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The Puget Sound Assessment and Monitoring Program: Sediment Monitoring Component, 2016-2017

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Addendum 8 to Quality Assurance Project Plan

The Puget Sound Assessment and Monitoring Program: Sediment Monitoring Component, 2016-2017

April 2016

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EAP: Environmental Assessment Program

EIM: Environmental Information System database

2.0 Abstract

This addendum to the 2009 PSAMP Sediment Monitoring Component Quality Assurance Project Plan (QAPP) (Dutch et al., 2009) provides details about sampling locations, parameters, and sampling/analysis schedules for the 2016-2017 sediment monitoring. Substantive modifications to the sample strategy include adding 12 new stations to the Long-term Element, revising the Regional Element, and postponing the Urban Bays Element for one year. All other quality assurance elements, including sampling methods, quality control, and data management, are as described in Dutch et al., 2009 and remain unchanged for the Long-term sampling program.

3.0 Background

The Washington State Department of Ecology (Ecology) Marine Sediment Monitoring Team conducts sediment sampling as part of the Puget Sound Ecosystem Monitoring Program (PSEMP), formerly known as PSAMP¹. Evaluation of data collected for the three programs described in the 2009 QAPP warrant significant modifications to the sampling strategy of the PSEMP Sediment Monitoring Component, and separate QAPP documents for each monitoring element are necessary. The Regional Element is being redeveloped. The Urban Bays Element of the PSEMP sediment component will be detailed in a new Urban Bays QAPP. This document covers revisions made to the Long-term Element of the program for the 2016-2017 biennium and will serve as a springboard for future program modifications to better characterize conditions in geographically and oceanographically diverse locations throughout Puget Sound.

4.0 Project Description

Ongoing Sediment Monitoring Programs

The PSEMP Sediment Component consists of three annual monitoring programs:

- Long-term² – Conducted at ten stations located throughout Puget Sound and sampled annually each April since 1989.
NOTE: Sampling will be conducted at a total of 22 stations in 2016 and 2017.
- Regional³ – Forty stations sampled within one of eight geographic regions annually each June since 1997. Sampling rotates among the regions over a ten-year period. A new set of randomly selected stations are sampled each time a region is revisited. NOTE: Regional sampling will not be conducted in 2016 or 2017.
- Urban Bays⁴ – Thirty randomly selected stations sampled within one of six urban bays annually each June since 2007. Sampling rotates among the bays over a six-year period. The same set of randomly selected stations is sampled each time an urban bay is revisited.
NOTE: Urban Bays sampling will not be conducted in 2016.

¹ Formerly known as the “Puget Sound Assessment and Monitoring Program (PSAMP)”

² Formerly known as “Long-term/Temporal”

³ Formerly known as “Spatial/Temporal”

⁴ An expansion of the sediment-monitoring component of Ecology’s “Urban Waters Initiative”

2016-2017 Monitoring

This QAPP addendum provides detailed information about the schedule, budget, measurement quality objectives, parameter list, sampling procedures, and measurement methods for the 2016-2017 sediment surveys that differ from the original QAPP (Dutch, 2009). The numbering scheme for the sections of this addendum reflects Ecology's current required format for QAPPs and is not found in the original QAPP.

4.2 Objectives

The objectives outlined for the PSEMP Sediment Monitoring Component in the 2009 QAPP have not changed. However, the addition of 12 sites that are co-located with marine waters sites will allow for a wider-ranging characterization of sediment conditions in geographically and oceanographically diverse locations throughout Puget Sound. Establishing baseline conditions at co-located monitoring stations will support future trend analysis near the sediment-water interface.

4.4 Target Population and Sampling Locations

The target population of the 2016-2017 sediment survey is the surficial sediments at each of 22 stations throughout Puget Sound (Figure 1).

5.0 Organization and Schedule

5.4 Project Schedule

Key activities for the 2016-2017 sediment monitoring work are listed in Table 1.

Table 1. Proposed schedule for completing the field and laboratory work, data entry into EIM, and reports for the 2016-2017 sediment monitoring program.

Field and laboratory work	Due date	Lead
Field work completed	April 2016, 2017	MSMT Staff
Laboratory analyses		
Grain Size	October 2016, 2017	Contract Laboratory
Total Organic Carbon	October 2016, 2017	Manchester Laboratory
Metals	February 2017, 2018	Manchester Laboratory
Organics	February 2017, 2018	Manchester Laboratory
Taxonomy	April 2017, 2018	Dany Burgess and Angela Eagleston
Environmental Information System (EIM) database		
EIM Study ID	PSAMP_LT	
Product		
EIM data loaded	April 2017, 2018	Sandra Weakland
EIM quality assurance	April 2017, 2018	Maggie Dutch
EIM complete	April 2017, 2018	Sandra Weakland
Final report		
Author lead / support staff	Staff to be assigned	
Schedule		
Draft due to supervisor	December 2018	
Draft due to client/peer reviewer	January 2019	
Draft due to external reviewer(s)	January 2019	
Final (all reviews done) due to publications coordinator	February 2019	
Final report due on web	March 2019	

MSMT: Marine Sediment Monitoring Team

5.6 Budget

The proposed budget for the 2016-2017 annual sediment monitoring is provided in Table 2. This budget does not include the full cost of the monitoring program. It is limited to direct expenses for the specific elements below.

Table 2. Project Budget.

Parameter	2016	2017	Total
Total Organic Carbon	\$ 2,904.00	\$ 2,904.00	\$ 5,808.00
Grain Size	\$ 5,940.00	Deferred to next biennium	\$ 5,940.00
Chemistry	\$ 75,688.00	\$ 0.00	\$ 75,688.00
Taxonomy	\$ 17,800.00	Deferred to next biennium	\$ 17,800.00
Total	\$ 102,332.00	\$ 2,904.00	\$ 105,236.00

7.0 Sampling Process Design

7.1 Study Design

The sampling process design for the 2016 and 2017 PSEMP Sediment Component Long-term Monitoring Element includes sampling and analysis of sediments and benthos collected from 22 monitoring stations located throughout Puget Sound to meet the objectives described in Dutch et al., 2009. This design differs from the 2009 QAPP in that 12 sites were added to the program to obtain better spatial coverage and alignment with marine waters stations. Details regarding field measurements, sampling location and frequency, and parameters to be measured are listed below.

7.1.2 Station Locations and Frequency

Twenty-two stations will be sampled (Figure 1, Table 3) in 2016 and 2017. Ten of the sites were originally selected (core) and, with only a few exceptions, sampled annually since 1989. An additional 12 stations (new) will be sampled to increase the spatial coverage of the annual monitoring. Station locations for the additional stations were chosen because they:

- Represent unique habitat types and benthic species assemblages.
- Are located near existing Marine Waters monitoring stations (Keyzers and Krembs, 2016; Bos et al., 2015).
- Provide a more uniform spatial coverage of Puget Sound.

Table 3. PSEMP Sediment Component 2016-2017 monitoring stations, including station number, station name and location, and parameters to be sampled.

Station ID	Station Location	NAD 1983 HARN		Approx. Station Depth (m)	Station Type	Sediment Chemistry	Benthos	TOC and Grain Size
		Latitude	Longitude					
3	Strait of Georgia	48.87025	-122.97842	228	Core Sediment	X	X	X
4	Bellingham Bay	48.68397	-122.53820	26	Core Sediment	X	X	X
BLL009	Bellingham Bay - Pt. Frances	48.68593	-122.59962	16	Core Water	X	X	X
209R	Skagit Bay	48.29533	-122.48850	24	New	X	X	X
19	Saratoga Passage	48.09792	-122.47134	124	New	X	X	X
21	Port Gardner/ Everett Harbor	47.98547	-122.24283	23	Core Sediment	X	X	X
119	Admiralty Inlet	47.87615	-122.48217	211	New	X	X	X
29	Shilshole	47.70075	-122.45403	204	Core Sediment	X	X	X
191	Central Elliott Bay	47.59842	-122.37581	102	New		X	X
34	Sinclair Inlet	47.54708	-122.66208	10	Core Sediment	X	X	X
38	Point Pully (3 Tree Point)	47.42833	-122.39363	204	Core Sediment	X	X	X
281	Commencement Bay	47.29229	-122.44193	144	New		X	X
40	Thea Foss Waterway	47.26130	-122.43730	12	Core Sediment	X	X	X
44	East Anderson Island	47.16133	-122.67358	21	Core Sediment	X	X	X
265	Carr Inlet	47.25240	-122.66572	105	New	X	X	X
252	Case Inlet	47.26957	-122.85101	55	New	X	X	X
52	W. of Devils Head, Case Inlet (Nisqually Reach)	47.17060	-122.78051	109	New	X	X	X
49	Budd Inlet	47.07997	-122.91347	9	Core Sediment	X	X	X
13R	North Hood Canal (south of bridge)	47.83758	-122.62895	23	Core Sediment	X	X	X
222	Hood Canal	47.67821	-122.81466	120	New	X	X	X
HCB003	Hood Canal - Central	47.53787	-123.00960	144	Core Water	X	X	X
305R	Lynch Cove	47.39717	-122.93124	20	New	X	X	X
Total number of stations						20	22	22

7.1.3 Parameters to be Determined

Table 4 lists a modified suite of analytes that will be measured in 2016-2017. As a way to leverage additional scientific knowledge from our field efforts, a small amount of extra sediment will be collected from each station and distributed as a courtesy to various academic partners for pursuit of their own sediment-related research (Table 4).

After review of all chemistry data collected from 1989 through 2014, from Long-term, Regional, and Urban Bays elements of the program, it was determined that a large number of chemicals are rarely or never quantified above the reporting limit during analyses. These chemicals have been removed from the current analyte list. They include chlorinated alkenes, chlorinated and nitro-substituted phenols, chlorinated aromatic chemicals, chlorinated pesticides, miscellaneous extractable chemicals, organonitrogen chemicals, and phenols (Table 5).

Parameters measured by Marine Sediment Monitoring Team partners

- *Alexandrium catenella* cysts: Dr. Cheryl Greengrove, University of Washington-Tacoma.
- Foraminifera: Dr. Liz Nesbitt, University of Washington-Seattle.
- Microplastics: Dr. Julie Masura, University of Washington-Tacoma and Dr. Peter Hodum, University of Puget Sound (a potential joint project with the Marine Sediment Monitoring Team).

Table 4. Parameters measured in sediments for the 2016-2017 sediment monitoring stations in Puget Sound.

Field Measurements	Polynuclear Aromatic Hydrocarbons	PCB Aroclor 1254
Sediment temperature	LPAHs	PCB Aroclor 1260
Salinity of overlying water	1,6,7-Trimethylnaphthalene	PCB congener 8
	1-Methylnaphthalene	PCB congener 18
Macroinvertebrate Abundance	1-Methylphenanthrene	PCB congener 28
Total Abundance	2,6-Dimethylnaphthalene	PCB congener 44
Major Taxa Abundance	2-Methylnaphthalene	PCB congener 52
Taxa Richness	2-Methylphenanthrene	PCB congener 66
Calculated values:	Acenaphthene	PCB congener 77
Pielou's Evenness	Acenaphthylene	PCB congener 101
Swartz's Dominance Index	Anthracene	PCB congener 105
	Biphenyl	PCB congener 118
Conventionals	Dibenzothiophene	PCB congener 126
Grain size	Fluorene	PCB congener 128
Total organic carbon	Naphthalene	PCB congener 138
	Phenanthrene	PCB congener 153
	Retene	PCB congener 169
Metals		PCB congener 170
		PCB congener 180
Priority Pollutant Metals	Calculated values:	PCB congener 187
Arsenic	Total LPAHs	PCB congener 195
Cadmium		PCB congener 206
Chromium	HPAHs	PCB congener 209
Copper	Benzo(a)anthracene	
Lead	Benzo(a)pyrene	Polybrominated Diphenylethers
Mercury	Benzo(b)fluoranthene	PBDE- 47
Nickel	Benzo(e)pyrene	PBDE- 49
Selenium	Benzo(g,h,i)perylene	PBDE- 66
Silver	Benzo(k)fluoranthene	PBDE- 71
Zinc	Chrysene	PBDE- 99
	Dibenzo(a,h)anthracene	PBDE-100
Organics	Fluoranthene	PBDE-138
	Indeno(1,2,3-c,d)pyrene	PBDE-153
Phthalate Esters	Perylene	PBDE-154
Bis(2-Ethylhexyl) Phthalate	Pyrene	PBDE- 183
Butylbenzylphthalate	Calculated values:	PBDE- 184
Diethylphthalate	Total HPAH	PBDE- 191
Dimethylphthalate	Total Benzofluoranthenes	PBDE-209
Di-N-Butylphthalate		
Di-N-Octyl Phthalate	Polychlorinated Biphenyls	Other
	PCB Aroclor 1016	2-Chloronaphthalene
	PCB Aroclor 1221	Carbazole
	PCB Aroclor 1232	Dibenzofuran
	PCB Aroclor 1242	
	PCB Aroclor 1248	

Table 5. Parameters outlined in the 2009 QAPP that will *not* be measured in sediments for the 2016-2017 sediment monitoring program.

Toxicity Parameters

Solid phase Amphipod Survival
 Porewater Urchin fertilization
 Organic Extract Microtox
 Elutriate Echinoderm Embryo development

Element

Tin

Organics

Chlorinated Alkenes

Hexachlorobutadiene

Chlorinated and Nitro-Substituted Phenols

Pentachlorophenol

Chlorinated Aromatic Chemicals

1,2,4-Trichlorobenzene
 1,2-Dichlorobenzene
 1,3-Dichlorobenzene
 1,4-Dichlorobenzene
 Hexachlorobenzene

Chlorinated Pesticides

2,4'-DDD
 2,4'-DDE
 2,4'-DDT
 4,4'-DDD
 4,4'-DDE
 4,4'-DDT
 Aldrin
 Alpha-BHC
 Beta-BHC
 Chlorpyrifos
 Cis-Chlordane (Alpha-Chlordane)
 Cis-Nonachlor
 Delta-BHC
 Dieldrin
 Endosulfan I

Endosulfan II
 Endosulfan Sulfate
 Endrin
 Endrin Aldehyde
 Endrin Ketone
 Gamma-BHC (Lindane)
 Heptachlor
 Heptachlor Epoxide
 Methoxychlor
 Mirex
 Oxychlordane
 Toxaphene
 Trans-Chlordane (Gamma)
 Trans-Nonachlor

Miscellaneous Extractable Chemicals

Benzoic Acid
 Benzyl Alcohol
 Beta-coprostanol
 Beta-Sitosterol
 Cholesterol
 p-Isopropyltoluene
 Isophorone

Organonitrogen Chemicals

Caffeine
 N-Nitrosodiphenylamine

Organotin, Butyl tin

Dibutyltin Dichloride
 Monobutyltin Trichloride
 Tetrabutyltin
 Tributyltin Chloride

Phenols

2,4-Dimethylphenol
 2-Methylphenol
 4-Methylphenol
 Phenol
 Phenol, 4-Nonyl-

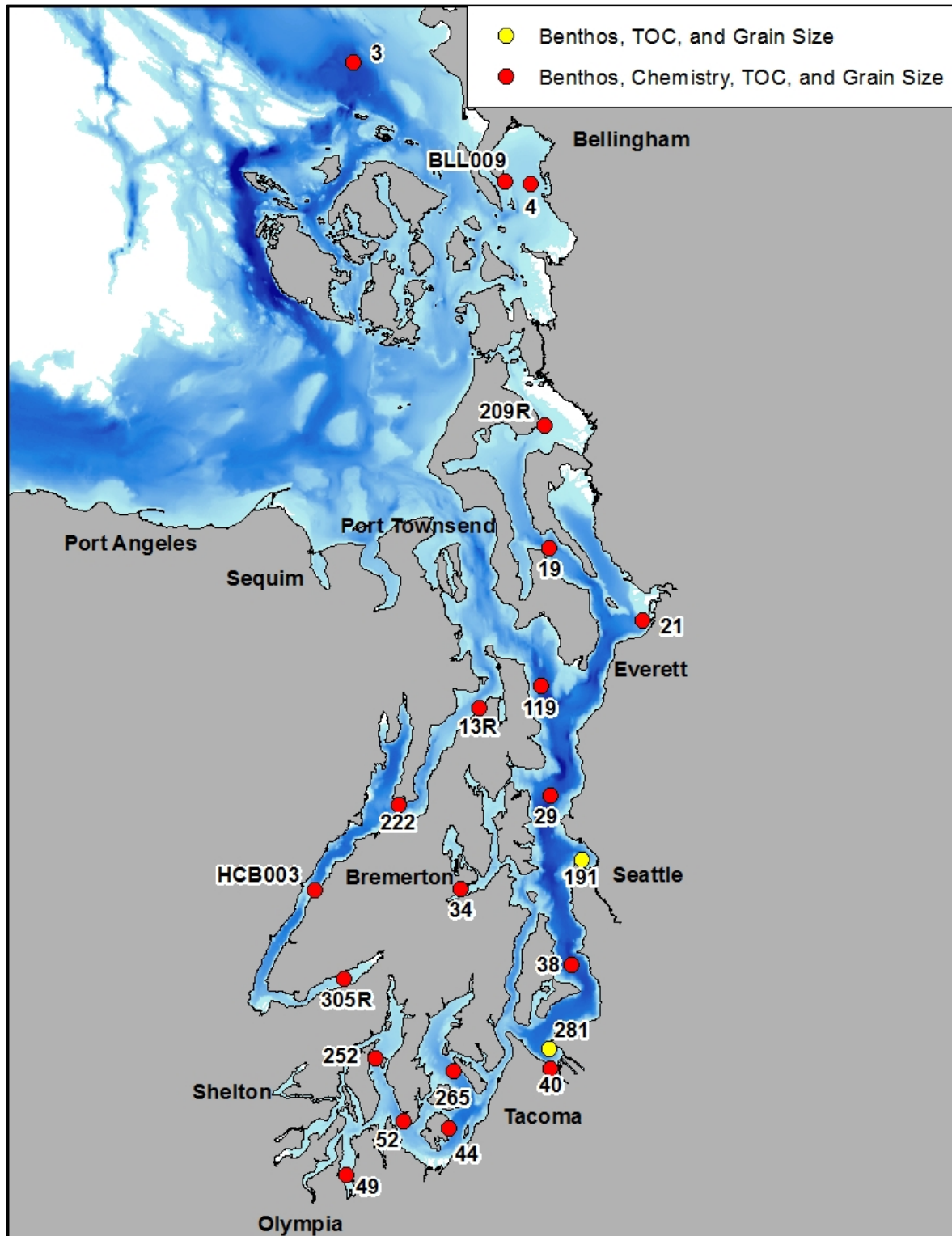


Figure 1. PSEMP Sediment Component 2016-2017 monitoring station locations.

8.0 Sampling Procedures

8.1 Field Measurement and Field Sampling SOP

8.1.1 Sampling Platform and Station Positioning

A marine research vessel of adequate size and speed, and suitably equipped for deployment of sample collection equipment and shipboard sample processing, will be reserved from the Ecology fleet for this work. From this platform, station-positioning protocols will follow PSEP (1998). Positioning will rely on Differential Global Positioning System (DGPS) with expected accuracy of better than 10 meters 95% of the time.

All of the sampling locations selected for this element have been sampled successfully in the past, with the exception of stations HCB003 in Hood Canal and BLL009 in Bellingham Bay. It is possible that bottom conditions have changed to a degree where some of these locations would be of a sediment type unsuitable for sampling. If during the course of field sampling it is found that any station has changed and is deemed unsamplable (e.g., station lacks fine-grained particles in the sediment, rocks prevent grab closure, the substrate is composed of all shell hash, etc.), it will be necessary to take alternate action.

If possible, the first course of action will be to move up to 300 m offshore, in a direction perpendicular to shore. If it is not possible to sample successfully after moving up to 300 m seaward, then that station will be rejected and not replaced.

9.0 Measurement Methods

9.2 Lab Procedures Tables

9.2.1 Grain Size, TOC, Chemistry

Extraction methods will be changed from Accelerated Solvent (Soxhlet) Extraction with methylene chloride (USEPA 3545) to Soxtherm with methylene chloride (USEPA 3451 (Me)) for all polynuclear aromatic hydrocarbon (PAH), polychlorinated biphenyl (PCB), and polybrominated diphenylether (PBDE) analyses. Bias and precision differences associated with this method change are documented in a method comparison study performed by Manchester Environmental Laboratory (Weakland, 2016). In addition, the extraction method for all phthalates will be changed from the current Soxtherm with acetone (USEPA 3451 (Ace)) to the Soxtherm with methylene chloride (USEPA 3451 (Me)).

15.0 References

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[Soxtherm Method Comparison Memo dtd 160216.pdf](#)