Quality Assurance Project Plan for Status and Trends Monitoring of Marine Nearshore Sediment: For Monitoring Conducted using Pooled RSMP Funds contributed by Municipal Stormwater Permittees

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Preparation Date:
7/20/2016
Prepared under:
USGS Agreement Number: 16WNWA30046

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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.

The overall goals of the nearshore monitoring program are to characterize the nearshore marine sediment by urbanized areas throughout the Puget Sound. 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 parallel to established Urban Growth Areas (UGAs).
2. Document geographic patterns in nearshore sediment chemistry.
3. Document natural and human-caused changes over time in Puget Sound nearshore sediments.
4. Identify existing nearshore sediment chemistry quality problems and, where possible, provide data to help target sources.
5. Support nearshore sediment chemistry research activities by making available uniformly collected, high quality data.
6. Provide nearshore sediment chemistry data to assist the SWG, PSP, Ecology, Washington Department of Natural Resources (WADNR), and others in measuring the success of stormwater and other environmental management programs.

The specific objectives of nearshore sediment monitoring include:

1. Characterize the status, spatial extent and quality, of nearshore marine sediments within the UGAs sampling framework.
2. Track the trends, changes in spatial extent and quality, over time in the UGA sampling framework.

Scope of this Quality Assurance Project Plan

Monitoring for this Quality Assurance Project Plan (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 for Phase I and Phase II communities (Ecology, 2012a, b) effective August 1, 2013 through July 31, 2018. To fulfill an ongoing need to collect information that supports adaptive management of the permits' stormwater management requirements, all permittees located in Puget Sound were given two options to comply with the permits' Special Condition S8.B for status and trends monitoring. 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.

Nearly all permittees located in the Puget Sound watershed officially selected the first option except Pierce County and Redmond. Funding for this effort is provided by the municipal permittees that selected Option 1, and is administered by the Washington State Department of Ecology (Ecology) under the direction of the Pooled Resources Oversight Committee (PRO-Committee) of the SWG.

This QAPP defines the permit-required marine nearshore sediment scientific monitoring design and protocols that the RSMP, using the pooled funds contributed by the Option 1 permittees, will follow as well as the data and reports that will be produced. Sediment monitoring will be conducted from July through September 2016. This QAPP prepared for the Pooled Funds RSMP nearshore sediment monitoring contains the same site confirmation and sampling protocols as the

QAPP developed for the Option 2 permittee (Pierce County) required to monitor the marine nearshore. These RSMP QAPPs were prepared in accordance with Ecology's QAPP guidelines (Lombard and Kirchmer, 2004) and are Ecology-approved. This document is one of two "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.

Roles and Responsibilities

As the administrator of the RSMP, Ecology's RSMP coordinator has formed a marine nearshore sediment monitoring team made up of federal, state, and local government entities to conduct the monitoring for marine sediment in the Puget Sound nearshore. King County, Washington State Department of Natural Resources (WADNR) and the United States Geological Survey (USGS) will conduct the RSMP marine nearshore sediment sampling. These entities are referred to as "RSMP Contractors" in this document. The RSMP contractors will conduct monitoring at suitable sites in the nearshore environment from July through September of 2016. The key dates for the monitoring activities including field and laboratory work, data entry into Ecology's Environmental Information Management (EIM) database, and submission of monitoring summary reports, are summarized in Table 1. Ecology and RSMP contractor responsibilities for activities detailed in this QAPP are listed in Table 2.

Table 1. Key dates for QAPP completion, monitoring activities, and reports for status and trends monitoring in nearshore.

Due	Item	Description
June 30, 2016	Draft RSMP Nearshore Sediment QAPP due	Revised RSMP Nearshore sediment QAPP submitted to RSMP PRO-Committee. Committee reviews QAPP within 10 days.
July 30, 2016	RSMP Nearshore Sediment QAPP	RSMP Coordinator edits QAPP based on comments from RSMP PRO-Committee. Final RSMP Nearshore Sediment QAPP posted on RSMP website.
July 30 – September 15, 2016	Sediment Sampling	RSMP Nearshore sediment contractor team conducts sediment sampling at the required number of nearshore sediment sites.
April 30, 2017	Electronic data submittal due	All QA/QC'ed data submitted to Environmental Information Management (EIM) database.
July 30, 2017	Draft report due	Draft summary reports submitted to Ecology.
September 30, 2017	Final Report	Final report on the status of nearshore sediment in the Puget Sound.

Table 2. Project staff and responsibilities.

Implementation of Nearshore Sediment Permit Monitoring		
Name/Contact	**Role**	**Responsibility**
Brandi Lubliner, PE brandi.lubliner@ecy.wa.gov Ecology - WQP 360-407-7140	RSMP Coordinator	RSMP Coordinator manages ongoing implementation and administration of the RSMP; coordinates laboratory selection; and oversees contracts; approves QAPP; verifies whether QAPP is followed and monitoring data are of known and acceptable quality; ensure adequate training of staff, complies with corrective action requirements
Colin Elliott, King County Abbey Barnes, WADNR Robert Black, USGS	RSMP Nearshore Sediment Monitoring Team Leads	RSMP Sediment Monitoring Team Leads will manage and oversee monitoring activities and sampling decisions; coordinate laboratory deliveries and equipment maintenance; and manage field teams.
Colin Elliott, King County Abbey Barnes, WADNR Robert Black, USGS	RSMP Contractors	RSMP Contractors will collect and process field samples, and oversee field assistants. WADNR and USGS will work together during field sampling.
Colin Elliott, King County Environmental Laboratory	Laboratory Coordination	Coordinate supplies and sample delivery with field crews, laboratory analysis, laboratory QC, and delivery of results to the RSMP Coordinator.
Joel Bird, Nancy Rosenbower, and Leon Weiks; Ecology-Manchester Environmental Laboratory	Laboratory Coordination	Coordinate supplies and sample delivery with field crew, laboratory analysis, laboratory QC, and delivery of results to the RSMP Coordinator.
Robert Black, USGS	EIM Data Review	Reviews and QAs data collected by Contractors.

EIM: Environmental Information Management database
USGS: United States Geological Survey
WADNR: Washington Department of Natural Resources

King County, WADNR and the USGS will sample the first 40 qualifying sites along shorelines of the Puget Sound UGA areas excluding the unincorporated UGA areas of Pierce County. King County staff will be responsible 10 sites while WADNR and USGS will be responsible for 30 sites.

Nearshore Sediment Monitoring 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 sampling of nearshore sediment within the urban 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). The intent of the study design was to create a random list of sites, using the GRTS model for drawing spatial samples, from a population of sites along UGAs of the Puget Sound excluding unincorporated Pierce County. Each site represents an average shoreline length of 800 meters (m). The RSMP used an 800 m length of shoreline to represent a sampling site based on criteria used by the National Centers for Coastal Ocean Science's COAST National Status & Trends Mussel Watch Contaminant Monitoring program. The GRTS algorithm resulted in a total of 2048 sites in Puget Sound's UGAs, of which 40 locations were selected based on a randomized numerical ordering of potential sites. If any of the original 40 sites are found unsuitable for sampling, the next randomly ordered site within the 2048 sites will be sampled until 40 sites (30 by USGS/WADNR and 10 by King County) have been sampled. The list of 40 original sites and the first 8 back-up sites are presented in the Study Design section of this QAPP. 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).

Assumptions Underlying the Design

This monitoring program design is based on several assumptions; 1) for the purposes of assessing stormwater impacts on nearshore sediment within the UGA, the study design characteristics take into account the desire for Puget Sound-scale estimates within the UGA 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 monitoring program 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 sediment quality 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 *Sampling 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 *Sampling 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 *Sampling Procedures* section.

Laboratory Measurements

Sediment grain size analyses, total organic carbon (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. The laboratories selected for this QAPP are presented in Table 3. A list of the constituents to be analyzed in the laboratories can be found in the *Sampling Procedures* section, and methods and reporting limits are describe in the expanded *Laboratory Measurements* section.

All work is expected to meet the QC requirements of the analytical methods used for this project. These requirements are summarized in the *Laboratory Quality Control (QC) 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 expanded *Laboratory Measurements* section

Laboratory Selection

Laboratories for sediment parameters have been 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 contractors. Table 3 lists the laboratories and analyses that will be used for this project.

Table 3. Laboratories selected for sample processing and analysis.

Laboratory Name	Analytical Purpose	Address	Phone
Manchester Environmental Laboratory (MEL)	Sediment Analysis for Grain Size, Total Organic Carbon (TOC), Metals, PAH, Phthalates	7411 Beach Drive East Port Orchard, WA 98366	(360) 871-8724
King County Environmental Laboratory (KCEL)(1)	Sediment Analysis for Grain Size, Total Organic Carbon (TOC), Metals, PAH, Phthalates	322 West Ewing Street Seattle, WA 98119-1507	(206) 477-7200
AXYS Analytical Services Ltd.	Sediment Analysis for PBDE, PCB, Subcontracted by MEL	2045 Mills Road W. Sidney BC Canada V8L 5X2	(250) 655-5800

(1) An inter-laboratory comparison for metals, PAH and Phthalates will be performed between KCEL and MEL and is discussed in the *Laboratory Quality Control Section* of this QAPP. Samples will be sent to MEL by King County.

Study Design

Site Selection

Initial sampling site criteria for marine monitoring and assessment are discussed in this section. All of the 2048 sites selected from the GRTS model described above and presented in Appendix A were considered candidate sites. Each of these 2048 sites were randomly assigned a numeric rank from 1 to 2048. An initial desk top and field evaluation (performed by the Puget Marine Nearshore Mussels study team (http://wdfw.wa.gov/publications/01760/)) of the sites in numerical order was performed until 40 original and 8 back-up sites that appear suitable for sampling were identified (Table 4). The locations of the first 40 sites selected for this study are presented in Figure 1. These sites represent the original 40 targeted sampling RSMP Pooled Fund sites that meet the following Target Status characteristics:

1. They are located in the nearshore sub-tidal zone
2. They are parallel to an designated Urban Growth Area
3. They are NOT within a marina or port (i.e. where multiple motorized vessels are kept in the water).

Only three candidate sites were excluded from sampling based on the initial evaluation: two in the Blair Waterway in Tacoma that were within a port (did not meet target status characteristic 3), and one in the Port of Everett in the vicinity of active nearshore remediation.

The USGS, WADNR and King County will make a good faith effort to sample at the selected sites per this QAPP's requirements. However, field personnel may disqualify sites upon visitation based on criteria described in the *Sample Collection* section of this QAPP. In that case, the reason(s) for site disqualification will be documented with photos and field notes. For each site that is disqualified, a back-up site will be selected in numerical order from the list of 8 back-up sites in Table 4, and if necessary, from additional sites listed in Appendix A.

Table 4. List of initial 40 randomly selected nearshore sediment sampling sites plus the first 8 backup sites. Additional backup sites can be found in Appendix A of this report.

Randomly Selected Site Order	Location ID	Study Specific Location ID	Longitude (DD)	Latitude (DD)	Original 40 Sampling Sites?	Sampling Agency	Mussel Site?	Reason For Exclusion
1	PSS13175-000001	1-NUGA	-122.91126	47.04765	Yes	DNR/USGS		
2	PSS13175-000002	2-NUGA	-122.38594	47.50204	Yes	King	Yes	
3	PSS13175-000003	3-NUGA	-122.50706	47.68262	Yes	King	Yes	
4	PSS13175-000004	4-NUGA	-122.73630	48.85755	Yes	DNR/USGS	Yes	
5	PSS13175-000005	5-NUGA	-122.52806	47.29181	Yes	DNR/USGS	Yes	
6	PSS13175-000006	6-NUGA	-122.52759	47.61871	Yes	King	Yes	
7	PSS13175-000007	7-NUGA	-122.41750	47.64877	Yes	King		
8	PSS13175-000008	8-NUGA	-122.77652	48.04868	Yes	DNR/USGS	Yes	
9	PSS13175-000009	9-NUGA	-122.37604	47.25521	Dropped			Site dropped on recommendation of WDFW study manager and with concurrence from RSMP manager due to oversampling of the Blair Waterway; three sites in the Blair Waterway does not line up with intent of this study.
10	PSS13175-000010	10-NUGA	-122.57753	47.64458	Yes	DNR/USGS	Yes	
11	PSS13175-000011	11-NUGA	-122.50606	48.72568	Yes	DNR/USGS	Yes	
12	PSS13175-000012	12-NUGA	-122.57945	48.29690	Yes	DNR/USGS	Yes	
13	PSS13175-000013	13-NUGA	-122.49510	47.29253	Yes	DNR/USGS	Yes	
14	PSS13175-000014	14-NUGA	-122.60648	47.57101	Yes	DNR/USGS	Yes	
15	PSS13175-000015	15-NUGA	-122.67746	48.49230	Yes	DNR/USGS	Yes	
16	PSS13175-000016	16-NUGA	-122.33472	47.85424	Yes	King	Yes	
17	PSS13175-000017	17-NUGA	-122.91975	47.06878	Yes	DNR/USGS	Yes	
18	PSS13175-000018	18-NUGA	-122.36868	47.46333	Yes	King	Yes	
19	PSS13175-000019	19-NUGA	-122.49952	47.66154	Yes	King	Yes	
20	PSS13175-000020	20-NUGA	-123.42336	48.11780	Yes	DNR/USGS	Yes	
21	PSS13175-000021	21-NUGA	-122.51146	47.30376	Yes	DNR/USGS	Yes	
22	PSS13175-000022	22-NUGA	-122.59715	47.55888	Yes	DNR/USGS	Yes	
23	PSS13175-000023	23-NUGA	-122.49572	47.62206	Yes	King	Yes	
24	PSS13175-000024	24-NUGA	-122.74896	48.02680	Yes	DNR/USGS	Yes	
25	PSS13175-000025	25-NUGA	-122.41519	47.27454	Yes	DNR/USGS	Yes	
26	PSS13175-000026	26-NUGA	-122.59829	47.60311	Yes	DNR/USGS	Yes	
27	PSS13175-000027	27-NUGA	-122.50434	48.68975	Yes	DNR/USGS	Yes	
28	PSS13175-000028	28-NUGA	-122.63749	48.27141	Yes	DNR/USGS	Yes	
29	PSS13175-000029	29-NUGA	-122.65216	47.74626	Yes	DNR/USGS	Yes	
30	PSS13175-000030	30-NUGA	-122.64058	47.54111	Yes	DNR/USGS	Yes	
31	PSS13175-000031	31-NUGA	-122.91127	48.69258	Yes	DNR/USGS	Yes	
32	PSS13175-000032	32-NUGA	-122.22664	47.97529	Dropped			Port of Everett remediation activity.
33	PSS13175-000033	33-NUGA	-122.67593	47.10396	Yes	DNR/USGS		
34	PSS13175-000034	34-NUGA	-122.35304	47.58710	Yes	King	Yes	
35	PSS13175-000035	35-NUGA	-122.56549	47.66726	Yes	DNR/USGS	Yes	
36	PSS13175-000036	36-NUGA	-123.42576	48.14204	Yes	DNR/USGS	Yes	
37	PSS13175-000037	37-NUGA	-122.61066	47.16998	Yes	DNR/USGS	Yes	
38	PSS13175-000038	38-NUGA	-122.66985	47.60149	Yes	DNR/USGS	Yes	
39	PSS13175-000039	39-NUGA	-122.38082	47.63128	Yes	King	Yes	
40	PSS13175-000040	40-NUGA	-122.76251	48.13084	Yes	DNR/USGS	Yes	
41	PSS13175-000041	41-NUGA	-122.40166	47.26899	Dropped			Site dropped on recommendation of WDFW study manager and with concurrence from RSMP manager due to oversampling of the Blair Waterway; three sites in the Blair Waterway does not line up with intent of this study.
42	PSS13175-000042	42-NUGA	-122.62899	47.57617	Yes	DNR/USGS	Yes	
43	PSS13175-000043	43-NUGA	-122.61545	48.52084	Yes	DNR/USGS	Yes	
44	PSS13175-000044	44-NUGA	-122.39957	48.03641	Extra	DNR/USGS		
45	PSS13175-000045	45-NUGA	-122.35080	47.42844	Extra	King	Yes	
46	PSS13175-000046	46-NUGA	-122.49468	47.78584	Extra	King	Yes	
47	PSS13175-000047	47-NUGA	-122.78201	48.89548	Extra	DNR/USGS	Yes	
48	PSS13175-000048	48-NUGA	-122.30929	47.92779	Extra	DNR/USGS		
49	PSS13175-000049	49-NUGA	-122.59049	47.33837	Extra	DNR/USGS		
50	PSS13175-000050	50-NUGA	-122.52673	47.58137	Extra	King		
51	PSS13175-000051	51-NUGA	-122.37688	47.73996	Extra	King		

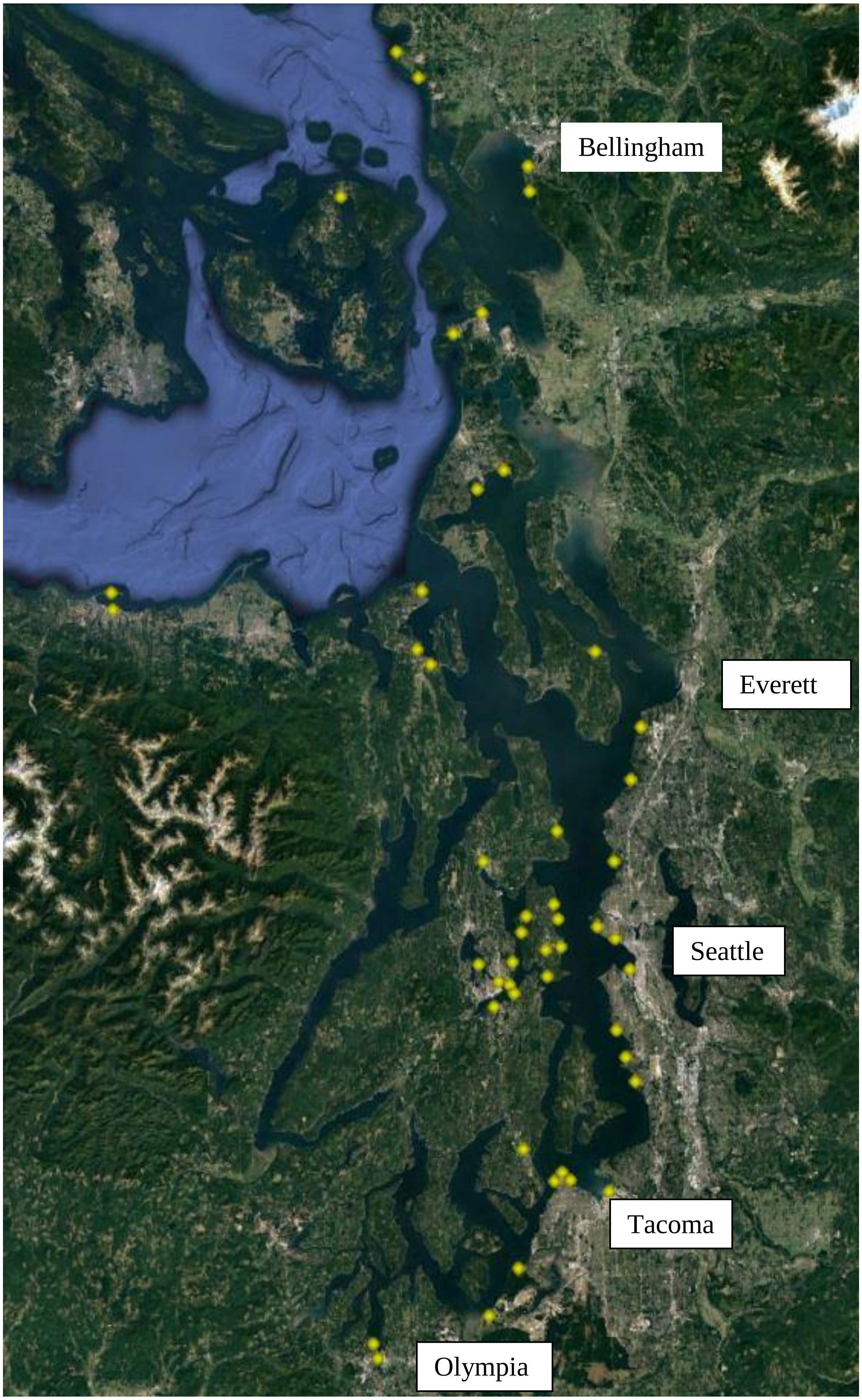

Figure 1. Initial nearshore sediment sites.

Location ID and Site Name

Sample sites have been identified by a unique, pre-assigned “Location ID”. The Location ID will eventually be used 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.

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

The Location Name will be assigned by the field crew while at the site to take advantage of obvious and appropriate descriptors seen during sampling.

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 “44-NUGA”. All of these values, except the Location Name have been pre-assigned and can be found in Table 4.

Overview of Site Layout

A linear nearshore sampling frame was developed for marine monitoring. Each candidate site’s coordinates mark a location in the center of an 800 meter (m) long shoreline segment within the Puget Sound (hereafter called the candidate “site center”). The site center is located in the high intertidal zone. Figure 2 illustrates the layout of the sampling locations at each candidate marine site. Extending from the candidate site center (shown with a star in Figure 2) in a straight line perpendicular to the shoreline and into the subtidal zone are three distinct marine sampling locations. The first of the three locations (at the waterline), is intended for sampling of bacteria (which is not included in this initial RSMP sampling), the second location (in the intertidal zone) is designated for mussel cage deployment (which was completed winter of 2015-16), and the third location (in the subtidal zone) is intended for sediment sampling (the focus of this study.)

Sediment sampling is targeted to 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. If sampling conditions at the targeted position are unsafe or unsuitable (with consideration to the criteria discussed in the *Sample Collection* section of this QAPP), the sediment sample may be collected up to one-quarter mile (1320 ft., or approximately

400 m) along the -1.8 m MLLW elevation contour in either direction of the latitude/longitude coordinates given.

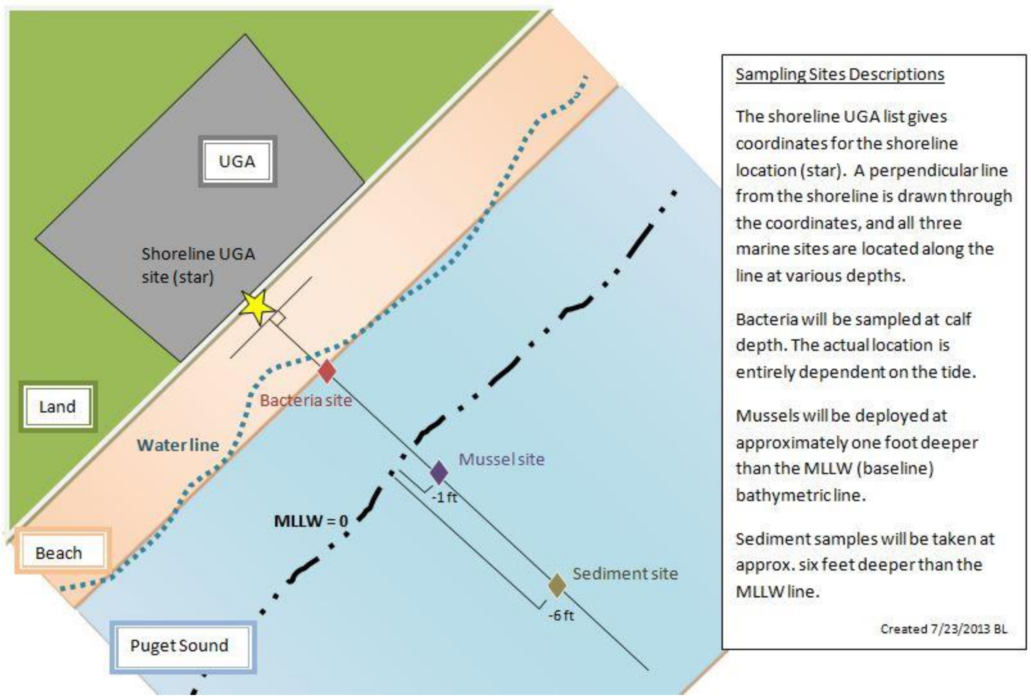

Figure 2. RSMP marine monitoring site layout along UGAs.

Sampling Procedures

Collection of sediment for physical characteristics and chemistry will be conducted by field staff from USGS and WADNR working together, and from King County. Sampling methods will, in general, follow those described by the Puget Sound Estuary Program (PSEP 1997a). These methods are summarized below.

Sampling Platform

Marine research vessels of adequate size operated by WADNR and King County, and suitably equipped for deployment of sample collection equipment and shipboard sample processing, will be reserved for this work. From this platform, site-positioning protocols will follow PSEP (1998). Positioning will rely on Global Positioning System (GPS) with expected accuracy of better than 3 meters. Variable radar ranging, water depth, and line-of-sight fixes on land objects may supplement the GPS if necessary.

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, bed elevation or water depth
- Sampling crew
- Weather and sea state
- Collection gear
- Collection status (i.e., successful, site rejected, site moved)
- Visual description of sediments
- Field measurements
- Lab analyses requested
- Location coordinates and penetration depth of individual sediment grabs
- Observations of adjacent shoreline land uses, beach condition, and other landscape features
- Field log recorder
- 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 according to criteria explained in the following section of this QAPP. 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 logs are shown in Appendix B.

Sample Collection

Sediment samples are collected using a stainless-steel Van Veen grab sampler or similar sampler to collect a volume of sediment which allows samples to be collected simultaneously for chemistry, TOC, and grain size analyses. The approximately 22 to 40 ounces (0.65 to 1.2 L) of sediment needed under this monitoring program will likely require 1 to 3 grab samples using a single Van Veen sampler, depending on the size (sampling area) of the sampler. Sediment sampling protocols are described below and generally follow Ecology's SOP, *Marine Sediment Sample Collection* (Ecology, 2007) and PSEP (1997a) with consideration to sampling in shallower water.

The grab sampler is attached to the vessel's cable and winch system and lowered to about 1 m below the water surface while the vessel is maneuvered into position above the target location. The grab sampler is then lowered to the bottom where it will be triggered 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 sampler may grab a sediment sample more than 2-3 cm thick, but only the top 2-3 cm will be used. The collected sediment sample is then visually inspected with consideration to criteria for suitability.

Criteria for Disqualifying a Site as Unsuitable:
In order to obtain sufficient numbers of high quality samples to meet the goals and objectives of the RSMP, the sediment samples must be composed of sand-sized (<2 mm) particles or finer. Sediments >2.0 mm are often stable inorganic silicate minerals that are usually not associated with stormwater contaminants, so chemical analyses of those coarse materials would not provide data to help characterize the status, spatial extent and quality, of nearshore marine sediments, nor would they be suitable for tracking the trends and changes in spatial extent and quality in the UGA sampling framework. Thus, the primary criteria for disqualifying a safe and accessible site that possesses suitable target status characteristics is the inability to obtain a sufficient volume of fine (<2 mm) sediment with reasonable effort and expense.

Any grab sample lacking a readily visible volume of fine-grained particles, or for which the jaws of the grab sampler do not close completely, is rejected. Likewise, any grab sample that has less than 2-3 cm of penetration depth is rejected. If a sample is rejected, it is dumped overboard after the vessel has been repositioned away from the target location. A single rejected sample is not cause for disqualifying a site; additional grabs are attempted in the same vicinity to try and obtain suitable samples. If consecutive attempts (~3-5) to collect an acceptable sample from a location are unsuccessful, the field crew will move parallel to the beach along the -1.8 m MLLW contour to a second location within 400 meters in either direction of the initial sampling location. The objective is to find a more quiescent location more conducive to sediment deposition. At the second location, the field crew will repeat grab sampling using the same criteria to accept or reject samples. If 3 to 5 consecutive attempts to collect an acceptable sample from the second location are also unsuccessful, a third site will be tried using the same criteria. If the third site proves to be unsuccessful, the site will be deemed unsuitable and will be disqualified. Using the above criteria, approximately 15 grab attempts will be made at a site before it is rejected. The decision to reject a site will be documented, and the next back-up site on the list will be added to the sampling effort.

Field Processing

Once a successful sediment sample is collected, a series of field activities will occur.

Measurements and Observations:
One side of the Van Veen device, or the samples' periphery area, will be used for determining physical/environmental characteristics. Table 5 lists field parameters to be observed or measured.

Table 5. Marine sediment chemistry monitoring field measurements and observations.

Field Measurements and Observations
Sediment temperature
Sample penetration depth
Salinity of overlying water (sample collected in the field can be measured in the lab within 24 hours)
Sediment texture, color, and odor

Field personnel will be trained to follow measurement and QC methods specified in Table 6 to obtain consistent field measurements of the various sediment sample characteristics specified in this QAPP.

Field sieving composite sample:

A homogenized composite sediment sample composed of enough Van Veen samples to provide an adequate amount (approximately 0.65 – 1.2 L) of sieved sample material to fill all of the sample bottles necessary will be sieved in the field to remove material larger than 2.0 mm in size. A metal sieve will be used to prepare samples for organics analysis and a plastic sieve will be used to prepare the sample for metals analysis. The list of parameters for lab analysis is found in Table 7.

The composite sample is created using a Teflon and/or stainless steel spoon to scoop sediments from the top 2-3 cm of the Van Veen into a pre-cleaned Pyrex glass or stainless steel bowl and covered with a lid or foil. Care is required to avoid the sediment that is in contact with the sides or bottom of the Van Veen. On subsequent grabs, if necessary, the top 2-3 cm of sediment on both sides of the grab are collected and added to the bowl. Grabs are taken until it appears that enough sediment is collected, with consideration to the proportion of sand and finer particles in each grab. Wear nitrile gloves and thoroughly mix (homogenize) the composite sample in the glass or stainless steel bowl using the Teflon and/or stainless steel spatula until a uniform color and texture is achieved.

The required sediment volume will be passed through one of two types of a 2.0 mm sieves in the field; a mesh nylon or plastic sieve for metals analyses, and a stainless-steel sieve for organic analyses. Equipment and supplies for processing the composited marine sediment samples are listed in Appendix C.

Table 6. 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 sampler and subtract from the maximum grab depth.	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[(a)]	7-34 ppt	Refracto-meter or multiprobe sonde (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 sonde: 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

(a) The salinity of an overlying water sample collected in the field can be analyzed in the lab within 24hours of collection. Such a sample should be kept on ice until the salinity analysis is performed.

Field Sieving and processing for organics samples:

While in the field, place a pre-cleaned 2.0-mm stainless-steel sieve over a 500-1,000-mL glass or stainless steel sample container. Gently work an aliquot of the composited sample through the sieve with a Teflon policeman or spatula designated for the organic sample. Do not use the spoon or spatula used to composite the whole sample to work the organic sample through the 2.0-mm stainless-steel sieve as this will potentially contaminate the metals sample. Do not use water. The bottom of the sieve may require periodic removal of the material that adheres to it. Collect enough sieved material to fill each specific analysis sample container approximately half full or until an adequate amount of sample material has been collected (See below); about 500 mL of wet sediment is typically needed for analyses of organic contaminants and TOC.

Field sieving and processing for particle size samples:
Using the same 2.0-mm sieve described above, continue to sieve until approximately 2 cm of wet sediment accumulates into a 500-1,000-mL plastic sample container. For KCEL particle size samples, fill an 8-ounce PP sample jar to near full with sieved sample.

After the sample jars are filled, they are placed in polyethylene bags, and set in coolers on ice. Leftover sediment from sieving is returned to the water column at the site or kept for an archive sample.

Field sieving and processing for metals samples:
After storing all organic and particle size samples (i.e. all non-metal) samples on ice, field crews should put on new sampling gloves and prepare the metal sampling equipment. The metals sampling will follow the same procedure used for organics, but will use a pre-cleaned nylon or plastic 2.0 mm sieve. The crew should continue to use the composited sample used for the organics. Crews should collect at least 20 or more grams of material for metals analysis which is approximately 2 cm of sediment on the bottom of a typical 500 ml sample bottle.

Sample Containers, Preservation, and Holding Times

Recommended sample sizes, containers, preservation techniques, and holding times for all sediment samples are summarized in Table 8. Samples for chemistry, TOC, and grain size 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 contracted laboratories until results are deemed acceptable by the project lead.

Cooling the sample to 4° or 6°C or less, but not freezing, is necessary for preservation in the field for most parameters. Composite samples can be made over the course of 4 field days, if kept on ice and well homogenized with each additional aliquot. 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.

Table 7. Marine sediment chemistry monitoring parameters analyzed in the laboratory.

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)[a]: ○ 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)[a]: ○ 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[a]: ○ bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate • Polybrominated diphenylethers (PBDEs): all 209 congeners • Polychlorinated biphenyls (PCBs): all 209 congeners

[a] KCEL (PAHs): 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, retene, benzo(a)anthracene, benzo(a)pyrene, benzo(b,j,k)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, perylene, and pyrene

[a] KCEL (Phthalates): bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, diethyl phthalate, dimethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate

KCEL (additional semivolatile compounds): 2-chloronaphthalene, dibenzofuran, carbazole

Table 8. Sample volume, containers, preservation, and holding times.

Parameter	Size of Sample	Container [(a)(d)]	Preservation[(c)]	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)[(f)]	2 or 4 oz.	1 2-oz or 4-oz wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4°C or freeze at -18°C	14 days at 4°C / 6 months if frozen
Metals	4 oz.	1 4-oz wide-mouth glass jar with Teflon-lined lid or plastic jar	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 4-18°C
PAH[(b)(e)(f)]	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	14 days at 4°C/ 1 year if frozen
Phthalates[(b)(e)(f)]	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	14 days at 4°C/ 1 year if frozen
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	14 days at 4°C/ 1 year if frozen
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	14 days at 4°C/ 1 year if frozen

(a) Or as specified by laboratory.

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

(c) Preservation needs to be done in the field. Ice will be used to cool samples to approximately 4 C.

(d) Glass containers with Teflon -lined lids, certified clean by manufacturer or laboratory in accordance with OSWER Cleaning Protocol #9240.0-05 (MEL, 2008).

(e) PAHs and phthalates can be combined in the same jar.

(f) These jars should not be filled more than 50% due to the potential of breaking during the freezing process. It is preferable to have multiple half-filled jars rather than one jar filled to the top

Holding time is the maximum allowable length of time between the first day of sample collection and laboratory extraction/digestion. 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. 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.

Sample Numbers, Field Replicates and Inter-laboratory Replicates

Sampling responsibilities will be divided between two field team: USGS/WADNR and King County. The USGS/WADNR team will be responsible for sampling 30 sites while King County will be responsible for 10 sites. Field QC sampling will include collection of field-split samples for chemistry, TOC, and grain size analyses at 4 sites (10% of the sites sampled). Field-split samples will require that double the amount of sediment will need to be collected and composited. 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.) 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.

In addition to the field replicate samples, an inter-laboratory comparison will be performed for PAH/Phthalates and metals at all 10 of the King County sites. It will be necessary for King County to collect double the amount of sediment so they can process and submit one sample to the Manchester Laboratory (MEL) and one sample to the King County lab for each of these samples. Table 9 provides a breakdown of number and type of sample to be collected by each field team.

Table 9 Sample responsibilities and replicate numbers.

	USGS/WADNR Field Crew			King County Field Crew			
Parameter	Number of Field Samples	Number of Field Replicates	Laboratory Submitted To	Number of Field Samples	Laboratory Field Samples Submitted To	Number of Inter-Laboratory Field Samples	Laboratory Inter-Lab Samples Submitted To
Grain Size	30	4	MEL	10	KCEL		
Total Organic Carbon (TOC)	30	4	MEL	10	KCEL		
Metals	40	4	MEL	10	KCEL	10	MEL
PAH	40	4	MEL	10	KCEL	10	MEL
Phthalates	40	4	MEL	10	KCEL	10	MEL
PBDE	30	4	Axys	10	Axys		
PCB	30	4	Axys	10	Axys		

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

All equipment that comes into contact with the sediment sample must be cleaned prior to sampling and between sampling sites. The grab sampler that comes in contact with the sampled sediment will be scrubbed and rinsed with marine water from the sampling site 3 or more times. This removes any sediment and contaminants from that site. The sampler will be stored in a clean plastic bag and stored in a protected bucket for transport to the next site. Prior to sampling at the next site, the grab sampler will be thoroughly "dunked" in the marine water overlying the next sampling site.

All other Teflon, Pyrex and stainless-steel scoops and bowls used to collect sediments for organic and trace element analysis need to be properly cleaned prior to sampling using the following procedure. Clean implements will be stored in aluminum foil or polyethylene bags for transport to each field site.

1. Washing in non-phosphate detergent and tap water.
2. Rinsing with tap water.
3. Rinsing with deionized water three times.
4. Rinsing with pesticide-grade acetone or methanol (for equipment used for sampling for organics; nylon/plastic sieves for metals analysis do not require a solvent rinse).
5. Air drying in clean area free of contaminants.

After drying, equipment will be wrapped in aluminum foil (except nylon/plastic sieves) and stored in polyethylene bags until used in the field. Sampling equipment will be dedicated to a single site. Reuse will require cleaning as outlined in the procedure above, which is based on EPA guidelines (EPA, 1990). If more than one site is to be sampled per day, field crews should be prepared to clean equipment on the sampling boat or pre-clean multiple sets of sampling equipment for each site to be sampled. All cleaned equipment should be wrapped in aluminum foil and/or stored in polyethylene bags to avoid contamination of the samples from engine exhaust, atmospheric particulates, and rain.

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. Based on consultation with information provided by Ecology (www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html), invasive species do not appear to be present in the sampling region. Nevertheless, it is possible that during sampling, invasive species of benthic invertebrates or marine plants currently unknown to occur in the nearshore environment 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., Van Veen 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.

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 D.

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 than the concentrations from the PSEMP offshore sediment monitoring shown in Table 10. Higher concentrations could occur due to the closer proximity to potential urban sources, while lower concentrations could occur due to the potential for the nearshore substrate to be coarse and lacking the fines typically associated with higher concentrations of contaminants. Table 10, 11 and 12 presents the best approximation for the planned sediment monitoring for all of the laboratories involved in this effort.

Table 10. MEL 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[(1)]	<20% - >80% silt+clay	N/A	N/A	PSEP (1986)	Sieve-pipette method	1.0%
Total Organic Carbon (TOC)[(1)]	0.01 - 15.0%	Drying sediment material	N/A	PSEP (1986)	Determination of CO_2 by non-dispersive infrared spectroscopy	0.1%
Metals[(2)] (except mercury)	< 0.1 - 500 ppm (up to 1500 for zinc)	EPA 3050B	N/A	EPA 6020A	ICP-MS	0.1 mg/kg dry weight (0.2 for Sn, 0.5 for Se, 5.0 for Zn)
Total Mercury	0.001 - 10 ppm	N/A	N/A	EPA 7471B	CVAA	0.0036 mg/kg dry weight
Polynuclear Aromatic Hydrocarbons (PAHs)[(2)]	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[(2)]	0.01 - 50,000 ppb 12 – 120 ppb	EPA 3541*	EPA 3630C	EPA 8270D	Modification with capillary GC/MS	12 – 600 ug/kg dry weight

*= Samples are air dried prior to extraction.

[(1)]= MEL and KCEL laboratory managers are confident that inter-laboratory comparison for these compounds are unnecessary given the consistent and comparable results each laboratory achieves for these parameters.

[(2)] = Part of inter-laboratory comparison

Table 11. KCEL 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[(1)]	<20% - >80% silt+clay	N/A	N/A	ASTM D422	Sieve-hydrometer method	1.0%
Total Organic Carbon (TOC)[(1)]	0.01 - 15.0%	Drying sediment material with H_3PO_4	N/A	SW846 9060 /PSEP (1996)	Determination of CO2 by non-dispersive infrared spectroscopy	0.1%
Metals[(2,3)] (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 Se, 5.0 for Zn)
				EPA 200.7	ICP	Cd 0.1 mg/Kg Cr 0.15 mg/Kg Ag, Cu 0.2 mg/Kg Ni, Zn 0.25 mg/Kg Pb, Sn 1.0 mg/Kg As, Se 1.25 mg/Kg
Total Mercury	0.001 - 10 ppm	EPA 245.5	N/A	EPA 7471	CVAA	0.0036 mg/kg dry weight
Polynuclear Aromatic Hydrocarbons (PAHs)[(2)]	0.01 - 50,000 ppb	EPA 3550B	EPA 3630C	EPA 8270D SIM	Modification with capillary GC/MS-SIM	1- 5 ug/kg dry weight
Phthalates [(2)]	0.01 - 50,000 ppb 12 – 120 ppb	EPA 3550B	EPA 3630C	EPA 8270D SIM	Modification with capillary GC/MS	12 – 600 ug/kg dry weight

(1)= MEL and KCEL laboratory managers are confident that inter-laboratory comparison for these compounds are unnecessary given the consistent and comparable results each laboratory achieves for these parameters.
(2) = Part of inter-laboratory comparison
(3) = KCEL will analyze the marine sediments using a tiered approach - samples not detectable by ICP will be analyzed by ICPMS

Table 12. Axys 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
PBDE Congeners	< 0.1 - 4,000 ppb	EPA 3545	EPA 3620, 3665	EPA 1614	HRGC/HRMS	2 ng/kg dry weight
PCB Congeners	< 0.1 - 4,000 ppb	EPA 3545	EPA 3620 and EPA 3665	EPA 1668A	HRGC/HRMS	20 ng/kg dry weight

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 13 and, at a minimum, includes:

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

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.

Table 13. 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
	Conventionals		
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	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 sample concentration or qualifying results. No action necessary if samples are >10x blank concentrations
	Conventionals		
	Organics		
Spiked (or Fortified) Blanks	Metals, Organics and Conventionals	5% of total samples or 1 per batch	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 / Conventionals	5% of total samples or 1 per batch (spiked blank). If available, solid batches only	
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.

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 14.

Table 14. 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 / Certified or Standard Reference Material	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%	80-120	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 specific for KCEL)	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 (85-115 for KCEL	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 10x method blank concn. or qualified as an estimate	75-125	NA
Phthalates	RPD ≤ 40%	RPD ≤40%	Compound specific RPD ≤ 40%	50-150 (analyte specific for KCEL)	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	50-150	Analyte specific; within 50-150
Polynuclear Aromatic Hydrocarbons (PAHs)	RPD ≤ 40%	RPD ≤ 40%	Compound specific RPD ≤ 40%	50-150 (analyte specific for KCEL)	Analyte concentration <MDL; if ≥ MDL, lowest analyte concn. must be ≥ 5x method blank concn.	50-150	Analyte specific; within 50-150

Parameter	Field Blank	Field Replicate (Split Sample)	Analytical (Laboratory) Replicate	Laboratory Control Sample / Certified or Standard Reference Material	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
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 25-150
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.	25-150	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.

Inter-laboratory Comparison for Metals, PAHs and Phthalate Testing

The RSMP will target 10 samples for an inter-lab comparison study. The laboratory comparison study conducted for the RSMP stream sample showed few and minor differences between MEL and KCEL but different analytical techniques between the 2 labs will be used for the nearshore sediments for the metals, PAHs and phthalates. The samples tested by KCEL will include only a subset of the PAHs reported by MEL (see Table 7).

Data Management Procedures

The Contractors will collect and manage data from field observations/measurements and laboratory analysis of field samples. All data will be managed and stored by the contractors. 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.
- 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 contractors until completion of sampling and analysis. All entries will be independently verified for accuracy by another individual on the project team. Scanned copies of the field data sheets will be sent to the RSMP Coordinator. Field data will be entered into EIM by the contractors.

Laboratory Data

Chemical laboratory data will be sent to the contractors 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 contractors (USGS and King County) for errors or missing data; contractors 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 14).
- 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.

Prior to data entry to EIM, the contractors will follow a data review procedure (further described in the Data Verification and Usability section) 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.

Data storage

All field forms, photographs, electronic data, and laboratory electronic or printed data generated for this project will be stored by the contractors 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 sent to the RSMP Coordinator for entry into Ecology's EIM database under the Study ID RSMP MNS2016.

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 Procedures* section were obtained.
- Results for QC samples as specified in the *Measurement quality objectives (MQOs) for laboratory samples* 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 contractor's project lead and crew members are responsible for implementation of sample-collection procedures. The contractor'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 contractor'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 contractor'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 contractor'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.

Questions to be Addressed

A series of questions and analytical approaches have been developed that can effectively be addressed and utilized based on the proposed study design. These questions and analytical approaches are presented below.

> **Q1**: What is the range of nearshore sediment chemical concentrations for select metal and organic compounds within the Urban Growth Areas (UGAs) and how do these concentrations compare to published sediment criteria and other Monitoring programs in Puget Sound?

All field and sediment chemistry results will be summarized and spatially characterized in relation to the potential population of nearshore sites with the UGAs. These summaries will be in the form of tables and figures and will provide the baseline information necessary for the first cycle of nearshore sediment sampling as part of the RSMP. Overall results will be statistically summarized (mean, median, maximum, minimum, etc.). Data analysis tools will include the use of R stats, Access, Excel, or other programs to produce summary statistics, graphics (boxplots, charts), and tables.

Sediment chemistry data will also be compared to appropriate and relevant criteria (WAC 173-204-563). Values exceeding criteria will be identified in tables and/or figures. In addition, sediment results will also be compared to published results:

- Ecology's Marine Sediment Monitoring Program (Dutch et al. 2009), Long et al. 2003, Long et al. 2005) (http://www.ecy.wa.gov/programs/eap/psamp/index.htm)
- EPA's Western Coastal Environmental Monitoring and Assessment Program (http://www.ecy.wa.gov/programs/eap/psamp/DesignMethods/emapWestDandM.html)
- RSMP's Puget Sound Lowland streams sediment assessment (http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html) completed in 2016.

These comparisons will be undertaken using descriptive statistics and graphical comparisons. These comparisons will help summarize how potential stormwater related sediment bound chemicals vary across different aquatic habitats. The purpose of comparing the results of this study to other marine and stream sediment studies in the Puget Sound is to put these results in perspective by examining how different marine sediment chemical concentrations from different environments and sediment bound chemical concentrations form streams suspected of delivering chemicals to the nearshore compare for similar contaminants. This comparison will help focus or modify future sampling efforts.

Q2: Are sediment bound chemical concentrations in the nearshore environment related to adjacent watershed natural features and / or levels of anthropogenic disturbance?

Organic and metal sediment concentrations will be statistically compared to levels of various natural and anthropogenic disturbance levels based on available GIS coverages of land cover data (watershed area, surficial geology, drainage network, road density, impervious surface, population densities, etc.) within the watershed adjacent to the sampling site. Site condition information collected during sampling and developed from available GIS coverages will also be utilized in these analyses. In addition to the chemical concentrations, chemical metrics (PAH and PCB ratio analysis) will also be examined to further evaluate potential anthropogenic factors responsible for the potential levels of observed sediment contamination (Lanksbury et al. 2014). The available GIS data sets are listed in Table 15. For this effort we will also capitalize on previous local efforts to identify key “predictor” variables for impacts to other Puget Sound aquatic systems.

Table 15. Geographic data sets available for analysis

GIS Data Type	Source
General geographic info: basin areas, NHD HiRes, REV100kStrahler, ecoregions, cities, gages,	Ecology, USGS
Land use/Land Cover: standard categories	National Land Cover Database 2011, Ecology, USGS
Road use density (AADT), stream crossings	Ecology, WSDOT, Counties
Wetlands	USGS

NHD = National Hydrography Database
AADT = Annual average daily traffic

These statistical comparisons will take the form of correlations and parametric and non-parametric regression techniques. The specific types of analyses will be dependent on the structure of the data. Data analysis tools will include the use of R stats, Access, Excel, Systat or other programs to produce summary statistics, graphics (boxplots, charts), and tables.

Q3. How do sediment bound chemical concentrations compare to levels of chemicals found in caged mussel tissues?

The RSMP also supports a caged mussel contaminant monitoring study that share’s approximately ~ 30 of the 40 sediment sites sampled for this effort (http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html). To date, a statistically randomized assessment of the relationship between sediment chemistry and mussel tissue contamination has not been performed. Using similar statistical tools to those described above, these relationship will be examined along with the interactions with the GIS based anthropogenic disturbance levels also discussed above.

> **Q4**: What is the spatial distribution of microplastics in marine sediment and are they related to natural features and/or levels of anthropogenic disturbance?

Concerns over microplastics in aquatic environments have increased over the past few years (Andrady 2011, Cole and others. 2011). The abundance of microplastics in surface waters in the Puget Sound have recently been examined, but an assessment of microplastics in marine sediments has not been done. At ~30 of the 40 sites, sediment samples will be examined for microplastics at the WAWSC's microplastics lab using published analytical methods (NOAA, 2016). Results from this effort will be summarized using the statistical methods outlined in issue number 2. Given that recent studies have found that microplastics can impact shellfish health (Sussarellu and others, 2016.), the results from this effort could provide valuable insight into the role microplastics play in evaluating sediment quality as well has help identify additional analyses appropriate for future nearshore sediment assessment activities. The proposed analyses will help identify natural and or anthropogenic factors that might be responsible for the levels of microplastics observed.

Trend Monitoring Recommendations for RSMP Nearshore Sediment

> **Q5:** What sediment chemistry analyses and methods should be carried forward or added for trend assessment of RSMP nearshore sediment monitoring in the future?

The sediment parameters that should be carried forward for trend assessment of RSMP nearshore sediment monitoring in the future will be discussed in relation to results generated by this study and comparisons to other marine sediment activities within the Puget Sound as well as other studies that are examining the delivery of contaminated sediment or potential impact of contaminated sediment to the nearshore environment. A final question has been generated to address this issue.

For example, results from the RSMP stream monitoring (Ecology 2014) and mussel monitoring (WDFW, 2015) work are likely to provide valuable insight into what chemical constituents are likely to be of value in future monitoring activities based on their presence and/or abundance in various monitoring programs.

The exploratory/pilot nature of the proposed nearshore sediment study design presents a number of opportunities to discuss the benefits of maintaining or modifying future nearshore monitoring efforts. For example, there was no opportunity to perform a detailed site reconnaissance of the randomly selected monitoring sites prior to sampling nor were the sites stratified beyond the proposed “within a UGA” versus “outside a UGA”. Unlike the current study, previous monitoring programs within the study area that have utilized a randomized site selection design, have often benefited from a more extensive stratification of sites during the randomized site selection process. As an example, many stream monitoring programs utilize stream order as part of its stratified random site selection which can help isolate impacts more effectively. It is anticipated that the field documentation complied as part of this project as well as on going characterizations of nearshore environments may help refine the nearshore monitoring programs.

Reporting and Communication Strategy

The technical analytical team for Questions number 1 through 5 will be made up of experts at the USGS, Ecology, King County and the WADNR. USGS will produce a final report summarizing the results of this monitoring effort and addressing the 5 questions discussed above. All project data will be contained with Ecology’s EIM data base for public viewing.

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Appendices

Appendix A: First 150 of 2048 randomly selected nearshore sediment sites. A complete list of all 2048 sites can be found at: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html by selecting Table of candidate marine nearshore sites from the Mussel tab.

Appendix B. Example of Field Log to be used during field collections. Log will be printed on waterproof paper. If more than one sample is needed to fill all of the sample jars for chemical analyses, a separate sheet will be used for each sample.

Appendix C. Equipment and supplies for collecting and processing nearshore sediment as well as cleaning procedures and equipment.

Appendix D. Example Chain of Custody

Appendix A: First 150 of 2048 randomly selected nearshore sediment sites. A complete list of all 2048 sites can be found at: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html by selecting Table of candidate marine nearshore sites from the Mussel tab

Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
1	-122.91126	47.04765	PSSI3175-000001	1-NUGA	Olympia	Olympia - Incorporated UGA	Thurston	South Sound	Moderate	Very Protected
2	-122.38594	47.50204	PSSI3175-000002	2-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
3	-122.50706	47.68262	PSSI3175-000003	3-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Semi-protected
4	-122.73630	48.85755	PSSI3175-000004	4-NUGA		Cherry Point - Unincorporated UGA	Whatcom	Strait of Georgia	Moderate	Semi-protected
5	-122.52806	47.29181	PSSI3175-000005	5-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
6	-122.52759	47.61871	PSSI3175-000006	6-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
7	-122.41750	47.64877	PSSI3175-000007	7-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Semi-protected
8	-122.77652	48.04868	PSSI3175-000008	8-NUGA		Jefferson Co. - Unincorporated UGA	Jefferson	Admiralty Inlet	Abundant	Protected
9	-122.37604	47.25521	PSSI3175-000009	9-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
10	-122.57753	47.64458	PSSI3175-000010	10-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
11	-122.50606	48.72568	PSSI3175-000011	11-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Protected
12	-122.57945	48.29690	PSSI3175-000012	12-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
13	-122.49510	47.29253	PSSI3175-000013	13-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
14	-122.60648	47.57101	PSSI3175-000014	14-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
15	-122.67746	48.49230	PSSI3175-000015	15-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Scarce	Very Protected
16	-122.33472	47.85424	PSSI3175-000016	16-NUGA	Edmonds	Edmonds - Incorporated UGA	Snohomish	Central Sound	Scarce	Semi-protected
17	-122.91975	47.06878	PSSI3175-000017	17-NUGA	Olympia	Olympia - Incorporated UGA	Thurston	South Sound	Moderate	Semi-protected
18	-122.36868	47.46333	PSSI3175-000018	18-NUGA	Burien	Burien - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
19	-122.49952	47.66154	PSSI3175-000019	19-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Semi-protected
20	-123.42336	48.11780	PSSI3175-000020	20-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Moderate	Semi-protected

Appendix A: First 150 of 2048 randomly selected nearshore sediment sites. A complete list of all 2048 sites can be found at: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html by selecting Table of candidate marine nearshore sites from the Mussel tab

Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
21	-122.51146	47.30376	PSSI3175-000021	21-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Very Protected
22	-122.59715	47.55888	PSSI3175-000022	22-NUGA		Port Orchard - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
23	-122.49572	47.62206	PSSI3175-000023	23-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
24	-122.74896	48.02680	PSSI3175-000024	24-NUGA		Jefferson Co. - Unincorporated UGA	Jefferson	Admiralty Inlet	Abundant	Very Protected
25	-122.41519	47.27454	PSSI3175-000025	25-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
26	-122.59829	47.60311	PSSI3175-000026	26-NUGA		Central Kitsap - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
27	-122.50434	48.68975	PSSI3175-000027	27-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Protected
28	-122.63749	48.27141	PSSI3175-000028	28-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
29	-122.65216	47.74626	PSSI3175-000029	29-NUGA	Poulsbo	Poulsbo - Incorporated UGA	Kitsap	Central Sound	Scarce	Very Protected
30	-122.64058	47.54111	PSSI3175-000030	30-NUGA	Port Orchard	Port Orchard - Incorporated UGA	Kitsap	Central Sound	Scarce	Protected
31	-122.91127	48.69258	PSSI3175-000031	31-NUGA		Eastsound - Unincorporated UGA	San Juan	San Juan Archipelago	Scarce	Protected
32	-122.22664	47.97529	PSSI3175-000032	32-NUGA	Everett	Everett - Incorporated UGA	Snohomish	Whidbey Basin	Moderate	Protected
33	-122.67593	47.10396	PSSI3175-000033	33-NUGA	DuPont	DuPont - Incorporated UGA	Pierce	South Sound	Moderate	Very Protected
34	-122.35304	47.58710	PSSI3175-000034	34-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Protected
35	-122.56549	47.66726	PSSI3175-000035	35-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
36	-123.42576	48.14204	PSSI3175-000036	36-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Semi-exposed
37	-122.61066	47.16998	PSSI3175-000037	37-NUGA	Steilacoom	Steilacoom - Incorporated UGA	Pierce	South Sound	Moderate	Semi-protected
38	-122.66985	47.60149	PSSI3175-000038	38-NUGA		Bremerton - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
39	-122.38082	47.63128	PSSI3175-000039	39-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Very Protected
40	-122.76251	48.13084	PSSI3175-000040	40-NUGA	Port Townsend	Port Townsend - Incorporated UGA	Jefferson	Admiralty Inlet	Abundant	Semi-protected

Appendix A: First 150 of 2048 randomly selected nearshore sediment sites. A complete list of all 2048 sites can be found at: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html by selecting Table of candidate marine nearshore sites from the Mussel tab

Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
41	-122.40166	47.26899	PSSI3175-000041	41-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
42	-122.62899	47.57617	PSSI3175-000042	42-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
43	-122.61104	48.52109	PSSI3175-000043	43-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Scarce	Protected
44	-122.39957	48.03641	PSSI3175-000044	44-NUGA	Langley	Langley - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
45	-122.35080	47.42844	PSSI3175-000045	45-NUGA	Normandy Park	Normandy Park - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
46	-122.49468	47.78584	PSSI3175-000046	46-NUGA		Kingston - Unincorporated UGA	Kitsap	Central Sound	Moderate	Semi-protected
47	-122.78201	48.89548	PSSI3175-000047	47-NUGA		Birch Bay - Unincorporated UGA	Whatcom	Strait of Georgia	Abundant	Semi-protected
48	-122.30929	47.92779	PSSI3175-000048	48-NUGA	Mukilteo	Mukilteo - Incorporated UGA	Snohomish	Central Sound	Moderate	Semi-protected
49	-122.59049	47.33837	PSSI3175-000049	49-NUGA	Gig Harbor	Gig Harbor - Incorporated UGA	Pierce	Central Sound	Moderate	Very Protected
50	-122.52673	47.58137	PSSI3175-000050	50-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Scarce	Protected
51	-122.37688	47.73996	PSSI3175-000051	51-NUGA	Shoreline	Shoreline - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
52	-123.45576	48.12584	PSSI3175-000052	52-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Scarce	Semi-protected
53	-122.40846	47.27687	PSSI3175-000053	53-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
54	-122.70792	47.60765	PSSI3175-000054	54-NUGA		Silverdale - Unincorporated UGA	Kitsap	Central Sound	Abundant	Very Protected
55	-122.51908	48.71193	PSSI3175-000055	55-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Protected
56	-122.53921	48.39735	PSSI3175-000056	56-NUGA		Swinomish - Unincorporated UGA	Skagit	Whidbey Basin	Abundant	Protected
57	-122.43130	47.24649	PSSI3175-000057	57-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
58	-122.63607	47.58171	PSSI3175-000058	58-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
59	-122.57520	48.49191	PSSI3175-000059	59-NUGA		Anacortes - Unincorporated UGA	Skagit	Strait of Georgia	Moderate	Very Protected
60	-122.58601	48.46759	PSSI3175-000060	60-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Moderate	Very Protected
61	-122.42765	47.31948	PSSI3175-000061	61-NUGA		Tacoma - Unincorporated UGA	Pierce	Central Sound	Moderate	Semi-protected

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Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
62	-122.51677	47.70579	PSSI3175-000062	62-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
63	-122.76634	48.99194	PSSI3175-000063	63-NUGA	Blaine	Blaine - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Semi-protected
64	-122.23047	48.00545	PSSI3175-000064	64-NUGA	Everett	Everett - Incorporated UGA	Snohomish	Whidbey Basin	Moderate	Protected
65	-122.91204	47.04624	PSSI3175-000065	65-NUGA	Olympia	Olympia - Incorporated UGA	Thurston	South Sound	Moderate	Very Protected
66	-122.39520	47.52018	PSSI3175-000066	66-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
67	-122.54720	47.72014	PSSI3175-000067	67-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Semi-protected
68	-124.26875	48.25370	PSSI3175-000068	68-NUGA		Clallam Bay - Unincorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Semi-exposed
69	-122.53121	47.29627	PSSI3175-000069	69-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
70	-122.54731	47.60279	PSSI3175-000070	70-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
71	-122.40332	47.69051	PSSI3175-000071	71-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
72	-122.76823	48.10934	PSSI3175-000072	72-NUGA	Port Townsend	Port Townsend - Incorporated UGA	Jefferson	Admiralty Inlet	Abundant	Protected
73	-122.40519	47.24386	PSSI3175-000073	73-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
74	-122.57750	47.63316	PSSI3175-000074	74-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
75	-122.49268	48.74124	PSSI3175-000075	75-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Protected
76	-122.62405	48.29186	PSSI3175-000076	76-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
77	-122.48499	47.28453	PSSI3175-000077	77-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
78	-122.68120	47.57220	PSSI3175-000078	78-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
79	-122.68452	48.50897	PSSI3175-000079	79-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Scarce	Protected
80	-122.33911	47.84736	PSSI3175-000080	80-NUGA	Edmonds	Edmonds - Incorporated UGA	Snohomish	Central Sound	Scarce	Semi-protected

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Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
81	-122.90304	47.05885	PSSI3175-000081	81-NUGA	Olympia	Olympia - Incorporated UGA	Thurston	South Sound	Moderate	Protected
82	-122.36117	47.48479	PSSI3175-000082	82-NUGA	Burien	Burien - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
83	-122.51928	47.64990	PSSI3175-000083	83-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
84	-123.41527	48.14039	PSSI3175-000084	84-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Protected
85	-122.57912	47.21093	PSSI3175-000085	85-NUGA	University Place	University Place - Incorporated UGA	Pierce	South Sound	Abundant	Semi-protected
86	-122.62115	47.64996	PSSI3175-000086	86-NUGA		Central Kitsap - Unincorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
87	-122.49368	47.63493	PSSI3175-000087	87-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Abundant	Semi-protected
88	-122.74950	48.02620	PSSI3175-000088	88-NUGA		Jefferson Co. - Unincorporated UGA	Jefferson	Admiralty Inlet	Abundant	Very Protected
89	-122.41851	47.26864	PSSI3175-000089	89-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
90	-122.57540	47.60749	PSSI3175-000090	90-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
91	-122.51623	48.70809	PSSI3175-000091	91-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Moderate	Protected
92	-122.62896	48.26813	PSSI3175-000092	92-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
93	-122.65058	47.74002	PSSI3175-000093	93-NUGA	Poulsbo	Poulsbo - Incorporated UGA	Kitsap	Central Sound	Abundant	Very Protected
94	-122.68628	47.53297	PSSI3175-000094	94-NUGA		Gorst - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
95	-122.91795	48.71375	PSSI3175-000095	95-NUGA		Eastsound - Unincorporated UGA	San Juan	San Juan Archipelago	Abundant	Semi-protected
96	-122.21815	47.98720	PSSI3175-000096	96-NUGA	Everett	Everett - Incorporated UGA	Snohomish	Whidbey Basin	Moderate	Very Protected
97	-122.82395	47.39273	PSSI3175-000097	97-NUGA		Allyn - Unincorporated UGA	Mason	South Sound	Moderate	Protected
98	-122.37223	47.58327	PSSI3175-000098	98-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Semi-protected
99	-122.56095	47.67379	PSSI3175-000099	99-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected

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Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
100	-123.44849	48.14008	PSSI3175-000100	100-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Protected
101	-122.58547	47.18498	PSSI3175-000101	101-NUGA	Steilacoom	Steilacoom - Incorporated UGA	Pierce	South Sound	Moderate	Very Protected
102	-122.65914	47.60170	PSSI3175-000102	102-NUGA		Bremerton - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
103	-122.35911	47.61728	PSSI3175-000103	103-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Semi-protected
104	-122.56071	48.27507	PSSI3175-000104	104-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected
105	-122.43355	47.25766	PSSI3175-000105	105-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
106	-122.62555	47.56124	PSSI3175-000106	106-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Scarce	Protected
107	-122.55794	48.50032	PSSI3175-000107	107-NUGA		Anacortes - Unincorporated UGA	Skagit	Strait of Georgia	Moderate	Protected
108	-122.52877	48.46397	PSSI3175-000108	108-NUGA		Anacortes - Unincorporated UGA	Skagit	Strait of Georgia	Scarce	Protected
109	-122.32549	47.39117	PSSI3175-000109	109-NUGA	Des Moines	Des Moines - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
110	-122.38586	47.81112	PSSI3175-000110	110-NUGA	Edmonds	Edmonds - Incorporated UGA	Snohomish	Central Sound	Moderate	Semi-protected
111	-122.78711	48.93252	PSSI3175-000111	111-NUGA		Birch Bay - Unincorporated UGA	Whatcom	Strait of Georgia	Abundant	Semi-protected
112	-122.31388	47.92133	PSSI3175-000112	112-NUGA	Mukilteo	Mukilteo - Incorporated UGA	Snohomish	Central Sound	Moderate	Semi-protected
113	-122.57850	47.33586	PSSI3175-000113	113-NUGA		Gig Harbor - Unincorporated UGA	Pierce	Central Sound	Moderate	Very Protected
114	-122.50418	47.59261	PSSI3175-000114	114-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Semi-protected
115	-122.39002	47.59376	PSSI3175-000115	115-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
116	-123.50197	48.13186	PSSI3175-000116	116-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Semi-exposed
117	-122.38556	47.27457	PSSI3175-000117	117-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
118	-122.67814	47.58125	PSSI3175-000118	118-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
119	-122.48985	48.74690	PSSI3175-000119	119-NUGA	Bellingham	Bellingham - Incorporated UGA	Whatcom	Strait of Georgia	Scarce	Very Protected
120	-122.53301	48.37959	PSSI3175-000120	120-NUGA		Swinomish - Unincorporated UGA	Skagit	Whidbey Basin	Abundant	Protected

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Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
121	-122.46883	47.27656	PSSI3175-000121	121-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
122	-122.66236	47.58014	PSSI3175-000122	122-NUGA		Bremerton - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected
123	-122.59943	48.49615	PSSI3175-000123	123-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Scarce	Protected
124	-122.55248	48.49111	PSSI3175-000124	124-NUGA		Anacortes - Unincorporated UGA	Skagit	Strait of Georgia	Moderate	Protected
125	-122.32372	47.35283	PSSI3175-000125	125-NUGA	Des Moines	Des Moines - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
126	-122.51077	47.70760	PSSI3175-000126	126-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
127	-122.75666	48.90834	PSSI3175-000127	127-NUGA		Birch Bay - Unincorporated UGA	Whatcom	Strait of Georgia	Abundant	Protected
128	-122.21226	48.01154	PSSI3175-000128	128-NUGA	Everett	Everett - Incorporated UGA	Snohomish	Whidbey Basin	Moderate	Protected
129	-122.89384	47.04732	PSSI3175-000129	129-NUGA	Olympia	Olympia - Incorporated UGA	Thurston	South Sound	Moderate	Very Protected
130	-122.36953	47.46711	PSSI3175-000130	130-NUGA	Burien	Burien - Incorporated UGA	King	Central Sound	Moderate	Semi-protected
131	-122.56508	47.68670	PSSI3175-000131	131-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
132	-124.29161	48.25780	PSSI3175-000132	132-NUGA		Clallam Bay - Unincorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Semi-protected
133	-122.53191	47.31583	PSSI3175-000133	133-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Moderate	Semi-protected
134	-122.56674	47.59088	PSSI3175-000134	134-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
135	-122.40021	47.66551	PSSI3175-000135	135-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Very Protected
136	-122.77304	48.10632	PSSI3175-000136	136-NUGA	Port Townsend	Port Townsend - Incorporated UGA	Jefferson	Admiralty Inlet	Scarce	Protected
137	-122.35960	47.26020	PSSI3175-000137	137-NUGA	Tacoma	Tacoma - Incorporated UGA	Pierce	Central Sound	Scarce	Very Protected
138	-122.60146	47.63869	PSSI3175-000138	138-NUGA		Central Kitsap - Unincorporated UGA	Kitsap	Central Sound	Abundant	Protected
139	-122.51799	48.76471	PSSI3175-000139	139-NUGA		Bellingham - Unincorporated UGA	Whatcom	Strait of Georgia	Moderate	Protected
140	-122.63211	48.28522	PSSI3175-000140	140-NUGA	Oak Harbor	Oak Harbor - Incorporated UGA	Island	Whidbey Basin	Moderate	Protected

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Site Order	Longitude (DD)	Latitude (DD)	Location ID	Study Specific Location ID	City	Urban Growth Area	County	Region	Sediment Abundance	Exposure Class
141	-123.09290	47.20965	PSSI3175-000141	141-NUGA	Shelton	Shelton - Incorporated UGA	Mason	South Sound	Moderate	Protected
142	-122.68516	47.52742	PSSI3175-000142	142-NUGA	Bremerton	Bremerton - Incorporated UGA	Kitsap	Central Sound	Moderate	Protected
143	-122.69108	48.50152	PSSI3175-000143	143-NUGA	Anacortes	Anacortes - Incorporated UGA	Skagit	Strait of Georgia	Scarce	Semi-protected
144	-122.36540	47.82898	PSSI3175-000144	144-NUGA	Edmonds	Edmonds - Incorporated UGA	Snohomish	Central Sound	Moderate	Semi-protected
145	-122.75489	47.11409	PSSI3175-000145	145-NUGA	Lacey	Lacey - Incorporated UGA	Thurston	South Sound	Moderate	Semi-protected
146	-122.35108	47.57143	PSSI3175-000146	146-NUGA	Seattle	Seattle - Incorporated UGA	King	Central Sound	Scarce	Very Protected
147	-122.54331	47.69359	PSSI3175-000147	147-NUGA	Bainbridge Island	Bainbridge Island - Incorporated UGA	Kitsap	Central Sound	Moderate	Very Protected
148	-123.40520	48.11724	PSSI3175-000148	148-NUGA	Port Angeles	Port Angeles - Incorporated UGA	Clallam	Eastern Strait of Juan de Fuca	Abundant	Semi-protected
149	-122.56149	47.24055	PSSI3175-000149	149-NUGA	University Place	University Place - Incorporated UGA	Pierce	South Sound	Moderate	Very Protected
150	-122.67283	47.63590	PSSI3175-000150	150-NUGA		Central Kitsap - Unincorporated UGA	Kitsap	Central Sound	Moderate	Protected

Appendix B. Example of Field Log to be used during field collections.

Location ID_____________________ Study Specific Location ID______-NUGA________________

Location Field Name:____

Sample Date_________________ Begin Sampling Time__________ End Sampling Time____________

Sampling Team:____

Tide Height/ Site Description/Characteristics/ Shoreline Landuse /Beach Condition/

____

____

____

Weather (Circle): Sunny Partial Clouds Full Clouds Drizzle Rain

Wind (Circle): Calm Light High Seas (Circle): Calm Moderate Rough

1st Attempt Latitude___________________ Longitude__________________ Depth________________

2nd Attempt Latitude___________________ Longitude__________________ Depth________________

3rd Attempt Latitude___________________ Longitude__________________ Depth________________

If site rejected, reason for rejection____

____

Site Photo taken (Circle): Y N Site Photo Number (s): ____

Replicate Sample Collected (Circle): Y N

Collection Gear____

Sample ______ of ______

Parameter	Instrument	Units	Reporting Limit	Value
Overlying Salinity	Refractometer or Multiprobe Sonde (Circle)	ppt	1.0ppt	
Sediment Temperature	Digital or alcohol thermometer (Circle)	C	1.0 C	
Sediment Penetration Depth	Metric ruler	cm	1cm	
Primary Sediment Type	Visual	Categorical	Small Cobble=65-90mm Gravel= 2-64mm Sand=0.05-2mm Silt=<0.05mm	
Secondary Sediment Type	Visual	Categorical	Small Cobble=65-90mm Gravel= 2-64mm Sand=0.05-2mm Silt=<0.05mm	
Material in sediment	Visual	Categorical	Shell, wood, trash, concreate, plant	
Sediment Color	Visual	Categorical	Olive, gray, brown, black	
Sediment Odor	Smell	Categorical	Hydrogen sulfide, petroleum, other	

Prepared By________________________

Lab Samples

Lab analysis	Collected (Yes or No)	Comments
Metals/Hg (4oz clear glass/plastic)		
PBDE/PCB (8oz Amber glass)		
PAH/phthalates (8oz clear glass)		
Grain Size (8oz Plastic)		
TOC (4oz clear glass)		

Comments:

Appendix C. Equipment and supplies for collecting and processing nearshore sediment as well as cleaning procedures and equipment.

Sampling and Processing

GPS
Sediment Sampling/ Van Veen grab sampler
Metric Ruler
Thermometer C°
Salinity probe - Refractometer or multi-probe sonde (which converts temperature and conductivity to salinity)
Teflon spatula (2)
Plastic (or nylon) sieve – 2.0 mm
Stainless Steel sieve – 2.0 mm
Teflon policeman (2)
Stainless Steel spoon
Water/Sediment thermometer
Teflon spoon (2)
Pyrex glass bowl (2)
Nitrile gloves
Polyethylene bags
Tape measure
Aluminum foil
Field sheets/notebook/sharpie
Squeeze bottle (3)
Storage bucket
Camera
Work gloves
Large Ziploc bags (for ice)
Bottle labels
Kit, first aid
Tissues, laboratory
Pens, marking, permanent

Equipment Cleaning

All equipment should be cleaned prior to field activities and between sites. Cleaning procedures are designed to control contamination by removing paper, glue, plasticizers, oils, and metals from the sampling and processing equipment. The equipment should be stored in a plastic food-storage container or wrapped in aluminum foil after cleaning. An overview of the proper cleaning procedures is given in Table C1.

Prepare a large tub or sink with a 0.2-percent phosphate-free detergent. Wash and soak for 30 minutes all equipment including all spatula, spoon, scoop, glass bowl, policeman, stainless-steel sieve, plastic sieve. Rinse with copious amounts of tap water and then with deionized water as the final rinse. Three sequential 1-L rinses are more efficient than one 3-L rinse.

Fill the Teflon wash bottle with methanol or acetone for further cleaning of the equipment used for processing the samples. Wrap these supplies in aluminum foil for those items used to process organics and a plastic bag for items used to sample trace elements. Store all sampling equipment in a plastic or other appropriate container for transport.

The grab sampler that comes in contact with the sampled sediment will be scrubbed and rinsed with marine water from the sampling site multiple times. This removes any sediment and contaminants from that site. The sampler may be stored in a clean plastic bag and stored in a protected bucket for transport to the next site. Prior to sampling at the next site, the grab sampler will be thoroughly "dunked" in the marine water overlying the next sampling site.

Table C1. Reference guide for equipment cleaning for nearshore sediment sampling.

EQUIPMENT CLEANING (prior to sampling)

Wash and soak equipment in phosphate-free detergent for 30 min.
Rinse with copious amounts of tap water.
Rinse with deionized water.
Rinse with methanol or acetone.
Allow to air dry.
Wrap in aluminum foil for organic sampling equipment or plastic bags for trace elements.

Cleaning Equipment

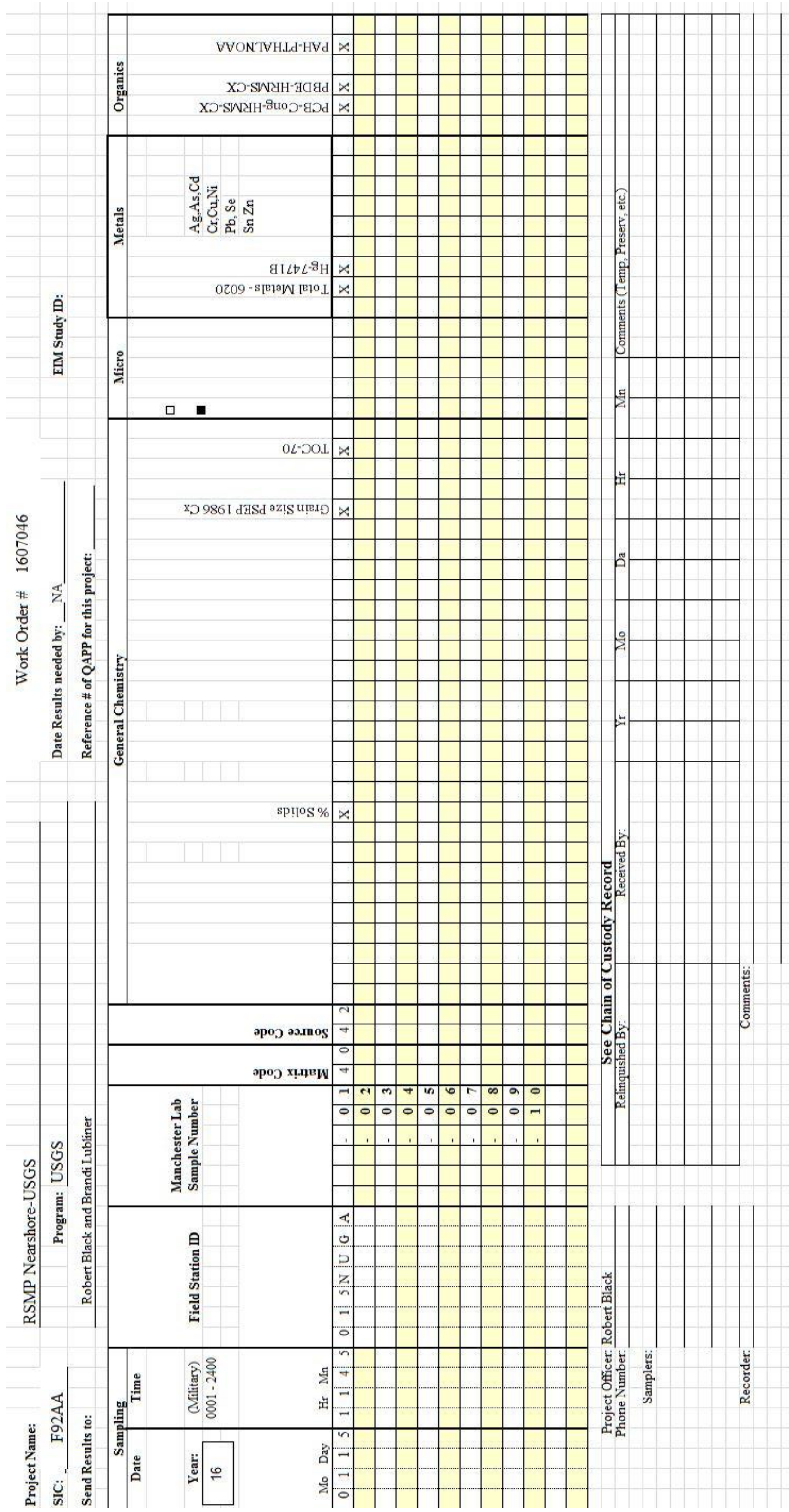
Acetone or methanol
Plastic tub/bucket (cleaning)
Alconox Soap or similar phosphate free cleaner
Deionized water
Soft brush (equipment cleaning)
Squeeze bottle (3)
Basins, wash, plastic
Container, waste, solvent, 2 gallon
Plastic bags
Aluminum foil

Control of Contamination

The awareness and avoidance of chemical contamination are necessary in each step of sample collection and processing: sampling, subsampling, field processing, shipping, and laboratory processing. Because sediments are natural accumulators of the target analytes, there is less concern of gross-sample contamination than in the water column. Nevertheless, extreme care must be taken to avoid contamination. The simultaneous sampling and field processing of nearshore sediment for trace elements and organic contaminants make the avoidance of contamination a unique challenge. The optimum materials for contacting samples collected for organic-contaminant analyses include glass, stainless steel, and Teflon. The optimum materials for trace-element analyses include plastics, glass, and Teflon (avoid contact with the stainless-steel samplers). The materials common to both lists, glass and Teflon, are the materials of choice to contact the sediments when analyzing for both trace elements and organic contaminants.

The cleaning procedures are designed to control contamination by removing paper, glue, plasticizer, oils, and metals from the sampling and processing equipment. This removal of contaminants is accomplished by a thorough soap and water cleaning and rinsing followed by solvent rinses for the organic-contaminant processing equipment and acid rinses for the trace-element processing equipment.

Appendix D. Example Chain of Custody



Project Name: RSMP Nearshore-USGS

Work Order # 1607046

SIC: F92AA

Program: USGS

Date Results needed by: NA

EIM Study ID:

Send Results to: Robert Black and Brandi Lubliner

Reference # of QAPP for this project:

Sampling Date (Year: 16) Mo Day	Time (Military) 0001 - 2400 Hr Mn	Field Station ID	Manchester Lab Sample Number	Matrix Code	Source Code	General Chemistry: % Solids	Grain Size PSEP 1986 Cx	TOC-70	Micro	Metals: Total Metals - 6020	Hg-7471B	Ag,As,Cd Cr,Cu,Ni Pb, Se Sn Zn	Organics: PCB-Cong-HRMS-CX	PBDE-HRMS-CX	PAH-PTHALNOAA
0 1 1 5	1 1 4 5	0 1 5 N U G A	- 0 1	4 0	4 2	X	X	X		X	X		X	X	X
			- 0 2												
			- 0 3												
			- 0 4												
			- 0 5												
			- 0 6												
			- 0 7												
			- 0 8												
			- 0 9												
			- 1 0												

Project Officer: Robert Black

Phone Number:

Samplers:

Recorder:

See Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Comments (Temp, Preserv, etc.)

Comments: