate any areas that may require cleanup or other remedial action.

6.4 Analysis of Tissue Residue Chemistry

The analysis of tissue residue data will include a comparison to co-located sediment chemistry results and to the DMMP target tissue levels. The tissue chemistry data will be summarized and presented in tables indicating collection locations, species, detected contaminants, and data qualifiers assigned by the laboratory or during the data validation efforts.

6.5 Analysis of Biological Data

The analysis of biological data will include comparison to SMS biological effects criteria. Toxicity test data results will be summarized and presented in tables indicating sediment locations and test results that exceed SQS and/or CSL biological effects interpretive criteria, along with the results of statistical comparisons to reference sediment test results. The sampling locations with sediment toxicity exceeding the SMS criteria will be mapped to delineate any areas that may require cleanup or other remedial action.

6.6 Reporting Procedures

A written data report documenting all activities associated with collection, transportation, chemical analyses, and biological testing of sediment samples will be prepared. The report will include recommendations for further action or investigation based on the data results of this investigation. The chemical, biological, 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;
- Physical descriptions of samples and site habitat;
- 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 summarizing SPI observations as they may relate to benthic community health;
- Maps and data tables of sediment chemistry (results in mg/kg organic carbon, and dry weight) and comparison of results to SMS interpretive criteria;
- Maps and data tables showing estimates of percent wood debris (both horizontally and vertically);
- Chain-of-custody records;
- Chemistry and biological testing results and laboratory reports;
- Copies of field and sampling logs as appendices; and
- QA/QC summary; and
- Data validation reports.

7.0 References

Barrick, R.C., D.S. Becker, L.B. Brown, H. Beller, and R. Pastorak. 1988. Sediment Quality Values Refinement: 1988 Update and Evaluation of Puget Sound AET. Volume I. Final Report. Prepared for tetra tech, Inc., Bellevue, WA, and the U.S. Environmental Protection Agency, Region 10, Seattle, WA. Prepared by PTI Environmental Services, Bellevue, WA.

Ecology. 2003. Sediment Sampling and Analysis Plan Appendix; Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards (Chapter 173-204 WAC). Prepared for the Washington State Department of Ecology, Sediment Management Unit, Lacey, WA. Prepared by PTI Environmental Service, Bellevue, WA. Ecology Publication No. 03-09-043. Revised April 2003.

Pearson, T.H. and R. Rosenberg. 1978. Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment. Oceanogr. Mar. Biol. Ann. Rev. 16: 229-311.

PSEP. 1995. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Final Report. Prepared for U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA. Washington State Department of Ecology, Olympia, WA.

PSEP. 1997a. Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. U.S. Environmental Protection Agency, Region 10, Seattle, WA, for Puget Sound Estuary Program. April 1997.

PSEP. 1997b. Recommended Guidelines for Measuring Metals in Puget Sound Water, Sediment, and Tissue Samples. U.S. Environmental Protection Agency, Region 10, Seattle, WA, for Puget Sound Estuary Program. April 1997.

PSEP. 1997c. Recommended Guidelines for Measuring Organic Compounds in Puget Sound Sediment and Tissue Samples. U.S. Environmental Protection Agency, Region 10, Seattle, WA, for Puget Sound Estuary Program. April 1997.

PSEP. 1997d. Recommended Quality Assurance and Quality Control Guidelines for the Collection of Environmental Data in Puget Sound. U.S. Environmental Protection Agency, Region 10, Seattle, WA, for Puget Sound Estuary Program. April 1997.

PTI. 1989a. Data validation guidance manual for selected sediment variable. Prepared for the Washington State Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1989b. Puget Sound Dredged Disposal Analysis guidance manual: data quality evaluation for proposed dredged material disposal projects. Prepared for the Washington State Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA.

Rhoads, D.C. and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiology 142: 291-308.

SAIC. 2008a. Sediment characterization study in Port Gardner and Lower Snohomish Estuary, Port Gardner, WA, data gaps report. Draft Report. Prepared for Washington State Department of Ecology, Lacey, WA. Prepared by Science Applications International Corporation. May 20, 2008.

SAIC. 2008b. Woodard Bay Sediment Characterization Report. Prepared for the U.S. Army Corps of Engineers, Seattle District. Prepared by Science Applications International Corporation, Bothell, WA.

USACE. 2003. Dredged material evaluation and disposal procedures. A users manual for the Puget Sound Dredged Disposal Analysis (PSDDA) program. February 2000 (updated with 2003 COC table). Prepared by the U.S. Army Corps of Engineers, Seattle District, U.S. Environmental Protection Agency, Region 10, Washington State Department of Natural Resources, and Washington State Department of Ecology.

USEPA. 1986. Test Procedures for Solid Waste. 3rd Edition. SW-846. U.S. Environmental protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Van den Berg, M., L.S. Bimbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, and R. Peterson. The 2005 World Health Organization Re-Evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. Prepared for the World Health Organization (WHO). ToxSci Advance Access published July 7, 2006. Published by Oxford University Press on behalf of the Society of Toxicology.

Appendix A
Health and Safety Plan

Location: Port Gardner, Everett, WA

Site description: Port Gardner 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 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 the manmade Jetty Island, composed of sediment from continual maintenance dredging of the river channel. The Snohomish River estuary additionally consists of a series of interconnected sloughs that flow through the lowlands east and north of the river's main channel. These waterways can experience tidal influence as far as 20 miles upstream.

The fluvial sediment load of the Snohomish River is deposited throughout Port Gardner Bay and maintains mudflats and tidal marshlands in the estuary. The extensive tide flats and sloughs provide important habitat for the spawning and rearing of forage fish (e.g., Pacific herring, surf smelt, and sand lance) and the migration of juvenile salmonids. However, dikes and other forms of tidally restrictive structures emplaced for agricultural development have resulted in the loss of considerable wetland habitat throughout the estuary. The waterfront of the City of Everett is heavily industrialized, and tideland filling, shoreline armoring, and over-water structures are present throughout the region.

Scope of work to be performed by SAIC and subcontractors: Under the direction of the Washington State Department of Ecology (Ecology), SAIC and its subcontractors will conduct a sediment investigation to determine the spatial extent of contaminant in the marine sediments of Port Gardner and the lower Snohomish River estuary. The objectives of the study will be to conduct a multi-faceted, tiered sediment characterization of the site designed to define the nature and extent of potential sediment contamination. Results of the sediment characterization will be used to determine whether potential cleanup action(s) are warranted to minimize the potential for adverse impacts to the biotic community. Detailed information on the scope of work can be found in the Sampling and Analysis Plan (SAP).

Sediment Profile Imaging

A Benthos® Sediment Profile Imaging (SPI) camera will be used to photograph the sediment profile at 114 locations throughout the Port Gardner study area. The SPI survey will be used to assess the condition of the benthic habitat and the physical characteristics of surface sediments. Information from the SPI survey may be used to refine the sampling locations for the other data types.

Bio-Marine Enterprises, a vessel subcontractor, will provide the research vessel (R/V) *Kittiwake*. A differential global position system (DGPS) will be used to position the vessel. The self-contained SPI camera system will be lowered to the seafloor three times at each station. Digital photographic images will be downloaded to a laptop at regular intervals to verify successful image acquisition.

Surface Sediment Sample Collection

Surface sediment (0 to 10 cm) samples will be collected at multiple locations in each Focus Area for a total of 61 sampling locations (Figures 2 to 5). Samples will be collected, as described in the SAP, using a 0.2 m^2 dual stainless steel van Veen grab sampler deployed from the R/V *Kittiwake.* A DGPS

will be used to position the vessel to an accuracy of ±3 meters. The grab sampler will be deployed from the vessel by winch and lowered to the seafloor to collect a surface sediment sample. The grab sampler will then be retrieved, the overlying water siphoned off, and the sediment processed by SAIC personnel.

The R/V *Growler*, owned and operated by SAIC, will be used to sample shallow water locations in Areas 2, 3, and 4 if not accessible by the R/V *Kittiwake*. Sediment samples will be collected at each station using a 0.06 m^2 stainless steel Ponar grab sampler. A global position system (GPS) will be used to position the vessel.

Sediment collected from each location will be homogenized with stainless steel utensils until uniform in color and texture. SAIC personnel will transfer the sediment to a pre-cleaned stainless steel bowl for compositing. Sediment will then be transferred to pre-labeled sample jars and placed on ice in coolers. Following completion of sampling operations, SAIC will pack the sample jars in iced coolers and send them by overnight courier to the analytical laboratories.

The Puget Sound Estuary Protocols (PSEP 1997) will be used for cleaning the grab sampler and stainless steel homogenizing equipment. Potentially contaminated sediments may be encountered; therefore, use of appropriate PPE will be in place. The cleaning procedure under these conditions consists of scrubbing with phosphate-free detergent (i.e., liquinox®) and rinsing with clean *in situ* site water, and a final rinse of distilled water. All excess sediment remaining after sampling will be washed overboard in the vicinity of the collection site.

Subsurface Sediment Core Sampling

Subsurface sediment cores will be collected at 15 locations throughout the study area. These samples will be co-located with surface sediment and SPI sample locations so that the vertical extent of contamination can be determined in the event that adverse impacts are observed in surface sediments. Core samples will be taken using an 11-foot vibracore sediment sampler deployed from the R/V *Nancy Anne*, as described in the SAP. The R/V *Nancy Anne* is owned and operated by Bill Jaworski of Marine Sampling Systems. Subsurface sediment samples will be individually composted over intervals (0-1, 1-3, 3-5, 5-7, 7-9, 9-11 feet) transferred to pre-labeled sample jars, and placed on ice in coolers. The samples will be sent to the analytical laboratories by overnight courier.

Fish, Clam, and Crab Sampling

A 7.6-meter otter trawl will be used to collect Dungeness crab (*Cancer magister*) and English sole (*Parophrys vetulus*) using the R/V *Kittiwake*. All fish will be immediately collected upon net retrieval and transferred to a holding tank to be identified and enumerated. Non-target species will be promptly and carefully released to the water.

Small shovels and trowels will be used to collect Littleneck clams and Manila clams at low tide from publicly accessible beaches in the vicinity of Focus Area 1 and 2 (Figure). If needed, the R/V *Growler* will be used to assist in the collection of crab and clam samples.

Field Equipment Decontamination

Sample homogenization equipment, including stainless steel mixing utensils and bowls, will be decontaminated following procedures in the SAP. The instrument will be scrubbed with site water, washed with phosphate-free detergent (i.e., Alconox™), and rinsed with distilled water. If a noticeable oily sheen or petroleum odor is observed, sampling gear and utensils used to process those samples will not be used for further sample processing. All hand work will be conducted with disposable nitrile gloves, which will be changed after handling each individual sample, as appropriate, to prevent cross contamination between samples and composites.

Figure 1. Port Gardner Bay Study Area Location

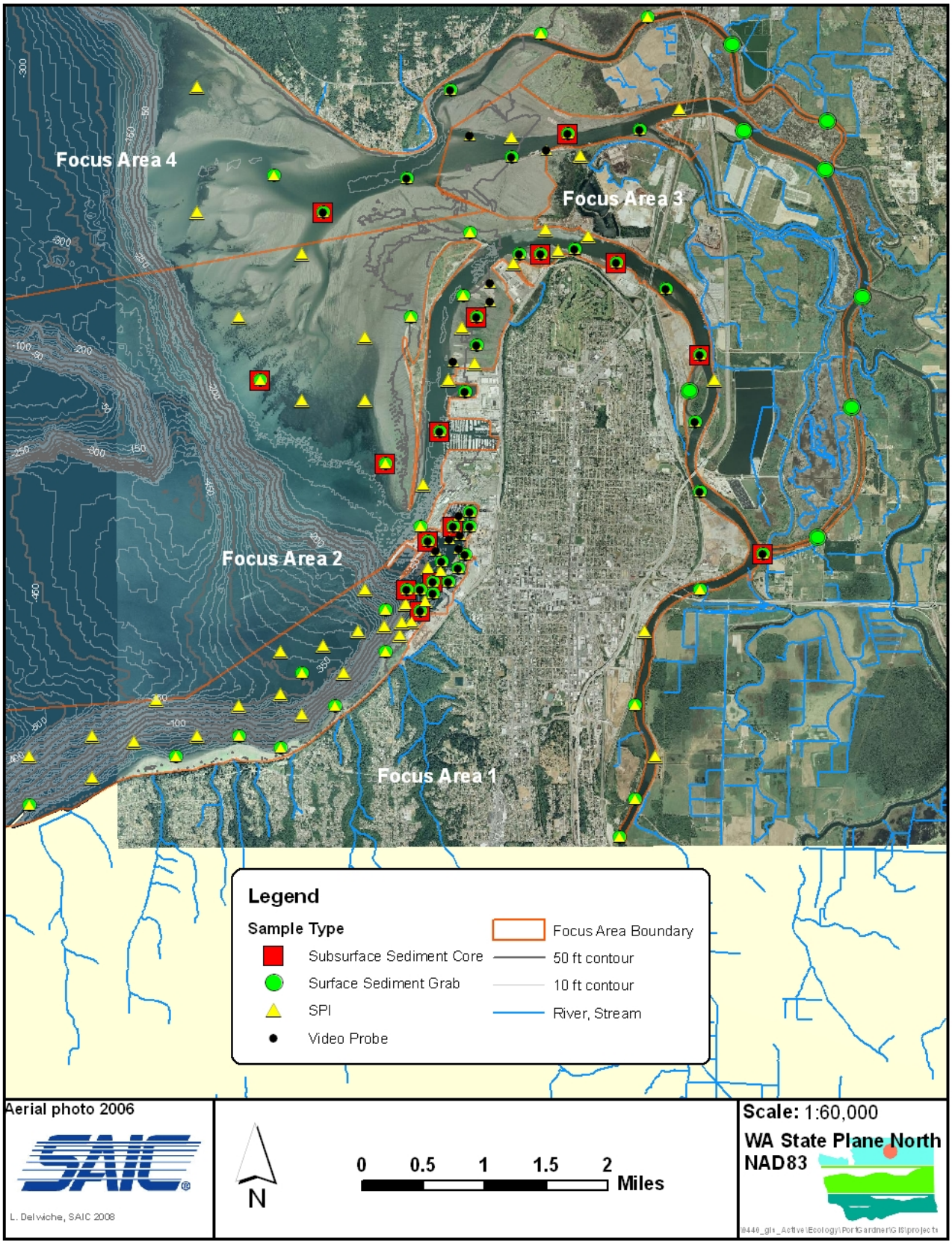


Figure 2. Port Gardner Target Sample Stations

SIGNATURES

Approval signatures: Signature below indicates review and approval of the plan and agreement that the anticipated hazards are correct and that planned hazard controls are sufficient.

Project Manager (PM) or Field Manager (FM) name and phone number:
(PM) John Nakayama (425) 482-3313 (FM) Leon Delwiche (425) 482-3313

Signature and date:

CIH, CSP, or designee name and phone number:
Ryan Rayburn (425) 482-3314

Signature and date:
July 15, 2008

Commitment to implement: Signature below indicates commitment to implement this plan and to ensure that project fieldwork is conducted safely.

Field Manager/Site Safety and Health Officer name and phone number:
John Nakayama (425) 482-3313 SSHO

Signature and date:

Commitment to comply:
Signature below indicates that the individual has reviewed this plan, has received site-specific training (briefing), and agrees to comply with the requirements of this plan.

Name	Signature	Date

Potential Hazards and Emergency Information

Potential Hazards

Traffic accidents associated with travel to and from the site
Struck by other vessels or land structures (piers, unmarked navigation hazards)
Person overboard, drowning
Lifting
Contact with powered rotating, pressurized and/or hydraulic equipment, pinching hazards (winch drum, boom, moving cables)
Contact with swinging sampling gear (sampler attached to winch cable over side of vessel)
Potential exposure to onsite contaminants (sediments)
Exposure to chemicals potentially used on site (liquinox, zinc acetate)
Environmental exposure (sunlight UV, rain, temperature extremes)
Physical hazards (trip/fall, cuts/contusions, etc.)
Fire or explosion

Emergency Phone Numbers

Medical /Police/Security/Fire: 911
Coast Guard: 911 or cell phone:*24, (206) 217-6001

SAIC INCIDENT NOTIFICATION CONTACT LIST

NAME	POSITION	OFFICE PHONE	CELL PHONE	E-Mail/PAGER
Ted Turk	Program Manager	(425) 482-3324	(206) 795-6051	ted.r.turk@saic.com
Steve Davis **All Safety Related Incidents**	H&S Manager	(865) 481-4755	(865) 414-9035	stephen.l.davis@saic.com
Ryan Rayburn	West Region H&S	(425) 482-3314	(425) 478-4491	ryan.s.rayburn@saic.com
John Nakayama	Project Manager	(425) 482-3313	NA	john.s.nakayama@saic.com

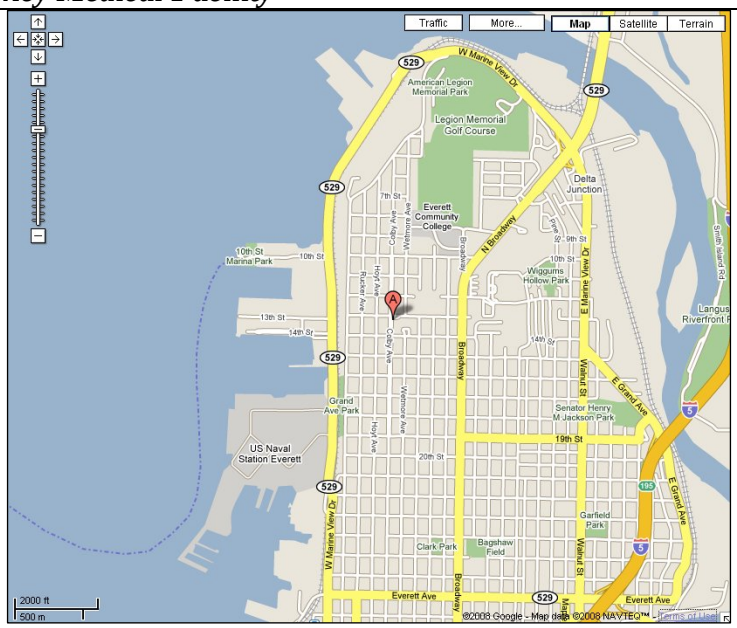
Emergency Medical Facility

Providence Everett Medical Center

1321 Colby Avenue
Everett, WA 98201

General: (425) 261-2000

Emergency: (360) 299-1311



1) Start on **W MARINE VIEW DR** (at W MARINE VIEW DR & 10TH ST in EVERETT) going toward W MARINE VIEW Dr – go **1.2** mi
2) Turn Right on **ALVERSON BLVD** - go **0.6** mi
3) Bear Left on **COLBY AVE** - go **0.8** mi
4) Make a U-Turn at 14TH ST onto **COLBY AVE**
5) Arrive at 1321 **COLBY AVE**, EVERETT, on the Right

Emergency Equipment Required On Site

Cellular phone (or verify immediate access to immediately available landline)
First aid kit (10 unit unitized kit or larger)
Fire extinguisher(s) rated at least 2A and 5B– Serviced annually and inspected monthly
Coast Guard approved floating devices (work vests or float coats)

Emergency Reporting

The FM will immediately report injuries or illnesses, vehicle accidents, releases (hazardous material, hazardous waste or uncharacterized waste), inspections by regulatory agencies, and any incident that could reasonably have caused a significant injury or property damage (fire, catastrophic equipment failure, capsized heavy equipment, etc.). The FM will contact emergency response organizations (if needed) and the PM. The PM will notify the client (as appropriate), Division Manager, Program Manager, and ECHS Manager. If the PM is not available, the FM will make the other notifications. See EC&HS Procedures 4.1, Incident Reporting and Investigation and 24, Regulatory Agency Inspections and Incident Reporting for details.

General Hazard Controls Applicable to all Work in this Program

General Hazard Controls Applicable to all Work

This plan represents a good-faith effort to identify, evaluate, and prescribe controls for the hazards that will be posed by this work. Revisions to this plan will be documented.
This work is subject to the requirements of the SAIC Environmental Compliance and Health and Safety (EC&HS) program. The FM will ensure that applicable provisions of EC&HS procedures are followed and that personnel have access to these procedures. Potentially applicable procedures include, but are not limited to: Procedure 4.1, Incident Reporting and Investigation; Procedure 8, Hazard Communication and Hazardous Chemical Control; Procedure 11, Lock Out/Tag Out; Procedure 12, Medical Surveillance; Procedure 13, Personal Protective Equipment; Procedure 15,

Hearing Conservation and Noise Control; Procedure 24, Regulatory Agency Inspections and Incident Reporting; Procedure 110, Vehicle Operation; Procedure 28, Hazardous Material Transportation; Procedure 130, Subsurface Asset/Hazard Avoidance; Procedure 150, Manual Lifting; Procedure 160, Excavation Safety; Procedure 170, Fall Protection and Procedure 180, Behavior Based Safety.

The FM will perform and document daily safety inspections to verify that the work is performed safely, that the requirements of this plan are met, that the public is not endangered by this work, and that no environmental releases or violations occur as a result of this work. All onsite personnel and subcontractors will be responsible to report unsafe, or potentially unsafe, conditions to the FM immediately. The FM will take action to correct any work that he/she judges to be unsafe or non-compliant with this plan.

SAIC subcontractors will be informed of the requirements of this plan and will be provided with copies or unrestricted access to this plan and must comply with the requirements of this plan. This plan does not relieve subcontractors of the regulatory requirement to provide a safe workplace for their employees. SAIC subcontractors are required to provide trained, experienced personnel and to operate equipment as required by the manufacturer's procedures, or the subcontractor's standard operating procedures; and are required have their own health and safety programs in compliance with all applicable regulations.

The FM will present a project kick-off safety briefing to cover this plan, physical hazards and chemicals, required hazard controls, and emergency contacts and additional safety briefings as needed (at least once per week). At least one person on site will have current first aid, cardiopulmonary resuscitation, and bloodborne pathogen training, unless emergency medical care is available within 5 minutes.

Portable electrical tools will be connected through a Ground Fault Circuit Interrupter. No energized electrical components will be exposed to potential personnel contact.

All vehicle operators must have valid drivers licenses and operate in compliance with applicable laws and regulations. Prohibited actions include driving while distracted and driving while using a cell phone. See EC&HS Procedure 110 for details.

No hot work or open flame is allowed in areas where flammable substances may be present. No hot work will be initiated without expressed authorization of the FM for each hot work event. Flammable and combustible liquids (gasoline, kerosene, fuel oil) will be transported and stored in containers approved by Factory Mutual, Underwriters Labs, or equivalent or in containers provided by the vendors (example: isopropanol).

Containers of hazardous chemicals must be labeled to indicate contents and hazard. MSDSs for hazardous chemicals must be available on site. Shipment and transportation of hazardous materials must be performed per DOT or IATA requirements. See QA FTP 651 for guidance.

An exclusion zone (at least barricade tape) will be established around any work that poses a risk of exposure to hazardous contaminants, hazardous chemicals, or physical hazards, in order to exclude unauthorized personnel. No food or drink will be allowed in exclusion zones. Personnel will wash their hands prior to eating or drinking if chemical contact occurs. The FM will determine if additional controls such as sawhorse barricades, traffic cones, or additional personal decontamination is needed.

The FM will ensure that equipment and supplies are available to control and remove any probable spills of chemicals. The required equipment and supplies will vary by project, type, and quantity of contaminants/chemicals, and may include sorbent pads, granular sorbent, sorbent boom, open-top drums, shovels, etc.

Each employee is empowered and expected to stop his or her own work or the work of co-workers if any person's safety or the environment are at risk. The FM is expected to support and reinforce this expectation.

Each major task must have a JSA and the work must be performed as required by the JSA.

Job Safety Analysis

Organization: SAIC
Work Activity: Dredged material mapping using sediment profile camera/photography

Personal Protective Equipment (PPE)	Selected	Comments
Clothing	X	Rain gear (tops and bottoms) as necessary
Safety Shoes	X	Steel toed rubber boots
Hard Hat	X	
Safety Glasses	X	As necessary
Fire Resistant Clothing		
Face Shields		
Goggles		If splash hazard exists
Coast Guard approved Type III Personal Floatation Devices (PFDs)	X	To be worn on deck. All PFDs with complaint whistle
Hearing Protection		
Air Purifying Respirator		
Supplied Air Respirator – SCBA		
Coast Guard-approved Type IV Life Ring	X	Required in vessel
Welding/Pipe Clothing		
Welding Mask/Goggles		
Gloves	X	As necessary
Other		
Safety Cones/Barricades		
Safety Vest		
Knee Pads		
Caution Tape		
Back Belt/Support		

Reviewer

Reviewer Name	**Position**	**Date Approved**
Ryan Rayburn	ECHS	July 15, 2008

Development Team

Development Team Member Name	Primary Contact	Position
John Nakayama	Y	SSHO

Job Steps

No	Job Steps	Potential Hazard	Critical Actions
1	Mobilize to work site	Traffic accident	Compliance with EC&HS Procedure 110, Vehicle Operation (valid drivers license, seat belt use, routine vehicle inspections, no cell phone use while driving).
2	Sediment sampling from vessel	Being struck by camera attached to winch cable	The vessel subcontractor will provide a trained winch operator. The operator will keep the sampler low to the deck when deploying the

			camera over the side to minimize swinging. The camera will be deployed and retrieved when the vessel is relatively stable (e.g., wait until wakes from passing vessels have dissipated). Personnel will stand clear of areas where the camera can swing and strike personnel (e.g., between camera and gunnel of vessel). If necessary, tag lines (see SAP) will be used to minimize the swing of the camera during deployment. Safety pins are removed only when the gear is over the rail. When not in use, the camera should be securely fastened to the deck.
		Man overboard and drowning	Personnel will wear Coast Guard approved Type III PFDs while on deck. A vessel safety briefing by the vessel subcontractor will be conducted prior to the start of operations to discuss steps to be taken if a man overboard should occur. Life ring with deployable rescue line available on board.
		Slips, trips, and falls	Lines, hoses, hatch covers, and mud on the deck present tripping, slipping, and falling hazards. Every crew member should make an effort to keep the working surfaces of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck.
		Temperature stress	If temperature is above 80°F or below 40°F, administrative controls will be implemented (cooled or warmed drinks, routine breaks in heated or shaded area (vessel cabin).
		Lifting (musculoskeletal injuries)	Compliance with ECHS Procedure 150, Manual Lifting. If equipment is to be moved, an evaluation of potential pinch points and/or weight strain will be conducted. Clear area of all unnecessary equipment and slip/trip hazards. Additional help will be obtained by workers or mechanical assistance used on-site if equipment to be moved is unwieldy, has a weight >50 lbs or has to be moved by maneuvering through awkward positioning.
		Fire	Fire extinguisher rated 2A and 5B (serviced annually and inspected monthly) in all fuel use areas.

		Potential contaminant exposure through sediments	Elevated concentrations of contaminants in the sediments may be expected in the East Waterway, based on historical sampling. Personnel will wear nitrile gloves when handing sediments. Goggles will be worn when splash hazards exist. If incidental skin contact occurs with sediments, rinse away sediment as soon as possible. Wash hands before eating or drinking.

Job Safety Analysis

Organization: SAIC
Work Activity: Sediment sampling from vessel using vibracore or van Veen sampler, or video probe

Personal Protective Equipment (PPE)	Selected	Comments
Clothing	X	Rain gear (tops and bottoms)
Safety Shoes	X	Steel toed rubber boots
Hard Hat	X	
Safety Glasses	X	As necessary
Fire Resistant Clothing		
Face Shields		If splash hazard exists
Goggles		
Coast Guard approved Type III Personal Floatation Devices (PFDs)	X	To be worn on deck. All PFDs with complaint whistle
Hearing Protection		
Air Purifying Respirator		
Supplied Air Respirator – SCBA		
Coast Guard-approved Type IV Life Ring	X	Required in vessel
Welding/Pipe Clothing		
Welding Mask/Goggles		
Gloves	X	Nitrile, PVC or similar for potentially contaminated material.
Other		
Safety Cones/Barricades		
Safety Vest		
Knee Pads		
Caution Tape		
Back Belt/Support		

Reviewers

Reviewer Name	Position	Date Approved
Terry McMahon CSP, CPEA	ES&I Safety and Health Manager	

Development Team

Development Team Member Name	Primary Contact	Position
John Nakayama	Y	SSHO

Job Steps

No	Job Steps	Potential Hazard	Critical Actions
1	Mobilize to work site	Traffic accident	Compliance with EC&HS Procedure 110, Vehicle Operation (valid drivers license, seat belt use, routine vehicle inspections, no cell phone use while driving).

2	Sediment sampling from vessel	Being struck by sampler attached to winch cable.	The vessel subcontractor will provide a trained winch operator. The operator will keep the sampler low to the deck when deploying the sampler over the side to minimize swinging. The sampler will be deployed and retrieved when the vessel is relatively stable (e.g., wait until wakes from passing vessels have dissipated). Personnel will stand clear of areas where sampler can swing and strike personnel (e.g., between sample table and gunnel of vessel). If necessary, tag lines will be used to minimize the swing of the sampler during deployment. Safety pins are removed only when the gear is over the rail. When not in use, the sampler should be securely fastened to prevent movement/shifting.
		Pinching hazard from sampler	Personnel will be trained in the operation of the sampler. Personnel will keep hands and fingers clear of the jaws of the sampler when in the open position (during deployment).
		Man overboard and drowning	Personnel will wear Coast Guard approved PFDs during over the side operations. A vessel safety briefing by the vessel subcontractor will be conducted prior to the start of operations to discuss steps to be taken if a man overboard should occur. Life ring with deployable rescue line available on board.
		Slips, trips, and falls	Lines, hoses, hatch covers, and mud on the deck present tripping, slipping, and falling hazards. Every crew member should make an effort to keep the working surfaces of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck.
		Temperature stress	If temperature is above 80°F or below 40°F, administrative controls will be implemented (cooled or warmed drinks, routine breaks in heated or shaded area (vessel cabin).
		Lifting (musculoskeletal injuries)	Compliance with ECHS Procedure 150, Manual Lifting. If equipment is to be moved, an evaluation of potential pinch points and/or weight strain will be conducted. Clear area of all unnecessary equipment and slip/trip hazards. Additional help will be obtained by workers or

			mechanical assistance used on-site if equipment to be moved is unwieldy, has a weight >50 lbs or has to be moved by maneuvering through awkward positioning.
		Fire	Fire extinguisher rated 2A and 5B (serviced annually and inspected monthly) in all fuel use areas.
		Potential contaminant exposure through sediments	Elevated concentrations of contaminants in the sediments may be expected in the East Waterway based on historical sampling. Personnel will wear nitrile gloves when handing sediments. Safety glasses will be worn when splash hazards exist. If incidental skin contact occurs with sediments, rinse away sediment as soon as possible. Wash hands before eating or drinking.
		Chemical exposure	Nitrile gloves and safety glasses will be worn during work with decontamination chemicals. Chemical containers will be labeled with identity and hazard. MSDSs will be on site for all chemicals in use. Site-specific training must address chemicals, hazards, and proper handling.
		Hazardous material transport	Hazardous material transport will be related to small quantity transport of decontamination chemicals under materials of trade exception. Materials will be secured against movement and protected against damage during transport. See FTP 651 for guidance.

Job Safety Analysis

Organization: SAIC
Work Activity: Equipment decontamination

Personal Protective Equipment (PPE)	Selected	Comments
Clothing	X	Rain gear (tops and bottoms)
Safety Shoes	X	Steel toed rubber boots
Hard Hat	X	
Safety Glasses	X	
Fire Resistant Clothing		
Face Shields		
Goggles	X	Goggles for zinc acetate use
Coast Guard approved Personal Floatation Devices (PFDs)	X	To be worn during vessel operations over the side (e.g. van Veen sampler operations)
Hearing Protection		
Air Purifying Respirator		
Supplied Air Respirator – SCBA		
Welding Hood		
Welding/Pipe Clothing		
Welding Mask/Goggles		
Gloves	X	Nitrile, PVC or similar for potentially contaminated material and decon fluids.
Other		
Safety Cones/Barricades		
Safety Vest		
Knee Pads		
Caution Tape		
Back Belt/Support		

Reviewers

Reviewer Name	Position	Date Approved
Terry McMahon CSP, CPEA	ES&I Safety and Health Manager	

Development Team

Development Team Member Name	Primary Contact	Position
John Nakayama	Y	SSHO

Job Steps			
No	Job Steps	Potential Hazard	Critical Actions
1	Mobilize to work site	Traffic accident	Compliance with EC&HS Procedure 110, Vehicle Operation (valid drivers license, seat belt use, routine vehicle inspections, no cell phone use while driving).
2	Equipment decontamination by liquinox and water rinse	Lifting (muskuloskeletal injury)	Compliance with EC&HS Procedure 150, Manual Lifting. If equipment is to be moved, an evaluation of potential pinch points and/or weight strain will be conducted. Clear area of all unnecessary equipment and slip/trip hazards. Additional help will be obtained by workers or mechanical assistance used on-site if equipment to be moved is unwieldy, has a weight >50 lbs or has to be moved by maneuvering through awkward positioning.
		Temperature stress	If temperature is above 80°F or below 40°F, administrative controls will be implemented (cooled or warmed drinks, routine breaks in heated or shaded area, provisions for emergency heating or cooling).
		Fire	Fire extinguisher rated 2A and 5B (serviced annually and inspected monthly) in all fuel/flammable liquid use areas.
		Chemical exposure	Nitrile gloves for chemical/contaminant contact. Wash hands before eating or drinking. Chemical containers labeled with identity and hazard. MSDSs on site for all chemicals in use. Site-specific training must address chemicals, hazards, and proper handling.

MATERIAL SAFETY DATA SHEETS

Liquinox

Section 1 — Chemical Product and Company Identification
Liquinox, Laboratory Cleaner
Flinn Scientific, Inc. P.O. Box 219 Batavia, IL 60510 (800)452-1261
CHEMTREC Emergency Phone Number: (800) 424-9300
MSDS #: 249
Revision Date: November 25, 2002

Section 2 — Composition, Information on Ingredients
Proprietary mixture manufactured by Alconox, Inc.
CAS #: None Established

Section 3 — Hazards Identification
Yellow liquid. Practically odorless.
Irritating to eyes. May be irritating to mucous membranes.

FLINN AT-A-GLANCE
Health-0
Flammability-0
Reactivity-0
Exposure-1
Storage-0
0 is low hazard, 3 is high hazard

Section 4 — First Aid Measures
Call a physician, seek medical attention for further treatment, observation, and support after first aid.
Inhalation: Remove to fresh air at once. If breathing has stopped give artificial respiration immediately.
Eye: Immediately flush with fresh water for 15 minutes.
External: Wash continuously with fresh water for 15 minutes.
Internal: Rinse out mouth, give 1 to 2 cups of water or milk, and induce vomiting. Call a physician or poison control at once.

Section 5 — Fire Fighting Measures
Non flammable, non combustible liquid.
When heated to decomposition, emits toxic fumes of CO, CO2, and SO2.
Fire Fighting Instructions: Use triclass, dry chemical fire extinguisher. Firefighters should wear PPE and SCBA with full facepiece operated in positive pressure mode.

NFPA CODE
None Established

Section 6 — Accidental Release Measures
Material foams profusely. Cleaner is biodegradable. Restrict unprotected personnel from area and ventilate area. Contain spill with sand or absorbent material; deposit in sealed bag or container. See Sections 8 and 13 for further information.

Section 7 — Handling and Storage
Flinn Suggested Chemical Storage Pattern: Inorganic Miscellaneous, or near washing area.

Section 8 — Exposure Controls, Personal Protection
Avoid contact with eyes, skin, and clothing. Wear chemical splash goggles, chemical-resistant gloves, and chemical-resistant apron.

Section 9 — Physical and Chemical Properties
Yellow liquid. Practically odorless.
Liquinox is a trade name. An anionic detergent.

Solubility: Completely soluble in water.
Specific Gravity: 1.065
Boiling Point: 210 C

Section 10 — Stability and Reactivity
Avoid contact with strong oxidizing agents.
Shelf life: Good.

Section 11 — Toxicological Information
Acute effects: Irritant
Chronic effects: N.A.
Target organs: N.A.
ORL-RAT LD50: N.A.
IHL-RAT LC50: N.A.
SKN-RBT LD50: N.A.

N.A. = Not available, not all health aspects of this substance have been fully investigated.

Section 12 — Ecological Information
Data not yet available.

Section 13 — Disposal Considerations
Please consult with state and local regulations.
Flinn Suggested Disposal Method #26b is one option.

Section 14 — Transport Information
Shipping Name: Not regulated
Hazard Class: N/A
UN Number: N/A

N/A = Not applicable

Section 15 — Regulatory Information
Not listed.

Section 16 — Other Information
Consult your copy of the Flinn Scientific Catalog/Reference Manual for additional information about laboratory chemicals. This Material Safety Data Sheet (MSDS) is for guidance and is based upon information and tests believed to be reliable. Flinn Scientific Inc. makes no guarantee of the accuracy or completeness of the data and shall not be liable for any damages relating thereto. The data is offered solely for your consideration, investigation, and verification. Flinn Scientific Inc. assumes no legal responsibility for use or reliance upon this data.

Liquinox, Laboratory Cleaner
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Zinc Acetate

Section 1--- Product Identification

Synonyms: Acetic acid, zinc salt, dihydrate; zinc diacetate; zinc acetate dihydrate
CAS No.: 557-34-6 (Anhydrous) 5970-45-6 (Hydrate)
Molecular Weight: 219.50
Chemical Formula: (CH3COO)2Zn 2H2O
Product Codes:
J.T. Baker: 4296, 4304, 5658
Mallinckrodt: 8740

Section 2--- Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Zinc Acetate	557-34-6	98 - 100%	Yes

Section 3--- Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath.
Ingestion:
Irritation of the mucous membranes due to hydrolysis and formation of acid in the stomach can occur. Large amounts can produce stomach cramps, stricture of the esophagus, nausea, and vomiting.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired respiratory function may be more susceptible to the effects

of the substance.

Section 4--- First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Section 5--- Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

Section 6--- Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

Section 7--- Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

Section 8--- Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its

source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

Section 9--- Physical and Chemical Properties

Appearance:
White crystals or powder.

Odor:
Slight acetic acid (vinegar) odor.

Solubility:
43g in 100g water.

Density:
1.74

pH:
No information found.

% Volatiles by volume @ 21C (70F):
0

Boiling Point:
Decomposes.

Melting Point:
237C (459F)

Vapor Density (Air=1):
No information found.

Vapor Pressure (mm Hg):
No information found.

Evaporation Rate (BuAc=1):
No information found.

Section 10--- Stability and Reactivity

Stability:
Loses water of hydration above 100C.

Hazardous Decomposition Products:
Freshly-formed zinc oxide or zinc oxide fumes at high temperatures (over 800C).

Hazardous Polymerization:
Will not occur.

Incompatibilities:
No incompatibility data found. Oxidizing agents, zinc salts in general, alkalis and their carbonates, oxalates, phosphates, sulfides.

Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

Section 11--- Toxicological Information

Oral rat: LD50: 2510 mg/kg. Investigated as a mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Zinc Acetate (557-34-6)	No	No	None

Section 12--- Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

Section 13--- Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

Section 14--- Transport Information

Not regulated.

Section 15--- Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Zinc Acetate (557-34-6)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	--Canada-- Korea	DSL	NDSL	Phil.
Zinc Acetate (557-34-6)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Zinc Acetate (557-34-6)	No	No	No	Zinc compoun

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	-RCRA- CERCLA	261.33	-TSCA- 8(d)
Zinc Acetate (557-34-6)	1000	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

Section 16--- Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Avoid breathing dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
****
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Appendix B
Field Forms

Sample Container Logbook

2008 Port Gardner Sediment Characterization	**Station:**
Project Number:	**Time Collected:**
Crew:	**Date:**
Comments:	

Sample Container Tag Number	Sample ID	Analysis	Laboratory

Notes:

SAIC
From Science to Solutions

Completed by:_____

Surface Sediment Collection Form

Project: 2008 Port Gardner Sediment Characterization

Station:_____

Sampling Event:_____

Date:_____

Crew:_____

Grab #:	**Bottom depth:**	**Penetration Depth:**	**Time:**
Sediment type:	***Sediment color:***	***Sediment Odor:***	***Comments:***
Cobble	Drab olive	None	
Gravel	Brown	Slight	
Sand C M F	Brown surface	Moderate	
Silt/clay	Gray	Strong	
Organic matter	Black	Overwhelming	
Woody debris	Other:	H_2S	
Shell debris		Petroleum	
Grab #:	**Bottom depth:**	**Penetration Depth:**	**Time:**
Sediment type:	***Sediment color:***	***Sediment Odor:***	***Comments:***
Cobble	Drab olive	None	
Gravel	Brown	Slight	
Sand C M F	Brown surface	Moderate	
Silt/clay	Gray	Strong	
Organic matter	Black	Overwhelming	
Woody debris	Other:	H_2S	
Shell debris		Petroleum	
Grab #:	**Bottom depth:**	**Penetration Depth:**	**Time:**
Sediment type:	***Sediment color:***	***Sediment Odor:***	***Comments:***
Cobble	Drab olive	None	
Gravel	Brown	Slight	
Sand C M F	Brown surface	Moderate	
Silt/clay	Gray	Strong	
Organic matter	Black	Overwhelming	
Woody debris	Other:	H_2S	
Shell debris		Petroleum	
Grab #:	**Bottom depth:**	**Penetration Depth:**	**Time:**
Sediment type:	***Sediment color:***	***Sediment Odor:***	***Comments:***
Cobble	Drab olive	None	
Gravel	Brown	Slight	
Sand C M F	Brown surface	Moderate	
Silt/clay	Gray	Strong	
Organic matter	Black	Overwhelming	
Woody debris	Other:	H_2S	
Shell debris		Petroleum	

Recorded By:_____

18912 North Creek Parkway, Suite 101
Bothell, Washington 98011
TEL: 425.485.5800 • FAX: 425.485.5566

From Science to Solutions

CHAIN OF CUSTODY RECORD

Project No.: _____ Project Mgr: _____
Project Name: _____
Project Location: _____
Sample Collectors: _____
Client Name: _____

Sample ID	Depth	Matrix	Date	Time	# of Containers	Analyses / Tests										Comments

Shipping Information

Number of Shipping Containers:

Date Shipped:

Carrier:

Waybill No.:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: _____	Signature: _____	Signature: _____	Signature: _____
Date/Time: _____	Date/Time: _____	Date/Time: _____	Date/Time: _____
Affiliation: _____	Affiliation: _____	Affiliation: _____	Affiliation: _____

• White: Lab Returns to Originator Upon Receipt of Samples; • Canary: Lab Retains; • Pink: Lab Returns to Project Manager with Final Report; • Goldenrod: Retained by Sampler

SEDIMENT CORING LOG

Core Number _____

PROJECT NAME:	Port Gardner	CORE PENETRATION:	
DATE SAMPLED:		CORE RECOVERY:	
LOCATION:		% RECOVERY:	
TIME:		SAMPLING METHOD:	Vibracore
UNCORRECTED DEPTH (-FT)		POSITION METHOD:	DGPS
NOS WATER LEVEL (TIDE):		LATITUDE:	
WATER DEPTH MLLW:		LONGITUDE:	
		NORTHING:	
SAMPLED BY:		EASTING:	
		WEATHER:	

DEPTH				
Recovered Core Length	Feet Below Mudline Based on Actual % Recovery	SAMPLE ID	SEDIMENT DESCRIPTION	COMMENTS
2				
4				
6				
8				
10				
12				
14				

REVIEWED BY: _____ PAGE ____ OF ____