Quality Assurance Project Plan for Status and Trends Monitoring of Marine Nearshore Sediment

For Monitoring Conducted by Pierce County to Comply with NPDES Municipal Stormwater Permit Special Condition S8.B Requirements

September 15, 2015

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This Quality Assurance Project Plan is available on the Department of Ecology's Regional Stormwater Monitoring Program (RSMP) website for National Pollutant Discharge Elimination System (NPDES) municipal stormwater permittees at http://www.ecy.wa.gov/programs/wq/stormwater/municipal/status.html.

Data for the RSMP will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search Study ID, RSMP_MNS2016. Data from Pierce County will be under Study ID RSMP_PC_MNS2016.

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Table of Contents

Page

Introduction....5
Background on stormwater monitoring strategy....5
Scope of this Quality Assurance Project Plan....5
Municipal stormwater permittees' roles....6
Ecology's roles....8

Status and Trends Experimental Design....9
Scale of regional monitoring....9
Goals....9
Objectives....10

Study Quality Objectives....11
Field measurements....11
Laboratory measurements....11
Laboratory selection....11

Study Design....13
Site Selection....13
Overview of site layout....15

Sampling Procedures....17
General....17
Marine sediment sampling procedures....18
Equipment decontamination....21
Sample containers, preservation, and holding times....21
Chain-of-custody....23

Measurement Procedures....23
Field measurements and sampling....23
Laboratory measurements....24

Laboratory Quality Control (QC) Procedures....26

Data Management Procedures....32
Field logs....32
Laboratory data....32
Audits....33
Data storage....33

Data Verification and Usability....34
Field data....34
Laboratory data....34
Data quality (usability) assessment....34

Nearshore Sediment Monitoring Reports....35
Summary Report....35

References....36

Appendices.....38
Appendix A. Pierce County candidate marine monitoring sites along unincorporated UGAs (sorted from master sample list) 39
Appendix B. Example Field log.....54
Appendix C. Example chain-of-custody forms 59
Appendix D. Glossary, acronyms, and abbreviations.....62

List of Figures and Tables

Page

Figures

Figure 1. Pierce County candidate sites for marine sediment monitoring along unincorporated urban growth areas (UGAs). 14
Figure 2. RSMP marine monitoring site layout along UGAs. 16

Tables

Table 1. Key deadlines for permittees' QAPPs, monitoring activities, and reports. 7
Table 2. Organization of permittee project staff and responsibilities. 7
Table 3. Ecology project staff and responsibilities. 8
Table 4. Laboratories selected for sample processing and analysis..... 12
Table 5. Marine sediment chemistry monitoring field measurements and observations, and parameters analyzed in the laboratory..... 20
Table 6. Sample volume, containers, preservation, and holding times..... 22
Table 7. Sediment quality field parameters, field methods, reporting limits, and QA/QC procedures..... 24
Table 8. Laboratory analysis and reporting requirements for marine sediment monitoring..... 25
Table 9. Field and laboratory measurement quality objectives (MQOs) for sediment grain size, total organic carbon, and chemistry analyses. 30
Table 10: Required monitoring report elements 35

Introduction

Background on stormwater monitoring strategy

The Stormwater Work Group (SWG) is a coalition of federal, tribal, state, and local governments; business, environmental, and agricultural entities; and academic researchers. All SWG members have interests and a stake in the Puget Sound watershed. The SWG was convened by the Puget Sound Partnership (PSP) and the Washington State Department of Ecology (Ecology) in October 2008 to develop a regional stormwater monitoring strategy and to recommend monitoring requirements in National Pollutant Discharge Elimination System (NPDES) stormwater permits issued by Ecology.

In 2010, the SWG published an overall strategy for monitoring (SWG, 2010a). This strategy included recommendations for status and trends monitoring in the Puget Sound nearshore, with a focus on an integrated approach to quantify stormwater pollutant impacts in Puget Sound and to provide information to efficiently, effectively, and adaptively manage stormwater to reduce harm to the ecosystem.

The SWG also recommended a specific NPDES municipal permittee-funded plan for monitoring the effects of stormwater under the permits in the Puget Sound region (SWG, 2010b). The resulting program, a subset of the overall strategy, is called the Regional Stormwater Monitoring Program (RSMP). Specifically, the RSMP includes status and trends probabilistic sampling which is compatible with ongoing status and trends monitoring programs.

Scope of this Quality Assurance Project Plan

Monitoring for this QAPP is focused on a single landscape scale, the marine shoreline and nearshore parallel to the City and Urban Growth Area (UGA). This sampling frame for Puget Sound was defined to include the basins, channels, and embayments of Puget Sound from the US/Canada border to the southern-most bays and inlets near Olympia and Shelton; Hood Canal; and portions of Admiralty Inlet, the San Juan Islands, and the eastern portion of the Strait of Juan de Fuca. The shoreline master sampling frame was targeted to the land-based UGA boundaries within the Puget Sound basin.

Permit Options

Ecology issued NPDES municipal stormwater permits (permits) for Phase I and Phase II communities (Ecology, 2012a,b) effective August 1, 2013 through July 31, 2018. The permittees in Puget Sound were given two options to comply with the permits' Special Condition S8.B for status and trends monitoring requirements. Every permittee in Puget Sound individually chose to either:

- Option 1: Pay a prescribed amount into a pooled fund to support RSMP status and trends monitoring. These permittees' role is limited to providing permit-defined amounts of funding for coordinated implementation of monitoring at sites throughout the Puget Sound region.

OR

- Option 2: Conduct status and trends monitoring themselves at specified sites inside their jurisdictional boundaries, following the same protocols as the RSMP.

In fall 2013, Pierce County, and the City of Redmond officially selected the second option. This Quality Assurance Project Plan (QAPP) does not apply to the City of Redmond because Redmond's jurisdiction does not include any Puget Sound shoreline and they will not conduct nearshore sediment monitoring. Pierce County must complete and follow this QAPP to comply with their permit requirements.

This QAPP defines the marine nearshore sediment scientific monitoring design and protocols that these permittees will follow as well as the data and reports that they will produce. Sediment monitoring will be conducted from June through August 2016.

This document is one of three "Ecology-approved QAPPs for RSMP Marine Nearshore Status and Trends Monitoring" referenced in Special Condition S8.B.1.b.ii of the Phase I permit and Special Condition S8.B.2.b of the Phase II Western Washington permit.

Municipal stormwater permittees' roles

Pierce County will sample the first **eight** qualifying sites along shorelines of their unincorporated UGA areas. If sampling at any of the original list of sites is unsuccessful, the permittee must sample the next qualifying site in the order listed for their jurisdiction.

The key deadlines for the permittees' required monitoring activities including completion of field and laboratory work, Ecology's Environmental Information Management (EIM) database data entry, and submission of monitoring summary reports are summarized in Table 1.

Table 1. Key deadlines for permittees' QAPPs, monitoring activities, and reports.

Due	Item	Description
Spring and summer 2015	Site selection and verification	Permittees have confirmed all sites to be monitored, including sufficient additional sites to sample if sampling attempted at any of the original sites is unsuccessful.
July 15, 2015	QAPP submitted to Ecology for review	Pierce County submits completed QAPP to Ecology Permit Manager and RSMP Coordinator for review.
August 15, 2015	Ecology QAPP review completed	QAPP reviewed within 30 days; RSMP Coordinator approves or provides comments via Permit Manager.
August 31, 2015	Site Selection and Verification	Pierce County has confirmed all monitoring sites, including sufficient additional sites to sample if sampling attempts at any of the original sites is unsuccessful. Site list sent via email to RSMP Coordinator and Ecology Permit Manager with selected sites and rationale on rejected sites.
September 15, 2015	Deadline for final QAPP	Final QAPP submitted to RSMP Coordinator with all comments addressed.
June – August, 2016	Conduct sediment collection at nearshore sites	Sediment quality sampling conducted at the required number of nearshore sites.
March 31, 2017	Final sediment monitoring report	Final summary report submitted to Permit Manager with Annual Report.
March 31, 2017	Electronic data submittal and monitoring report	All QA/QC'ed data submitted to Environmental Information Management (EIM) database.

Table 2 lists key permittee staff responsible for monitoring activities detailed in this QAPP.

Table 2. Organization of permittee project staff and responsibilities.

Phase I Permittees	Implementation of Stormwater Permit Monitoring	
Name/Contact	**Role**	**Responsibility**
Carla Vincent, Water Quality Supervisor 253.798.2467	NPDES Stormwater Monitoring Project Manager	Manage overall compliance activities; verify whether QAPP is followed and monitoring data are of known and acceptable quality; ensure adequate training of staff, complies with corrective action requirements
Scott Groce, Water Quality Specialist 3 253.798.2477	Field Lead	Manage and oversee monitoring activities and sampling decisions; coordinate laboratory selection and delivery, and equipment maintenance; manage internal and external field teams. Prepare and upload data to EIM.
Corrie Lee and Berl Eldridge, Water Quality Specialist 2	Field Assistant(s)	Assist in calibrating equipment, collecting and processing field samples, and managing data.

Ecology's roles

The RSMP Coordinator will either approve or comment on the permittees' completed QAPPs and transmit approval or comments to the permittee via the appropriate Regional Permit Manager by August 15, 2015. After the sampling is completed and the permittee has completed quality assurance and quality control (QA/QC) review of the data, they will submit the data to the EIM holding area. Ecology staff will provide a database compatibility review. The RSMP Coordinator will review monitoring reports. Ecology Permit Managers will review all submittals for compliance purposes. Ecology staff and their responsibilities for oversight and coordination of nearshore sediment monitoring are listed in Table 3.

Table 3. Ecology project staff and responsibilities.

Ecology – Staff	Administration of Stormwater Permits	
Name/Contact	**Role**	**Responsibility**
Brandi Lubliner Lacey, WA	RSMP Coordinator	Ongoing implementation and administration of coordinated monitoring for NPDES Municipal Stormwater Permits. Reviews and approves completed QAPPs and project deliverables from permittees' monitoring efforts.
Chris Montague-Breakwell SWRO: Lacey, WA	Permit Manager	Ecology's contact for stormwater permittees including Pierce County. Reviews QAPP and monitoring reports for permit compliance.
William Kammin Lacey, WA	Ecology Quality Assurance Officer	Draft template QAPP review and approval.
WQP staff	EIM coordinator	Reviews and uploads data submitted by permittees and RSMP contractors.

RSMP: Regional Stormwater Monitoring Program
QAPP: Quality Assurance Project Plan
SWRO: Southwest Regional Office
EIM: Environmental Information Management database
WQP: Water Quality Program

Status and Trends Experimental Design

Scale of regional monitoring

Status and trends is intended to report results at a high level of statistical confidence; as such, a probabilistic random stratified sampling design was selected for the nearshore urban and non-UGAs. This approach was developed by EPA as a spatially-balanced, generalized random tessellation stratified (GRTS) multi-density survey design (http://epa.gov/nheerl/arm/designing/design_intro.htm) and is described by Stevens (1997), and Stevens and Olsen (1999, 2003, 2004). Over 1 million random sampling points were generated to populate the Puget Sound marine nearshore sampling frame along Urban Growth Areas (UGAs) (which is linear) by Sitka Technology Group, LLC.

Candidate sites in unincorporated Pierce County UGAs are listed in Appendix A. The complete list of the marine UGA master sample RSMP candidate sites is available on Ecology's RSMP website (www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp.html).

Target Status

Candidate sites will reflect the following target status characteristics:

1. Be located in the nearshore sub-tidal zone
2. Be parallel to an designated Urban Growth Area
3. The site is NOT within a marina or port (i.e. where multiple motorized vessels are kept in the water)
4. There is suitable fine substrate for collection by a sediment

Goals

The overall goals of the nearshore monitoring program are partly based on those developed for the Puget Sound Ecosystem and Monitoring Program (PSEMP) Sediment Component (Dutch et al., 2009), an ongoing program at Ecology, and the desire to characterize the nearshore by urbanized areas. This QAPP focuses on sediment chemistry. The goals include:

1. Assess the health of Puget Sound sediment quality in the nearshore urban areas, defined as being inside parallel to established UGAs.
2. Document geographic patterns.
3. Document natural and human-caused changes over time in Puget Sound nearshore sediments.
4. Identify existing nearshore sediment quality problems and, where possible, provide data to help target sources.
5. Support nearshore research activities by making available uniformly collected, high quality data.
6. Provide nearshore data to assist the SWG, PSP, Ecology, WDFW, and others in measuring the success of stormwater and other environmental management programs.

Objectives

Specific objectives of nearshore sediment monitoring include:

1. Characterize the status, spatial extent and quality, of nearshore marine sediments in the UGA sampling frame.
2. Track the trends, changes in spatial extent and quality, over time in the UGA sampling frame. Is sediment quality improving, deteriorating, or remaining the same?

Assumptions underlying the design

This monitoring program design is based on several assumptions; #1) for the purposes of assessing stormwater impacts, the study design characteristics take into account the desire for Puget Sound-scale estimates at a high confidence level (80-90%) and potential for stratification of samples into other categories (e.g., land uses). The confidence level (i.e. the reliability of the result) is determined by the variance of the indicator variable and the sample size within populations (www.epa.gov/nheerl/arm/surdesignfaqs.htm).

The SWG also assumes #2) that the Urban Growth Area (UGA) assessment region is different than the Puget Sound wide or Urban Bay assessment regions monitored by Ecology. This assumption is based on the differences in stormwater management efforts required by permits inside UGA boundaries, and the differences in overall land use. Shorelines and nearshore areas in Puget Sound in urban and urbanizing areas are assumed to be more (or differently) influenced than shorelines and nearshore areas outside urban and urbanizing areas. The RSMP will monitor the shoreline and nearshore within the UGA assessment area. Data from prior marine monitoring studies in the urban bays or region wide will be considered for comparison, where available and appropriate.

This monitoring design also assumes #3) that the sites will be useable over the long term. The site layout is designed for a long-term monitoring program rather than for a targeted study. This study design assumes that general trends in nearshore ecosystem health can be described with the parameters outlined in this QAPP.

Study Quality Objectives

Quality objectives for marine sediment monitoring described here are set to obtain and analyze sufficient numbers of high quality samples to meet the goals and objectives of this program. Data quality indicators of precision, bias, sensitivity, representativeness, comparability, and completeness will be adopted for the sediment samples. These indicators are defined in Lombard and Kirchmer (2004). Measurement quality objectives (MQOs) for field and laboratory measurements are described in the *Quality Control Procedures* sections of this QAPP.

Field measurements

Measurements of sediment penetration depth, temperature, salinity of the water overlying the sediment surface, and sediment texture, color, and odor are taken by field staff during sample collection. Collection methods, reporting requirements, and quality control (QC) procedures summarized in the *Measurement* and *Quality Control Procedures* sections of this QAPP are intended to provide field measurement data that meet MQOs and RSMP objectives. Field measurement methods and QC procedures are listed in the *Measurement Procedures* section, in Table 7.

Laboratory measurements

Sediment grain size analyses, TOC, and chemical analyses will be conducted at Ecology-accredited laboratories. Ecology's Laboratory Accreditation Program maintains a searchable database that may be accessed from this website: www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html. Laboratory methods and reporting limits are listed in the *Measurement Procedures* section, in Table 8.

All work is expected to meet the QC requirements of the analytical methods used for this project. These requirements are summarized in the *Quality Control Procedures* section of this document and are found in detail in the Puget Sound Estuary Program protocols (PSEP, 1986, 1997a, b,c,d) and in the peer-reviewed standard operating procedures (SOPs) for each test. The QC samples and MQOs designated for all required laboratory analyses are summarized in the *Quality Control Procedures* section, in Table 9.

Laboratory selection

Laboratories for sediment parameters will be selected based on their current accreditation status with Ecology (www.ecy.wa.gov/programs/eap/labs/search.html) and their ability to achieve acceptable limits of detection for the parameters measured as part of this project. Contracting for laboratories is a responsibility of the permittee. Permittees may consider their own or other permittee's laboratories, commercial laboratories, or Ecology's Manchester Environmental Laboratory, as long as the laboratory is accredited for the method. Table 4 lists the laboratories and analyses that will be used for this project.

Table 4. Laboratories selected for sample processing and analysis.

Laboratory Name	Analytical Purpose	Address	Phone
Manchester Environmental Laboratory (primary)	Sediment Analysis	7411 Beach Drive East Port Orchard, WA 98366	(360) 871-8724
AmTest (secondary)	Sediment Analysis	13600 NE 126th Place Kirkland, WA 98034	(424) 885-1664
To be decided by RSMP Pooled Funds contractor	Inter-laboratory comparison samples[a]	7411 Beach Drive East Port Orchard, WA 98366	(360) 871-8800

(a) The RSMP will have an inter-laboratory comparison element. At one site two additional samples will be collected, stored and sent to the lab selected for analysis of the RSMP sediment samples. If the permittee has contracted to have marine nearshore sediment laboratory analyses conducted by the RSMP contracted laboratory, there is no need to collect and analyze this inter-laboratory comparison sample.

Study Design

Site Selection

Sampling site criteria for marine monitoring and assessment regions are discussed in this section. All sites are considered candidate sites until confirmed by Pierce County and this QAPP and any supplemental site selection documentation is approved by Ecology. Pierce County's tentative sediment sampling sites are shown in Figure 1 and a complete list of candidate sites is in Appendix A. The RSMP pooled fund candidate sites lists are also available on Ecology's RSMP website: www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp.html. The list of sites for Pierce County are the same for all the marine monitoring components (bacteria, sediment and mussels). Ideally, the same sites could be sampled for all 3 marine monitoring components, but due to site criteria the finalized lists will likely differ for each marine component. Pierce County must sample unincorporated areas of the county at eight sites per permit requirements.

Sites in Appendix A must be evaluated for suitability in numerical order (Order column). Sampling site information, such as coordinates, jurisdictions, and other classification information, is provided in Appendix A, and a larger list provided electronically to Pierce County by the RSMP Coordinator.

Site confirmation criteria

Pierce County will conduct a desktop reconnaissance of the required number of candidate sites, and alternate sites. Field crews will also field verify sites to determine suitability and/or access. Suitability is defined as:

1. If on-site conditions reflect target status, and
2. Whether the site can be safely accessed and sampled during seasonal conditions, and
3. If permits are secured for the site sediment collection, or access to a site is permitted by property owners (if necessary)
4. There is ample fine sediment material for sample collection.

If field crews disqualify sites upon visitation, the reason for site disqualification must be documented and alternates sites must then be visited and verified for replacement to reach the required number of sites. Documentation of disqualified sites includes photos and field notes pertaining to the three criteria above. The procedure is to be started prior to the sampling season.

RSMP Pooled fund sites

The RSMP Coordinator will contract to sample 40 marine nearshore sediment sites across Puget Sound. Pierce County's candidate sites do not overlap with the pooled fund sites. An analysis of bacteria concentrations in the Puget Sound marine shoreline areas will incorporate Pierce County's data collected under this QAPP.

Alternate sites

If one or more of the top eight candidate sites cannot be sampled successfully, Pierce County will sample viable sites from the remaining master sampling site list in the given list order.

Mid-Study Changes Affecting Site Suitability

Pierce County will make a good faith effort to sample at the selected sites per this QAPP's requirements. Due to the actual location of the sampling site (underwater), only desktop analysis or shoreline visit is necessary for field site criteria determination. Therefore, it is possible a site will lack the fine sediment necessary for sampling and this won't be known until the day of sampling. Preparedness will include **four** alternate sites that are desktop verified, have permission (if necessary), and sampling permit coverage.

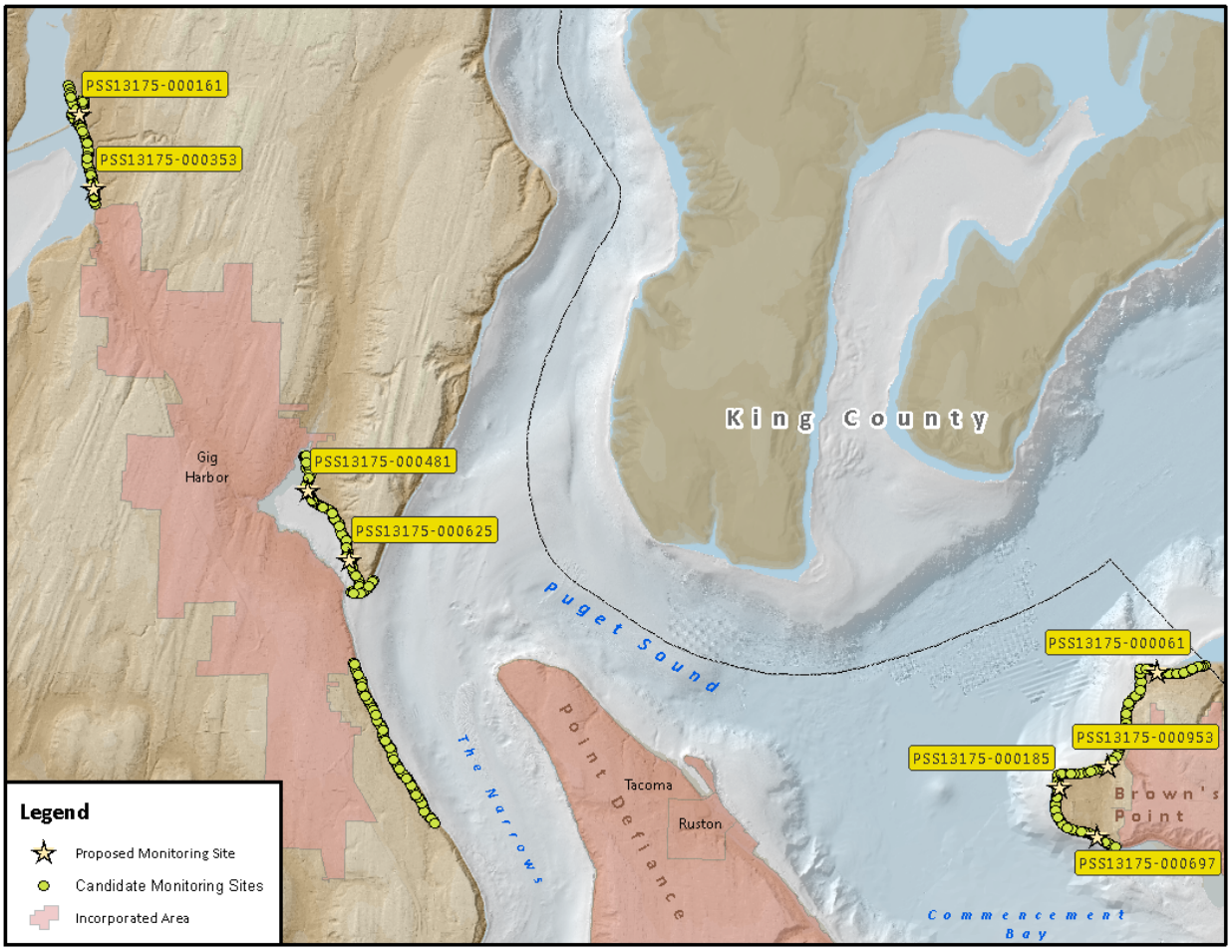

Figure 1. Pierce County candidate sites for marine sediment monitoring along unincorporated urban growth areas (UGAs).

Documentation of Site Evaluations

Documentation of observations from both the desktop and field visits will be recorded in a field Log and an Excel spreadsheet.

Site ID and Site Name

Site ID

Once appropriate sample sites are verified they will be identified by a unique, pre-assigned "Site ID". The Site ID will eventually becomes the "Location ID" in Ecology's EIM database and serves as the unique site identifier that relates the sampled sites to the GRTS study design, and is denoted as PSS13175-XXXXX where the "X" number changes for each site.

Location Name

The site will also carry a unique and appropriate "Location Name" to more easily identify the location of the site. The Location Name should be succinct, and is limited to 40 characters by the EIM database. The name may be general or describe the location (e.g. Tacoma, or Commencement Bay, or Ruston Waterfront, or Steilacoom) or be more specific descriptor like a nearby stream/river, neighborhood/street, marine location, or other identifying landmark (e.g. Thea Foss, or Hylebos Waterway, or Point Defiance, or Days Island, or Ferry Terminal).

Some examples of appropriate Site Names:

- Tacoma - Titlow Park
- Commencement Bay - Blair Waterway
- Point Defiance - Ferry Terminal
- Ruston Way - Dickman Mill Park
- Thea Foss Waterway - 11th St Bridge

Order #

The field in EIM called "Study_Specific_Location_ID" will be used to identify the GRTS study design ORDER and sampling strata. For the marine nearshore sampling design this field will be populated by combining the Order and the acronym "NUGA" which stands for nearshore along Urban Growth Area; for example "044-NUGA".

Overview of site layout

Ideally, at each coordinate point in the site list three distinct sampling sites are located perpendicular to the shoreline extending into the subtidal zone. The three locations exist for marine monitoring components (bacteria at the shoreline, mussel cage location in the intertidal zone, and sediment sampling in the subtidal zone). The marine sediment and mussel sampling are described in separate QAPPs. Figure 2 illustrates the site description at each candidate site.

A linear nearshore sampling frame was developed for marine monitoring. The coordinates describe the shoreline location. Sediment sampling will occur along a linear transect parallel to the shoreline and perpendicular from the target coordinate at a depth of approximately -1.8 m (6

feet, or 1 fathom depth below) mean lower low water (MLLW). The top 2-3 cm of sediment will be collected from each site for chemistry analysis. The sediment sample may be collected up to one-quarter mile (1320 ft, or approximately 400 m) along the -6 ft deeper than the MLLW contour in either direction of the latitude/longitude coordinates given.

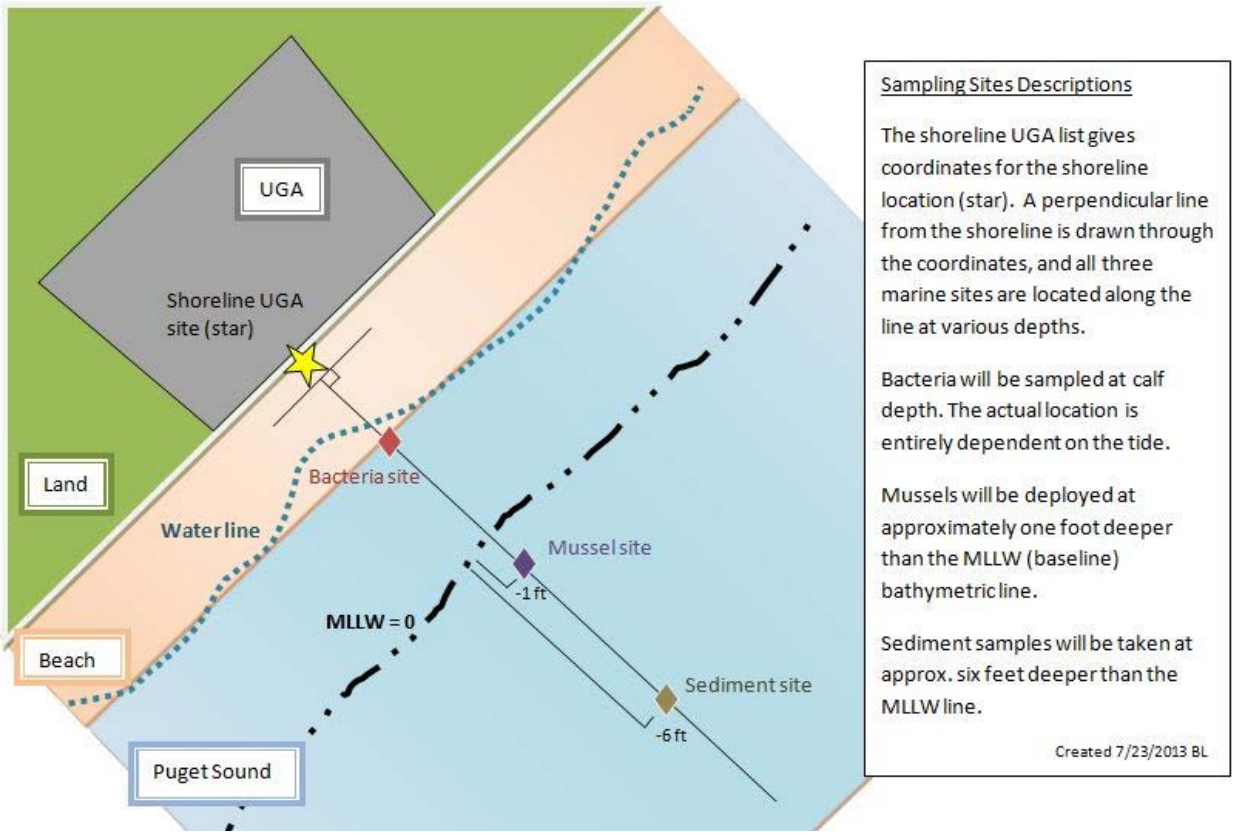

Figure 2. RSMP marine monitoring site layout along UGAs.

Sampling Procedures

General

Necessary permits

Permittees are responsible for obtaining the necessary permits for sampling marine nearshore sediments. Depending on the location, the following permits may be necessary:

- Washington State Department of Natural Resources, Right of Entry.
- Washington Department of Fish and Wildlife, Hydraulic Project Approval.

Permittees are advised that it may take several months to process and acquire these permits.

Decontamination/prevention of spread of aquatic invasive species (AIS)

Field work and equipment will be conducted in a manner as to prevent the spread of invasive species. A map of the areas confirmed to contain aggressive invasive species are shown in maps at the following link: www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html.

It is possible that during sampling invasive species of benthic invertebrates or marine plants could be collected. To avoid the spread of these species to other areas, procedures applicable to the marine environment from Ecology's SOP, *Minimizing the Spread of Aquatic Invasive Species* (Ecology, 2012a), will be implemented.

All sediment material not retained for analyses or archiving is washed overboard at or near the sampling location. Additionally, both the sediment sampler (e.g., vanVeen grab) and the bowls or buckets used for homogenization will be rinsed with seawater at each site and also scrubbed clean of any residual sediment and organisms immediately after completion of sampling at each site.

Safety

Collection of sediment samples aboard a research vessel poses a number of potential safety hazards to the field crew including falling overboard, being struck by heavy equipment, coming into contact with hazardous materials (e.g., acetone), and exposure to extreme temperatures and sunlight. To ensure their safety all crew members are required to follow appropriate jurisdictional guidelines including Ecology's SOP, *Marine Sediment Sample Collection* (Ecology, 2007), and to wear the following safety gear at all times while collecting samples:

- Life vest or floatation suit
- Hard hat
- Steel-toed boots
- Protective gloves
- Temperature and weather appropriate clothes

Field documentation

A field log will be completed for each sediment monitoring site. The field log will consist of the following information:

- Sample identification, date, time, location, depth, description
- Sampling crew
- Weather and sea state
- Collection gear
- Collection status (i.e., successful, site rejected, site moved)
- Visual description of sediments
- Field measurements
- Parameters sampled
- Information for individual sediment grabs
- Observations of adjacent shoreline land uses, beach condition, and other landscape features
- Who generated the field log
- Comments

Observations of the shoreline will include a description of the adjacent shoreline, including land uses, beach condition, municipal or private outfalls, streams, and other significant landscape features or in-water activities within approximately one-half mile in either direction along the shoreline from the sampling location.

Field log information must document rejected sites, if and when sites are found to be unsuitable. A daily log will also be generated with information on samples collected from each day. These logs are recorded on water-resistant paper. Example field and daily logs are shown in Appendix D.

Marine sediment sampling procedures

Collection of sediment for physical characteristics and chemistry will be conducted by field staff. Sampling methods will, in general, follow those described by the Puget Sound Estuary Program in PSEP 1997a. These methods are summarized below.

Sampling platform

A marine research vessel of adequate size, and suitably equipped for deployment of sample collection equipment and shipboard sample processing, will be reserved for, or contracted for, this work. From this platform, site-positioning protocols will follow PSEP (1998). Positioning will rely on Differential Global Positioning System (DGPS) with expected accuracy of better than 3 meters. Variable radar ranging, water depth, and line-of-sight fixes on land objects may supplement the DGPS if necessary.

Sample collection and field processing

Sediment samples are collected using a stainless-steel vanVeen grab sampler or similar sampler to collect volume of sediment, which allows sediment for chemistry, TOC, and grain size to be collected simultaneously. The mass of sediment needed under this monitoring program will likely require 1 to 3 grab samples using a single vanVeen. Sediment sampling protocols are

described below and generally follow Ecology's SOP, *Marine Sediment Sample Collection* (Ecology, 2007), and PSEP (1997a).

The grab sampler is attached to the vessel's cable and winch system and lowered to 2-3 meters just below the water surface, or about 2-3 meters above the sediment surface, until the vessel is maneuvered into position above the target location. The grab sampler is then lowered to the bottom where it will trigger and close upon contact with the sediment surface, and a sample will be collected. The grab sampler is then raised back up to the vessel and landed on a grab stand.

The collected sediment sample is visually inspected. Any grab sample lacking fine-grained particles in the sediment (e.g., composed of all cobble, shell hash, or wood), or for which the jaws of the grab sampler do not close completely, is rejected. Any grab sample that has either a less-than-adequate penetration depth or over-penetration is discarded. If a sample is rejected, it is dumped overboard after the vessel has been repositioned away from the target location. If a site is rejected after three consecutive failed attempts to collect an acceptable sample, an alternate site with a new site number will be sampled in its place.

When the site lacks fine-grained particles in the sediment (e.g., rocks prevent grab closure or the substrate is composed of all shell hash), Ecology recommends trying another location within a short distance in either direction parallel to the beach coordinates. However in some cases it will be necessary to reject that site, document it, and proceed to the next site on the list of replacement sites.

The successful sediment sample captures sediments with overlying water. Using a stainless-steel spoon, sediments from the top two to three centimeters are scooped up being careful to avoid the sediment touching the sides of the vanVeen. The sediment is put in a pre-cleaned stainless-steel bowl and covered with a lid or foil. On subsequent grabs, if necessary, the top two to three centimeters of sediment on both sides of the grab are collected and added to the bowl. Grabs are taken until enough sediment is collected to fill all necessary sample containers for the site.

The composited sediment in the bowl is homogenized by stirring with a pre-cleaned, stainless-steel spoon until a uniform texture and color are achieved. After the sample jars are filled, they are placed in polyethylene bags, and set in coolers on ice. Leftover sediment is returned to the water column at the site or kept for an archive sample.

Parameters Monitored

After the first acceptable grab sample is taken, field observations are made of the grab sample. One side of the double VanVeen device, or the samples' periphery area, is used for determining physical/environmental characteristics including sample penetration depth, sediment temperature, salinity of the overlying water, and sediment texture, color, and odor.

Table 5 lists both field and laboratory parameters to be observed or measured.

Table 5. Marine sediment chemistry monitoring field measurements and observations, and parameters analyzed in the laboratory.

Field Measurements and Observations
Sediment temperature
Sample penetration depth
Salinity of overlying water
Sediment texture, color, and odor
Laboratory Analyses
Conventional Parameters: • Grain size • Total organic carbon (TOC)
Metals: • Priority pollutant metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. • Metalloids: tin

Organics:
• Low molecular weight polynuclear aromatic hydrocarbons (LPAHs):
  o 1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 1-methylphenanthrene, 2,6-dimethylnaphthalene, 2-methylnaphthalene, 2-methylphenanthrene, acenaphthene, acenaphthylene, anthracene, biphenyl, dibenzothiophene, fluorene, naphthalene, phenanthrene, and retene
• High molecular weight polynuclear aromatic hydrocarbons (HPAHs):
  o benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, perylene, and pyrene
• Phthalates:
  o bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate
• Polybrominated diphenylethers (PBDEs):
  o 47, 49, 66, 71, 99, 100, 138, 153, 154, 183, 184, 191, 209
• Polychlorinated biphenyls all 209 congeners

Field replicates

At one of the site sampled by each permittee, double the amount of sediment will be collected and homogenized for a field replicate. Two sets of sample containers for chemistry, TOC, and grain size analyses will be filled. The site will be chosen by the project lead. The second set of sample containers will be assigned a different sample identification number and submitted to the laboratory as a blind field replicate.

Inter-laboratory comparison replicates

At one of the sites sampled by each permittee, double the amount of sediment will be collected and homogenized for a laboratory replicate sample to for inter-laboratory comparison for the metals and organic parameters only (PAHs, phthalates, PCBs and PBDEs). Two sets of sample containers will be filled. The site will be chosen by the project lead; it may be the same site as the field replicate. This set of samples will be assigned a different sample identification number and submitted to the laboratory. Storage may be needed until the RSMP laboratory is determined.

If the permittee has contracted to have marine nearshore sediment laboratory analyses conducted by the RSMP contracted laboratory, there is no need to collect and analyze this inter-laboratory comparison sample.

Archive samples

A portion of each sediment sample should be jarred and retained as grain size and TOC/chemistry archive samples. These samples should be kept for one year in case re-extraction or retrospective analysis is required. Sediment grain size samples should be held at 4°C. Chemistry and TOC samples should be frozen at -18°C (0°F).

Equipment decontamination

Equipment that comes into contact with the sediment sample must be cleaned prior to sampling and between sampling sites. The grab and all other sampling equipment that comes in contact with the sampled sediment will be scrubbed with a soft brush and Alconox soap and rinsed with *in situ* seawater. This removes any sediment and contaminants from previous sites. The equipment will then be rinsed with acetone, again followed by *in situ* seawater. Residual acetone used for decontamination evaporates quickly and is not produced in sufficient quantity to collect for disposal.

The spoons, spatulas, and homogenization paddle will be placed in the decontaminated sample collection bucket, and a decontaminated lid will be placed over them until needed for the next sample. These precautions are taken to avoid contamination of the samples from engine exhaust, atmospheric particulates, and rain.

Sample containers, preservation, and holding times

Recommended sample sizes, containers, preservation techniques, and holding times for all sediment samples are summarized in Table 6. Jar types and sizes may vary depending upon the selected laboratory. These are from PSEP (1997a), Ecology's sediment monitoring QAPP (Dutch et al., 2009), and Manchester Environmental Laboratory's *Lab Users Manual* (MEL, 2008).

Samples for chemistry, TOC, grain size, and toxicity analyses will be stored in labeled, sealed containers and placed in insulated coolers filled with ice. Laboratory staff will be notified prior to sampling and the day of sampling to confirm sample drop-off location and timing. Archive

samples may be stored by permittees or contracted laboratories until results are deemed acceptable by the project lead.

Table 6. Sample volume, containers, preservation, and holding times.

Parameter	Size of Sample	Container [(a)]	Preservation	Maximum Holding Time
Grain Size	8 oz.	1 8-oz wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C	6 months
Total Organic Carbon (TOC)	2 or 4 oz.	1 2-oz wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	14 days
Metals	4 oz.	1 4-oz wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	All metals except mercury: 6 months at 4°C or 2 years at -18°C; Mercury: 28 days at 4°C
PAH[(b)]	8 oz.	1 8-oz certified organic-free wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	1 year
Phthalates[(b)]	8 oz.	1 8-oz certified organic-free wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	1 year
PBDE [(b)]	8 oz.	1 8-oz certified organic-free wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	1 year
PCB[(b)]	8 oz.	1 8-oz certified organic-free wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	1 year

[(a)] Or as specified by laboratory.

[(b)] May be able to analyze multiple parameters from a single jar, check with laboratory.

Cooling the sample to 4° or 6°C or less, but not freezing, is necessary for preservation in the field for most parameters. Collected samples must be transferred from the field site to the lab in an ice-filled, or blue-ice-filled, cooler to maintain temperature requirements.

Holding time is the maximum allowable length of time between sample collection and laboratory manipulation. Holding times are different for each analyte and are in place to maximize analytical accuracy and representativeness. Each sample collected will be packaged in a container and labeled accordingly.

The permittee will coordinate with the analytical laboratory to ensure samples can be transported, received, and processed during non-business hours if necessary. Sample containers will be transported or sent by the field team to the laboratory following established sample handling and chain-of-custody procedures. At the laboratory, samples may be further divided for analysis or storage.

Chain-of-custody

Chain-of-custody procedures will follow those recommended in PSEP (1997a). These procedures will be initiated when the first sample is collected, updated continuously through the sampling event, and followed until all samples are relinquished to the analytical laboratory. Example chain-of-custody forms for chemistry, TOC, and grain size are shown in Appendix C.

Measurement Procedures

This section describes the laboratory selection process, sample processing, chain-of-custody, laboratory methods, and reporting limits.

Field measurements and sampling

Field personnel will be trained to follow measurement and QC methods specified in Table 7 to obtain consistent field measurements of the various sediment sample characteristics specified in this QAPP. All completed sample labels, chain-of-custody forms, and field logs will be double-checked by members of the field crew after sample collection.

Table 7. Sediment quality field parameters, field methods, reporting limits, and QA/QC procedures.

Parameter	Expected Range Of Results	Technique/ Instrument	Measurement Method	Reporting Limit	QA/QC
Sediment Penetration Depth	0-17 cm	Metric ruler	Measure amount of space between top of the sample and top of the grab and subtract from the maximum grab depth (17 cm).	1 cm	Careful measurement
Sediment Temperature	7-15°C	Digital or alcohol thermometer	Read from thermometer inserted into sediment sample.	1.0°C	Calibration of thermometer
Overlying Salinity	7-34 ppt	Refracto-meter or multiprobe sond (which converts temperature and conductivity to salinity)	Refractometer: Pipet a drop of the water overlying the sample onto the refractometer and read the salinity from measurement scale. Multiprobe sond: Equilibrate calibrated probe in the marine water and collect reading(s).	1.0 ppt	Set refractometer to 0 ppt with deionized water daily. Multiprobe sonde: ±1.0% of reading or 0.1 ppt; whichever is greater
Sediment Type	Cobble, gravel, sand, silt-clay	N/A	Visually examine sediment in the grab.	N/A	Careful observation
Material in Sediment	Wood, shell, plant fragments, and macro algae	N/A	Visually examine sediment in the grab.	N/A	Careful observation
Sediment Color	Olive, gray, brown, black	N/A	Visually examine sediment in the grab.	N/A	Careful observation
Sediment Odor	Hydrogen sulfide, petroleum, other	N/A	Smell sediment in the grab.	N/A	Careful observation

Field QC sampling will include collection of field-split samples for chemistry, TOC, and grain size analyses at 5% of the sites sampled. The field-split samples will be submitted to the laboratories as blind replicates, in order to measure the amount of variability within the compositing of sediment in the field and within the analytical procedures in the laboratories. (The two sources of variability cannot be separated unless analytical lab duplicates are run on the same samples.)

Laboratory measurements

Laboratory analyses for the marine sediment parameters are expected to achieve the ongoing analysis requirements of the long-term sediment programs in Puget Sound). Although the very nearshore sediments have not been routinely sampled, the expected concentrations are

anticipated to vary more widely (higher and lower) than the concentrations from the PSEMP offshore sediment monitoring shown. Higher concentrations are anticipated due to the closer proximity to potential urban sources, and lower concentrations are anticipated due to the potential for the nearshore substrate to be coarse, lacking the fines, and associated with contaminants. Table 8 presents the best approximation for the planned sediment monitoring.

Table 8. Laboratory analysis and reporting requirements for marine sediment monitoring.

Parameter	Expected Range Of Results	Extraction Method	Clean-Up Method	Analysis Method	Technique/ Instrument	Required Reporting Limit
Grain Size	<20% - >80% silt+clay	N/A	N/A	PSEP (1986)	Sieve-pipette method	1.0%
Total Organic Carbon (TOC)	0.01 - 15.0%	Drying sediment material	N/A	PSEP (1986)	Determination of CO2 by non-dispersive infrared spectroscopy	0.1%
Metals (except mercury)	< 0.1 - 500 ppm (up to 1500 for zinc)	EPA 3050B	N/A	EPA 200.8	ICP-MS	0.1 mg/kg dry weight (0.2 for Sn, 0.5 for Cr and Se, 5.0 for Zn)
Total Mercury	0.001 - 10 ppm	EPA 245.5	N/A	EPA 245.5	CVAA	0.005 mg/kg dry weight
Polynuclear Aromatic Hydrocarbons (PAHs)	0.01 - 50,000 ppb	EPA 3541*	EPA 3630C	EPA 8270D with isotopic dilution	Modification with capillary GC/MS-SIM isotopic dilution analysis	1- 5 ug/kg dry weight
Phthalates	0.01 - 50,000 ppb 12 – 120 ppb	EPA 3541*	EPA 3630C	EPA 8270D with isotopic dilution	Modification with capillary GC/MS-SIM isotopic dilution analysis	12 – 120 ug/kg dry weight
PBDE Congeners	< 0.1 - 4,000 ppb	EPA 3545	EPA 3620, 3665	EPA 8270D	Capillary GC/MS-SIM	0.40 -0.80† ug/kg dry weight
PCB Congeners	< 0.1 - 4,000 ppb	EPA 3545	EPA 3620 and EPA 3665	EPA 1668A	HRGC/HRMS	1 ug/kg dry weight

* = Samples are air dried prior to extraction.
† = Except PBDE congener 209, where the reporting limit is 4 ug/kg

Laboratory Quality Control (QC) Procedures

This section discusses QC procedures that will be implemented by the contracted analytical laboratory to provide high quality chemical and physical analyses that meet these QAPP requirements. Contract laboratories will make every effort to meet sample holding times and target reporting limits for all parameters. Laboratory QC procedures and results will be closely monitored throughout the duration of the permit-mandated sampling. The quality of laboratory data is subject to review via the established protocols in the *Measurement Quality Objectives* section. A typical schedule for laboratory QC samples is shown in Table 9 and, at a minimum, includes:

- Laboratory duplicates
- Matrix spikes
- Matrix spike duplicates
- Method/instrument blanks
- References (lab standards/surrogate standards/internal standards)

Table 9. Laboratory quality control schedule for monitoring.

Quality Control Sample[1]	Analysis Type	Frequency[2]	Corrective Action
Laboratory Duplicates	Metals	5% of total samples or 1 per batch (method-specific)	Evaluate procedure; reanalyze or qualify affected data
	Conventional		
Matrix Spikes (full constituent list)	Metals	5% of total samples or 1 per batch	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
	Organics	5% of total samples or 1 per batch	Evaluate duplicates and surrogate recoveries and assess matrix effects; evaluate or qualify affected data
Matrix Spike Duplicates[3]	Metals and Organics	At least 1 samples per year; Metals can be run either by MSD or lab duplicates at otherwise; 5% of total samples or 1 per batch	Evaluate procedure and assess potential matrix effects; reanalyze or qualify data
Method Blanks	Metals	5% of total samples or 1 per batch (method-specific)	Blank concentration may be used to define a new reporting limit. Evaluate procedure; ID contaminant source; reanalyze samples if blanks are within 10x concentration. No action necessary if samples are >10x blank concentrations
	Conventional		
	Organics		
Spiked (or Fortified) Blanks	Metals, Organics and Conventionals	5% of total samples or 1 per batch (primarily water)	Evaluate matrix spike recoveries; assess efficiency of extraction method; flag affected data
References (lab control standard, lab control sample, or standard reference materials)	Metals	5% of total samples or 1 per batch (spiked blank). If available, solid batches only: LCSs at 10% of total samples or 2 per batch (SRM/SRMD).	Evaluate lab duplicates/matrix spike recoveries; assess efficiency of extraction method; evaluate or qualify affected data
	Organics	5% of total samples or 1 per batch (spiked blank). If available, solid batches only: SRMs at 10% of total samples or 2 per batch (SRM/SRMD).	
Surrogates	Organics	Surrogates frequency is 100%	Evaluate results; qualify or reanalyze or re-prep/reanalyze samples.
Internal Standards	Metals and Organics	Internal Standard frequency is 100% for GC/MS and ICPMS methods	Evaluate results; dilute samples, reassign internal standards or flag data.

[1] Quality control samples may be from different projects for frequencies on a per-batch basis.
[2] Frequencies may be determined from the study number of samples collected by the permittee.
[3] The lab may use either a matrix spike duplicate or laboratory duplicate to evaluate precision based on the method.

Instrument calibration

The instrumentation used by the chosen laboratories will meet or exceed manufacturers' specifications for use and maintenance. Maintenance of this equipment will be conducted in a manner specified by the manufacturer or by the QA guidelines established by the chosen laboratory.

Duplicate/splits

Laboratory duplicate samples will be analyzed regularly to verify that the laboratory's analytical methods are maintaining their precision. The laboratory should perform "random" duplicate selection on submitted samples that meet volume requirements. After a sample is randomly selected, the laboratory should homogenize the sample and divide it into two identical "split" samples. To verify method precision, identical analyses of these lab splits should be performed and reported. Some parameters may require a double volume for the parameter to be analyzed as the laboratory duplicate. Matrix spike duplicates may be used to satisfy frequencies for laboratory duplicates.

Matrix spikes and matrix spike duplicates

Matrix spike samples are triple-volume field samples (per parameter tested) to which method-specific target analytes are added or spiked into two of the field samples, and then analyzed under the same conditions as the field sample. A matrix spike provides a measure of the recovery efficiency and accuracy for the analytical methods being used. Matrix spikes can be analyzed in duplicate (matrix spike/matrix spike duplicate [ms/msd]) to determine method accuracy and precision. Matrix spikes will be prepared and analyzed at a rate of 1/20 (five percent) samples collected or one for each analytical batch, whichever is most frequent. Use of ms/msd at the frequency of 5% of the total number of samples is common practice. For the purposes of permit monitoring, these frequencies meet the expectations.

Laboratory standards

Laboratory standards (reference standards) are objects or substances that can be used as a measurement base for similar objects or substances. In many instances, laboratories using digital or optical equipment will purchase from an outside accredited source a solid, powdered, or liquid standard to determine high-level or low-level quantities of a specific analyte. These standards are accompanied by acceptance criteria and are used to test the accuracy of the laboratory's methods. Laboratory standards are typically used after calibration of an instrument and prior to sample analysis.

Surrogate and internal standards

Surrogate standards are used to process and analyze extractable organic compounds (PAHs, phthalates, and pesticides). A surrogate standard is added before extraction, and it monitors the efficiency of the extraction methods. Internal standards are added to organic compounds and metal digests to verify instrument operation when using inductively coupled plasma mass spectrometry (ICP-MS) analysis and gas chromatography-mass spectrometry (GC-MS) analyses.

Method blanks

Method blanks are designed to determine whether contamination sources may be associated with laboratory processing and analysis. Method blanks are prepared in the laboratory using the same reagents, solvents, glassware, and equipment as the field samples. These method blanks will accompany the field samples through analysis.

Instrument blank

An instrument blank is used to "zero" analytical equipment used in the laboratory's procedures. Instrument blanks usually consist of laboratory-pure water and any other method-appropriate reagents, and they are used to zero instrumentation.

Measurement quality objectives (MQOs) for laboratory samples

This section refers to the MQOs, the acceptance thresholds for RSMP marine sediment data. MQOs specifically are used to address instrument and analytical performance. MQOs established for stormwater permit monitoring are based on guidance from multiple sources, including EPA, PSEP (1997d), Ecology, and laboratory experience and they represent how data will be verified prior to reporting results. Failure to meet the MQOs may result in data being qualified or rejected.

QC methods for organic analyses include both instrument calibration and analytical QC procedures (i.e., use of method blanks, surrogate spike compounds, analytical replicates, matrix spikes, spiked method blanks, and reference materials). QC for metals analyses also includes both instrument (e.g., calibration) and method (e.g., method blank, matrix spike) procedures. The frequency of each chemistry QC test is specified in Table 9.

Table 10. Field and laboratory measurement quality objectives (MQOs) for sediment grain size, total organic carbon, and chemistry analyses.

Parameter	Field Blank	Field Replicate (Split Sample)	Analytical (Laboratory) Replicate	Laboratory Control Sample	Method Blank	Matrix Spike (and Matrix Spike Duplicates)	Surrogate Spike
MQO Measured	RPD	RPD	RSD or RPD	% recovery limits	Comparison of analyte concentration in blank to quantification limit	% recovery limits	% recovery limits
Grain Size	NA	NA	RSD ≤ 20%	NA	NA	NA	NA
Total Organic Carbon (TOC)	RPD ≤ 20%	NA	RSD ≤ 20%	NA	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 10x method blank concn. or qualified as an estimate	75-125	NA
Metals	RPD ≤ 20%	RPD ≤ 20%	NA - when concentrations are low or below PQL, matrix spike/matrix spike duplicates serve as analytical duplicate	80-120	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 10x method blank concn. or qualified as an estimate	75-125	NA
Total Mercury	RPD ≤ 20%	RPD ≤ 20%	NA - when concentrations are low or below PQL, matrix spike/matrix spike duplicates serve as analytical duplicate	80-120	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 10x method blank concn. or qualified as an estimate	75-125	NA
Phthalates	RPD ≤ 20%	RPD ≤ 20%	Compound specific RPD ≤ 40%	50-150	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	50-150	Compound specific; within 50-150
Polynuclear Aromatic Hydrocarbons (PAHs)	RPD ≤ 20%	RPD ≤ 20%	Compound specific RPD ≤ 40%	40-140	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	40-140	Compound specific; within 50-150
PCB Congeners	RPD ≤ 20%	RPD ≤ 20%	Compound specific RPD ≤ 40%	50-150	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	50-150	Compound specific; within 50-150

Parameter	Field Blank	Field Replicate (Split Sample)	Analytical (Laboratory) Replicate	Laboratory Control Sample	Method Blank	Matrix Spike (and Matrix Spike Duplicates)	Surrogate Spike
MQO Measured	RPD	RPD	RSD or RPD	% recovery limits	Comparison of analyte concentration in blank to quantification limit	% recovery limits	% recovery limits
Polybrominated Dichloroethylene (PBDE)	RPD ≤ 20%	RPD ≤ 20%	Compound specific RPD ≤ 40%	50-150	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	50-150	Compound specific; within 50-150

RPD: relative percent difference. RSD: relative standard deviation. PQL: percent quantitation limit. MDL: method detection limit. MQO: measurement quality objective.

Method Blanks: Analyzed to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of sample extracts.

Surrogate Spike Compounds: A type of check standard that is added to each sample in a known amount prior to extraction or purging.

Analytical Replicates: Provide precision information on the actual samples; useful in assessing potential samples heterogeneity and matrix effects.

Matrix Spikes: Percent recoveries of matrix spikes are reported and should include a wide range of representative analyte types; compounds should be spiked about 5x the concentration of compounds in the sample or 5x the quantification limit.

Laboratory Control Samples: Sometimes called check standards or laboratory control samples, are method blanks spiked with surrogate compounds and analytes; useful in verifying acceptable method performance prior to and during routine analysis of samples.

Standard Reference Materials (SRM): A material or substance whose property values are sufficiently well established to be used for calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Certified Reference Material (CRM): A reference material, provided by standard setting organizations (e.g., NIST, CRM), accompanied by or traceable to a certificate or other documentation that is issued by a certifying body.

Data Management Procedures

Permittees will collect and manage data from field observations/measurements and laboratory analysis of field samples. All data will be managed and stored by the permittees. Post-processed data will be finalized and incorporated into annual reports and electronic reports. Reports and data will be submitted to Ecology in the format required.

Field logs

Field data and observations will be recorded on field logs (example log is shown in Appendix B) printed on waterproof paper and kept in a three-ring binder aboard the research vessel during sampling. Alternatively, the field crew may enter the field data directly into spreadsheets on a laptop computer aboard the vessel. If a laptop is used in the field, electronic files will be regularly backed up during sampling onto a portable flash drive. Field forms, electronic field data, and any notes made in the field to record information under this monitoring program will be kept in an organized filing system for paper and electronic files at the office. Field logs will contain the following information:

- Date and time of sampling
- Field station identification
- Crew members
- Weather observations at the time of sampling
- Precipitation amount in previous 24 hours prior to sampling. *(Rain gage needs only be located within 10 miles of shoreline station).*
- Estimated tide height at time of sampling

A new field log will be completed at every site including all sites that are rejected. The information for the sites that are successfully field sampled will be entered into an electronic database maintained by the permittees until completion of sampling and analysis. All entries will be independently verified for accuracy by another individual on the project team.

Laboratory data

Grain size, total organic carbon, and chemistry

Chemical laboratory data will be sent to the permittee from each laboratory following analysis. Reporting times may vary depending on holding time but should not exceed six months from the documented sampling date. Data will be submitted as an electronic data deliverable and a printed copy or PDF report. Laboratory reports will be reviewed by the permittees for errors or missing data; permittees may implement corrective actions.

The data packages from the laboratory will include:

- Printed values for all parameters measured at each site.

- A case narrative or report detailing methods used, any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers.
- All associated QC results. This information is needed to evaluate the accuracy of the data and to determine whether the MQOs have been met. This will include results for all required field and analytical (laboratory) control replicates, laboratory control samples, reference materials, method blanks, matrix spike, matrix spike duplicates, and surrogate spikes (Table 9).
- Data entered into EIM follow a data review procedure in which data are reviewed by the project manager of the study, the person entering the data, and an independent reviewer.

Audits

Routine audits will be conducted by senior staff to ensure this QAPP is being implemented correctly and the quality of the data is acceptable. A routine audit will ensure:

- Sampling locations were correctly identified and sampled.
- SOPs were followed.
- Documentation of the visit, chain-of-custody, or sample identification forms was correctly filled.
- Correction actions were made, as necessary.

Ecology's Laboratory Accreditation Unit provides accreditation and audits to local laboratories (commercial and state and local government). The accreditation process includes performance testing and periodic lab assessments. No additional audits are envisioned, unless prepared by the permittees through their contract agreements.

Data storage

All field forms, photographs, electronic data, and laboratory electronic or printed data generated for this project will be stored by the permittees in an organized filing system for paper and electronic files. These files may be sought by Ecology for permit compliance review and audit purposes and must be maintained in according to the records retention requirements for all documents related to the permits. Location, measurement, and sample result data will be evaluated through the data verification process outlined in this QAPP. Acceptable results will be used by scientists to prepare a summary report and entered into Ecology's EIM database.

Data Verification and Usability

The project lead and laboratory staff will verify the data by examining all field and laboratory-generated data to ensure:

- Specified methods and protocols were followed.
- Data are consistent, correct, and complete, with no errors or omissions.
- Data specified in the *Sampling Process Design* section were obtained.
- Results for QC samples as specified in the *Measurement Quality Objectives* and *Quality Control* sections accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.

Field data

Throughout the duration of field sampling, the permittee's project lead and crew members are responsible for implementation of sample-collection procedures. The permittee's project lead is also responsible for a systematic review of all field documentation generated (e.g., field logs, chain-of-custody sheets, sample labels) to ensure data entries are consistent, correct, and complete, with no errors or omissions. This review should be completed prior to leaving the site where the measurements were made.

Laboratory data

Laboratories shall submit data reports to the permittee's project lead. The reports should include:

- Sample chain-of-custody.
- Description of analytical methods.
- Data in electronic format.
- QA sample results.
- Data evaluation results.
- Any problems encountered and corrective actions which were taken.
- Any qualification of the results.

The permittee's project lead or another appropriate staff member shall review the data package. Discrepancies must be reported back to the laboratory or contractors for amendment. Archive samples may be run if necessary. After data have been reviewed and verified, staff will report on the data usability.

Data quality (usability) assessment

Data usability assessment follows verification. This involves a detailed examination of the data package using professional judgment to determine whether the quality objectives have been met. The permittee's project manager examines the complete data package to determine compliance with procedures outlined in this QAPP and referenced SOPs. The project manager also ensures that the MQOs have been met and determines if the quality of the data is usable for the project objectives.

Nearshore Sediment Monitoring Reports

Summary Report

Pierce County must provide an Annual Monitoring Report, consisting of a narrative report, an Excel spreadsheet with all data, and a submittal to Ecology's Environmental Information Management (EIM) database. For the Annual Monitoring Report to be considered on time, the EIM data submission process must be completed at the time the Annual Report submission (March 31, 2017). The reports must include all information listed in Table 11.

Table 11: Required monitoring report elements

Category	Reporting Requirement
Site Confirmation	Documentation of the site confirmation process, including desktop evaluation and field visits for each of the required number of assigned sites.
	List of sites disqualified and specific reasons for disqualification.
	List of final sites. In a table, provide final GPS coordinates for each site and the distances from the initial GPS locations provided in the Master Sample.
Ancillary Site Information	Description of the adjacent shoreline, including land uses, municipal or private outfalls, streams, and other significant landscape features or in-water activities within approximately one-half mile in either direction along the shoreline from the sampling location.
	Estimated tide height above MLLW at time of sampling; also indicate whether tide was incoming, at peak high or low, or outgoing?
	Weather condition at time of sampling; rainfall in previous 24 hours
	Other required and/or relevant field observations
Sediment Quality Monitoring	Sample information (dates, times, locations).
	Tabulated field measurements (results, dates, time)
	Tabular sediment quality data.
	Summary results for each site and for all of the sites.
	Documentation of adherence to QA/QC requirements.
Concerns	Narrative description of any deviations from this QAPP, including any delays, problems, and resolutions in conducting required monitoring activities. Data usability statement.
Costs	A summary of monitoring costs for this permit-required monitoring program component.

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Appendices

erce County candidate marine monitoring sites along UGAs (sorted from master sample list)

UGA_NM2	BCNAME	LON_DD	LAT_DD
Tacoma - Unincorporated UGA	Sand beach	-122.42765083600	47.31947715800
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57849932500	47.33585680100
Gig Harbor - Unincorporated UGA	Organics/fines	-122.62723174300	47.38544836000
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56681804700	47.30708115500
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44443520400	47.30313810400
Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42942761900	47.31731999600
Gig Harbor - Unincorporated UGA	Sand flat	-122.62436068200	47.37648708400
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56842564600	47.30957023700
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44250634400	47.30621081800
Gig Harbor - Unincorporated UGA	Sand flat	-122.58275338700	47.33831809500
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43194883600	47.31375141500
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57510704900	47.33026721100
Gig Harbor - Unincorporated UGA	Sand beach	-122.57390536200	47.31740756500
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43569055800	47.29802943400
Gig Harbor - Unincorporated UGA	Organics/fines	-122.58376416300	47.34196818300
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57648216000	47.33340918800
Gig Harbor - Unincorporated UGA	Organics/fines	-122.62639152200	47.38659847000
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56155876000	47.30117917500
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43514967600	47.30737998000
Tacoma - Unincorporated UGA	Sand flat	-122.42072510400	47.31934830500
Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42960254000	47.31926800900
Gig Harbor - Unincorporated UGA	Sand flat	-122.62384143700	47.37414470600
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57445147500	47.32903144600
Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56760504200	47.30782609400
Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43885797100	47.30644430200

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
1273	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43109520400	47.31553455500
1377	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62599495000	47.38241725500
1393	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57350498500	47.32795623000
1445	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57377675200	47.19087788500
1457	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57285582400	47.31578126200
1465	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44004327100	47.29910212100
1505	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58333999200	47.33906965900
1649	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56587203900	47.30544110000
1841	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57683799000	47.33383066200
1889	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62665840900	47.38711368400
1893	Pierce	Pierce Co. - Unincorporated UGA	Man-made, permeable	-122.57572305900	47.18725495600
1905	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56240610000	47.30208148000
1977	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43603516700	47.30708896500
2017	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58341891900	47.34014052600
2029	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42257756100	47.31903201500
2109	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41868497100	47.31998153300
2145	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62398999400	47.37488114200
2213	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57488866600	47.18815138900
2225	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.56961453100	47.31084125100
2233	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44432416000	47.30568839800
2297	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43177954600	47.31440286500
2401	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62547009300	47.38132605000
2417	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57324822700	47.32646835300
2481	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57252542200	47.31506382200
2489	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44357819000	47.30026664600
2657	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.62907757900	47.38854518800
2673	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55870582500	47.29833458000
2745	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43666823600	47.29849106600
2865	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57550677800	47.33085009100
2913	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62788765500	47.38620509000

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
2929	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56070480800	47.30024059000
3001	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43324733900	47.30885720300
3041	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58290756000	47.34131826400
3053	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42598273300	47.31912131700
3169	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62439277700	47.37683417800
3185	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57462981300	47.32674714100
3249	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57079329600	47.31274929200
3257	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44060069100	47.30625909200
3297	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58101306000	47.33727426200
3321	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43213800800	47.31183541600
3425	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62546908400	47.37954317200
3441	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57232670900	47.32689363900
3505	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57125479400	47.31321935600
3513	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44424608900	47.30100182700
3681	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62743447700	47.38415115700
3697	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55934135800	47.29877268900
3769	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43701514500	47.30680871600
3889	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57854512800	47.33606865900
3937	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62661988500	47.38560624100
3953	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56335070000	47.30326746200
3961	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44420433900	47.30373230700
4025	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43238221100	47.31072715600
4077	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42952135700	47.31847777900
4157	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42684997400	47.31930928200
4209	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57779153900	47.33536478400
4257	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62783997300	47.38537931800
4273	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56647364400	47.30635384700
4281	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44452515200	47.30263898900
4345	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42940325900	47.31763332400
4449	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62581033300	47.38211645600

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
4465	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57332925200	47.32697599000
4517	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57453399700	47.18946238800
4529	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56922619800	47.31046274300
4537	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44079530400	47.29917841400
4577	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58270331600	47.33826246400
4601	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43190859900	47.31403487100
4721	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57496944900	47.33001450500
4785	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57369224900	47.31703373100
4793	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43411227100	47.29739324500
4833	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58417591900	47.34338721100
4913	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57639901900	47.33327255700
4961	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62667655400	47.38705744800
4977	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56128307500	47.30108603700
5049	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43564140900	47.30720520000
5101	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.42021117800	47.31958238300
5217	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62388441200	47.37438987900
5233	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57433745400	47.32883223500
5297	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56752366200	47.30773575300
5305	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44023431100	47.30629075300
5369	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43013500800	47.31614610200
5473	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62565903000	47.38188181700
5489	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57420765400	47.32867262000
5553	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57300194600	47.31589534600
5561	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44273931200	47.29969849800
5729	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.62930393300	47.38896234200
5745	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56589441200	47.30546500100
5817	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43463841800	47.29756594900
5857	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58370786300	47.34279642500
5937	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57598195100	47.33265926200
5985	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62638493100	47.38627171200

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
6001	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56307377900	47.30300369600
6073	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43300688700	47.30937841300
6113	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58330499700	47.34045751600
6125	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42469929300	47.31907350900
6205	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41976546700	47.31969363900
6241	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62396954800	47.37448738700
6309	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57488358700	47.18842278900
6321	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.56991243300	47.31159356800
6329	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44430279700	47.30560040000
6393	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43176778300	47.31443640700
6497	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62531569400	47.38048938200
6513	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57331010600	47.32687840700
6577	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57223068900	47.31425501800
6585	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44435951800	47.30123428800
6753	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.62902453900	47.38847664300
6769	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55901356200	47.29856726700
6841	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43782938300	47.29873303600
6961	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57582037700	47.33109340300
7009	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62801689600	47.38629844100
7025	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56464248600	47.30416243900
7097	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43328963000	47.30881608700
7137	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58290241500	47.34129709800
7149	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42549912900	47.31908471900
7265	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62451193300	47.37707131100
7281	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57478374500	47.32655385600
7333	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57472474200	47.18928070600
7345	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57049019100	47.31233575600
7353	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44095074800	47.30622884200
7393	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58199992900	47.33766477600
7417	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43218667200	47.31154999500

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
7521	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62526558000	47.37884391100
7537	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57150911700	47.32753268400
7601	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57100777200	47.31296775000
7609	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43534454500	47.29782850900
7777	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62716490300	47.38394863100
7793	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56000654300	47.29918953600
7865	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43775959500	47.30667693200
7985	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57884283100	47.33649206100
8033	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62852695200	47.38521671600
8049	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56362888200	47.30346019600
8057	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44391232600	47.30474973800
8121	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43220910600	47.31141841800
8173	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42955921000	47.31873217800
8253	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42756139500	47.31945997300
8305	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57813286300	47.33556320300
8369	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56646135800	47.30628874300
8377	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43931535100	47.30637813300
8441	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42945186600	47.31827281800
8545	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62574342400	47.38201380500
8561	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57334492500	47.32766859400
8613	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57397832500	47.19008880100
8625	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57317316400	47.31612314400
8633	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44142292400	47.29927568000
8673	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58346096700	47.33941488400
8817	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57485869900	47.32981625100
8889	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43398425000	47.29735233500
8929	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58405845900	47.34352889500
9009	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57714999100	47.33439324800
9057	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62648198800	47.38723911700
9061	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57505671700	47.18761118700

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
9073	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56090575200	47.30068711100
9145	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43471281800	47.30758356100
9197	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.42204096200	47.31909158900
9277	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41766783000	47.32014308300
9313	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62408735800	47.37550003600
9393	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56824525300	47.30866908100
9401	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44454602800	47.30192398500
9465	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42992156900	47.31628178200
9569	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62535139900	47.38079897500
9585	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57371652400	47.32820807100
9637	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57387224100	47.19023994000
9649	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57259292100	47.31557599900
9657	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44249449800	47.29960554100
9825	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62867978300	47.38699025500
9841	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56532953300	47.30486157000
9913	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43758961000	47.29868307000
9953	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58390405500	47.34325799400
10033	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57587438700	47.33231240400
10081	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62665712300	47.38626007400
10097	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56297020500	47.30286064000
10169	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43287294900	47.30963025000
10209	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58366918300	47.34189034800
10221	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42396390000	47.31903209000
10301	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41806663300	47.32007029200
10337	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62463781000	47.37753060200
10405	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57489709900	47.18877298000
10417	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.56975273100	47.31114725600
10425	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44420099000	47.30595196900
10489	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43164336900	47.31483157000
10593	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62529761800	47.38033264900

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
10609	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57242223700	47.32683493000
10673	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57195835800	47.31396230900
10681	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44368449000	47.30035809500
10849	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.62893493500	47.38805300000
10865	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55962771100	47.29895213800
10937	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43842211100	47.29883787600
11057	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57581483400	47.33175677000
11105	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62843359000	47.38661332800
11121	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56414322700	47.30381654700
11129	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44388499800	47.30423475300
11193	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43258545700	47.31022447900
11245	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42586095800	47.31911571300
11361	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62506415700	47.37844903700
11377	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57435666800	47.32672151000
11429	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57467493100	47.18932638100
11441	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56890105400	47.31014563700
11449	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44190253700	47.30620793700
11489	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58163600900	47.33751105600
11513	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43198110600	47.31307365900
11633	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57130263300	47.32774266700
11697	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57357011300	47.31681948100
11705	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43471400000	47.29759179700
11873	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62694630400	47.38378440200
11889	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56047468800	47.29972922400
11961	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43405140400	47.30810873000
12081	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57949571000	47.33679786300
12129	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62825243700	47.38488828200
12145	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56722805300	47.30740760000
12153	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44416822200	47.30530608100
12217	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42962778100	47.31659695300

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
12269	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42801278300	47.31953032700
12349	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42929702700	47.31955932500
12401	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57742516000	47.33503109900
12465	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56835050900	47.30919488900
12473	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44002979900	47.30630842500
12537	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43137948100	47.31529687000
12641	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62639070000	47.38316204300
12657	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57333091100	47.32769493500
12721	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57342489900	47.31656474500
12729	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44110909300	47.29922511400
12769	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58353694500	47.33969197300
12913	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57090743700	47.32817587000
12985	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43341525700	47.29726785000
13105	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57708159000	47.33418820600
13153	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62639972200	47.38700695900
13157	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57563408700	47.18739994900
13169	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56226355000	47.30188458100
13241	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43647457500	47.30695925100
13281	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58352355400	47.33987387600
13293	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.42177754300	47.31912432000
13409	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62402053700	47.37500463700
13477	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57495745600	47.18782955100
13489	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56828861100	47.30888567700
13497	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44454584700	47.30203948600
13561	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43049420000	47.31592341400
13665	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62535917000	47.38086611800
13681	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57389560300	47.32639194200
13745	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57233625300	47.31436848200
13753	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44334525500	47.30008641700
13921	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62879135900	47.38715320800

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
13937	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56541826100	47.30495635600
14009	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43700016800	47.29856023800
14049	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58376993900	47.34310743200
14129	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57536538300	47.33060807000
14177	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62664537100	47.38627228900
14193	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56262835700	47.30238847200
14265	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43291240000	47.30955334900
14305	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58310422000	47.34092641300
14317	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42482121400	47.31908037500
14433	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62464443700	47.37761992600
14449	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57394098700	47.32638855400
14513	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57041860600	47.31220574000
14521	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44124888500	47.30620481400
14561	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58071572100	47.33719307400
14585	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43207513100	47.31226838500
14689	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62547816200	47.37941912100
14705	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57196596600	47.32712435700
14769	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57161846000	47.31359697100
14777	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44387179600	47.30053937800
14945	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62762043000	47.38429085900
14961	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55914061400	47.29864688800
15033	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43753348600	47.30673857000
15153	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57582427100	47.33161013000
15201	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62643603400	47.38577891300
15217	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56440471100	47.30399770700
15225	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44430967500	47.30350565300
15289	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43272678700	47.30993795300
15341	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42334195800	47.31899705600
15457	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62493248500	47.37820332400
15537	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56879946900	47.31004656300

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
15545	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44273845200	47.30620753500
15585	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58233279500	47.33776832900
15609	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43196570100	47.31339718900
15729	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57474241800	47.32962734600
15793	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57411565300	47.31777644400
15801	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43602852500	47.29819503900
15841	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58297556100	47.34170902000
15969	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62670186100	47.38360075300
15985	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56190135500	47.30138428800
16057	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43394737600	47.30819002500
16177	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.57992910400	47.33701083700
16225	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62808127600	47.38544320400
16241	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56666648500	47.30700074000
16249	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44398365300	47.30492172600
16313	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42970057100	47.31649246200
16365	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42817949500	47.31954422300
16423	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57833535700	47.33568773300
16446	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56649384400	47.30646088100
16507	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62435850100	47.37676799200
16535	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56840801400	47.30948215900
16553	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58257645600	47.33800283100
16627	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43655497300	47.29844882900
16734	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.42097127700	47.31929920600
16804	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43871295800	47.30646914600
16827	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43090650500	47.31566778600
16937	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57727283400	47.33470900800
16959	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56625704200	47.30585237200
17025	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57680278400	47.33379574600
17042	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62696912500	47.38607497000
17072	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43593353000	47.30711896800

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
17085	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58329649300	47.34054871700
17158	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.56945855500	47.31068929900
17218	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62553129300	47.38017924900
17249	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44309757900	47.29991273200
17338	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43910999100	47.29895252400
17445	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42655886900	47.31921203300
17603	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57131698700	47.31328270100
17664	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62695717400	47.38547952800
17670	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56034003000	47.29942998800
17754	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62849230200	47.38514037000
17762	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44388192500	47.30462431900
17784	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43227512400	47.31104996500
17872	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44454526700	47.30241118600
17896	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42937912600	47.31794373000
17955	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57420809000	47.18977453000
17962	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44150193400	47.29928841100
18092	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57605749500	47.33296130500
18115	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56083388700	47.30052742000
18227	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56808242200	47.30835601900
18288	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62559788500	47.38171981000
18294	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57415289700	47.32861082100
18315	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57253100900	47.31527257100
18379	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62899339700	47.38766170000
18409	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43732456000	47.29862783700
18515	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42425780600	47.31904864400
18554	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62411506300	47.37579273800
18578	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57489122000	47.18862056100
18586	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44369035900	47.30609358200
18607	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43148532200	47.31519893900
18739	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.55848656200	47.29806251700

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
18806	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57578460300	47.33105257800
18823	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62841961400	47.38658649600
18828	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56449744200	47.30406195200
18917	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57384980000	47.32668422800
18939	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57030795500	47.31200937600
19000	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62538105600	47.37910147000
19030	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43519054600	47.29775476600
19120	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43818651700	47.30656458900
19228	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42957246800	47.31888261300
19255	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42953957800	47.31949265000
19363	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57339008200	47.32731270000
19385	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57327254300	47.31629747800
19451	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57109418500	47.32796572200
19535	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57531295800	47.18741328200
19564	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43486054200	47.30751033700
19623	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62405641200	47.37518618800
19653	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44449220900	47.30157511200
19676	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43025708600	47.31607041700
19735	Pierce	Pierce Co. - Unincorporated UGA	Mud flat	-122.57374166200	47.19041562300
19742	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44218987200	47.29947923400
19874	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57587021000	47.33220457500
19897	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56285524600	47.30270185700
19937	Pierce	Gig Harbor - Unincorporated UGA	Mud flat	-122.58330508700	47.34070397900
19967	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41850440800	47.32003601900
20075	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57281868200	47.32662782100
20098	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57175794200	47.31374689400
20158	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62800266000	47.38462577500
20189	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43926303500	47.29897803100
20256	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44407567600	47.30392284200
20296	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42290786800	47.31899664400

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
20337	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62486044800	47.37805465600
20368	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44350365900	47.30611592600
20389	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43199569900	47.31276717000
20519	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56159034200	47.30118984400
20587	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57939128200	47.33674956600
20602	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62855094000	47.38539393700
20608	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56706989100	47.30723202300
20698	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57729060800	47.33475485400
20720	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56794326500	47.30820154700
20782	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62622899300	47.38284982000
20813	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43955915000	47.29902738300
20826	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58330590900	47.33897242900
21007	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.42155017500	47.31915488200
21036	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41890819200	47.31992028200
21142	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57320069000	47.32647676700
21165	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57251949100	47.31484222100
21226	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.62892593200	47.38746186500
21232	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56510997200	47.30462702000
21272	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58378496100	47.34349450400
21316	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62761526000	47.38600491000
21346	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.43352606300	47.30851771000
21405	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.62473542800	47.37779891000
21410	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57436561900	47.32640336400
21449	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58041116100	47.33709719900
21457	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43208516800	47.31214531800
21523	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44409970600	47.30078339400
21656	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57867027700	47.33642914700
21678	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56380135900	47.30357969200
21856	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57529311900	47.33052240600
21878	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.57399487300	47.31756458000

Order	COUNTY_NM	UGA_NM2	BCNAME	LON_DD	LAT_DD
21896	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58357786400	47.34232199700
21938	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62665696600	47.38656427300
21970	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43427386100	47.30793210000
22036	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44439973700	47.30323793500
22058	Pierce	Tacoma - Unincorporated UGA	Sand and gravel flat or fan	-122.42949033500	47.31691018600
22076	Pierce	Tacoma - Unincorporated UGA	Sand beach	-122.42842967000	47.31956507700
22105	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43193714700	47.31391378700
22130	Pierce	Tacoma - Unincorporated UGA	Sand flat	-122.41999496300	47.31964858300
22161	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.58366060900	47.34266465100
22234	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.57171444500	47.32732873000
22300	Pierce	Gig Harbor - Unincorporated UGA	Organics/fines	-122.62666655000	47.38680557000
22392	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43242089200	47.31062906700
22406	Pierce	Gig Harbor - Unincorporated UGA	Sand flat	-122.58249717300	47.33790024900
22471	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.43337146400	47.29725713600
22537	Pierce	Gig Harbor - Unincorporated UGA	Sand beach	-122.56980936900	47.31130554400
22545	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel flat or fan	-122.62550214300	47.37985087100
22623	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.62644150900	47.38326014200
22657	Pierce	Gig Harbor - Unincorporated UGA	Sand and gravel beach, narrow	-122.56198420900	47.30149873300
22716	Pierce	Tacoma - Unincorporated UGA	Sand and gravel beach, narrow	-122.44187384400	47.30620780000

Appendix B. Example Field log

2013 FIELD LOG

SAMPLE No.: _____ **SAMPLING DATE: _____/_____/20__**

TIME OF: 1ST GRAB: _____AM/PM LAST GRAB: _____ AM/PM

☐TARGET MOVED 100 200 300m **GRAB USED:** ☐ Weighted ☐Unweighted

CREW: _____

Other:_____

_____

LOCATION:_____

_____

SITE DESCRIPTION including weather and tide height:

_____

_____

SITE STATUS: ☐Target and Sampled ☐NN-Not Needed ☐NS-Not Sampled ☐NT-Not Targeted

☐OS-Other Sample ☐PB-Physically Inaccessible ☐ALTERNATE for Sample No.: _____

SITE FAIL REASON: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐ Shallow penetration

☐Rocky bottom ☐Algal Mats

FIRST ACCEPTED GRAB INFORMATION (GRAB NO. ____)

Meter Wheel Depth: _____ m Surface Salinity: _____ ppt Temp: _____°C

Penetration Depth: _____cm RPD: _____cm ☐Sheen Observed

SEDIMENT TYPE: ☐Cobble ☐Gravel ☐Sand ☐Silt-Clay

MATERIAL IN/ON SEDIMENT: ☐Wood Fragments ☐Shell Fragments ☐Plant Fragments ☐Macroalgae

SEDIMENT COLOR: ☐Olive ☐Gray ☐Brown ☐Black **–OVER–** ☐Olive ☐Gray ☐Brown ☐Black

SEDIMENT ODOR: ☐None ☐H_2S ☐Petroleum ☐Other: _____ ☐ Slight ☐Moderate ☐Strong

PARAMETERS SAMPLED: ☐Chemistry & TOC ☐Grain Size ☐Chemistry Split

PLACE
SITE SAMPLE TAG
HERE

PLACE
CHEMISTRY SPLIT SAMPLE TAG
HERE

SUBSEQUENT GRAB INFORMATION (indicate any differences in visual observations):

GRAB NO. ____: ☐Taken ☐Rejected;
Comments: _____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration
☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:
_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration
☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:
_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration
☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:
_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration
☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:
_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration ☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:

_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration ☐Rocky bottom ☐Algal Mats)

GRAB NO. ____: ☐Taken ☐Rejected; Comments:

_____

(REASON FOR REJECT: ☐Abandoned ☐Washed ☐Poor Closure ☐Disturbed Surface ☐Shallow penetration ☐Rocky bottom ☐Algal Mats)

FAUNA OBSERVED:

_____

_____

_____

_____

_____

_____

COMMENTS:

_____

_____

_____

_____

_____

_____

_____

RECORDED BY: ☐_____ ☐ _____
☐_____ ☐_____

	DATE	**SPECIAL ANALYSES**
	COMMENTS	
	DATE	**SPECIAL ANALYSES**
	COMMENTS	
	DATE	**SPECIAL ANALYSES**
	COMMENTS	
	DATE	**SPECIAL ANALYSES**
	COMMENTS	
	DATE	**SPECIAL ANALYSES**
	COMMENTS	

Appendix C. Example chain-of-custody forms

PUGET SOUND SEDIMENT MONITORING

CHAIN OF CUSTODY – CHEMICAL/TOC ANALYSIS

Project: _____ **PIC Code:**_____

Station Number	Lab Number	Sample Date	Total Organic Carbon (2 oz. jar)	Metals (4 oz. jar)	BNA/ Butyl tins (8 oz. jar)	PCB/PBDE Pesticides (8 oz. jar)	Other

Relinquished By	Received By	Date	Time	Comments

PUGET SOUND SEDIMENT MONITORING

CHAIN OF CUSTODY – GRAIN SIZE

Project: _____ PIC Code:_____

Station Number	Date Sampled	Lab Number	Grain Size (8 oz jar)	Comments

Relinquished By	Received By	Date	Time

Appendix D. Glossary, acronyms, and abbreviations

Glossary

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities. This includes, but is not limited to, atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Parameter: A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

EAP	Environmental Assessment Program (at Ecology)
Ecology	Washington State Department of Ecology
e.g.	For example
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GIS	Geographic Information System software
GPS	Global Positioning System
GRTS	Generalized Random Tessellation Stratified
i.e.	In other words
MLLW	Mean lower low water
MQO	Measurement quality objective
NonUGA	NonUrban Growth Area
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbons
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyls
PSAMP	Puget Sound Assessment and Monitoring Program
PSEMP	Puget Sound Ecosystem Monitoring Program (formerly PSAMP)
PSEP	Puget Sound Estuary Program
PSP	Puget Sound Partnership
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
RSD	Relative standard deviation
RSMP	Regional Stormwater Monitoring Program
SOP	Standard operating procedures
SRM	Standard reference materials
SWG	Stormwater Work Group
TOC	Total organic carbon
UGA	Urban Growth Area

Units of Measurement

°C	degrees centigrade
°F	degrees Fahrenheit
cm	centimeter
ft	feet
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
km	kilometer, a unit of length equal to 1,000 meters
m	meter
mg	milligram
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)

mL	milliliters
ng/g	nanograms per gram (parts per billion)
ng/Kg	nanograms per kilogram (parts per trillion)
ug/kg	micrograms per kilogram (parts per billion)