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Nearshore Sediment Monitoring Addendum to the Quality Assurance Project Plan for:

The Puget Sound Assessment and Monitoring Program: Sediment Monitoring Component

December 2011

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Publication Information

Addendum

This addendum is an addition to an original Quality Assurance Project Plan. The addendum is not a correction (errata) to the original plan.

This addendum is available on the Department of Ecology's website at
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Quality Assurance Project Plan: The Puget Sound Assessment and Monitoring Program: Sediment Monitoring Component

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DEPARTMENT OF ECOLOGY

Environmental Assessment Program

December 31, 2011

TO: Marine Nearshore Status and Trends Subgroup of the Stormwater Work Group for Puget Sound

THROUGH: Carol Maloy, Unit Supervisor, Environmental Assessment Program
Robert F. Cusimano, Section Manager, Environmental Assessment Program

FROM: Margaret Dutch, Environmental Assessment Program

SUBJECT: Nearshore Sediment Monitoring Addendum to: Quality Assurance Project Plan for the Puget Sound Assessment and Monitoring Program: Sediment Monitoring Component

Activity Tracker Code: 01-900
Publication No: 09-03-121-Addendum4

The Marine Nearshore Status and Trends Subgroup (Subgroup) of the Stormwater Work Group for Puget Sound has engaged with the Washington State Department of Ecology's Marine Sediment Monitoring Team (MSMT) to develop a Sediment Component for the Marine Nearshore Status and Trends Monitoring Program.

Based on discussions of the Subgroup, it was agreed that the Sediment Component would be designed and conducted as a nearshore modification of the existing Puget Sound Assessment and Monitoring Program (PSAMP) Sediment Component, conducted by the MSMT. All elements of the existing PSAMP Sediment Component are described in the Quality Assurance Project Plan (QAPP) (Dutch et al., 2009).

This addendum to the 2009 PSAMP QAPP describes all modifications to the parent program necessary to monitor sediment quality in the Puget Sound nearshore environment.

Any questions regarding this work can be directed to Margaret Dutch at margaret.dutch@ecy.wa.gov or 360-407-6021.

cc: Sandra Weakland, Environmental Assessment Program
Valerie Partridge, Environmental Assessment Program
Kathy Welch, Environmental Assessment Program
Ed Long, Environmental Assessment Program
Stuart Magoon, Environmental Assessment Program
Bill Kammin, Environmental Assessment Program

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Background

The Stormwater Work Group (SWG) is a coalition of federal, tribal, state, and local governments; business, environmental, and agricultural entities; and academic researchers; all with interests and a stake in the Puget Sound watershed. The SWG was convened in 2008 at the request of the Puget Sound Partnership (PSP) and Department of Ecology (Ecology) to develop a Stormwater Assessment and Monitoring Strategy for the Puget Sound Region. This strategy, completed in June, 2010, is intended to provide a coordinated, integrated approach to quantifying the stormwater problem in Puget Sound and to efficiently and effectively manage stormwater to reduce harm to the ecosystem.

Fifty-five key recommendations were developed by the SWG for establishing a Stormwater Assessment and Monitoring Program for Puget Sound (SWAMPPS). Included in these recommendations is a mandate to develop 1) status and trends monitoring, 2) source identification and diagnostic monitoring, and 3) effectiveness studies to identify stormwater-related impacts to the marine nearshore environment from urban and urbanizing land uses.

A Marine Nearshore Status and Trends Subgroup (Subgroup) of the SWG was formed in December, 2010 to address the status and trends monitoring element of SWAMPPS. The Subgroup developed a set of recommendations to launch a nearshore status and trends monitoring program that will sample 1) sediment quality, 2) health of the biota (i.e., mussels), and water quality (i.e., presence of fecal coliform bacteria). The Washington State Department of Ecology's Marine Sediment Monitoring Team (MSMT) was asked to participate in the Subgroup to develop the sediment quality component of the new nearshore monitoring program.

Based on discussions and recommendations of the Subgroup (**Appendix A**), it was agreed that a Nearshore Sediment Quality Monitoring Program would be designed and conducted as a nearshore modification of the existing PSAMP Sediment Component.

The new program will characterize sediment quality in a newly created nearshore sampling frame that intersects with and is adjacent to the existing PSAMP Spatial/Temporal sampling frame. This nearshore frame will be further subdivided to correspond with Puget Sound's urban/urbanizing growth areas (UGA) and nonurban growth areas (non-UGA). Sediment collection, sample analysis, and data interpretation would be implemented based on methods from the existing PSAMP Sediment Component (Dutch et al., 2009).

A full-scale Nearshore Sediment Quality Monitoring Program including analysis of sediment chemistry, sediment toxicity, and condition of benthic invertebrates is described in this addendum. It is recognized that budgetary constraints may initially restrict implementation of the full program.

Project Description

Nearshore Sediment Quality Monitoring

Goals

The overall goals of the Nearshore Sediment Quality Monitoring Program are modified from those developed for the PSAMP Sediment Component. They have been tailored to apply to the newly developed nearshore sampling frame, and include:

1. Assess the health of Puget Sound nearshore sediments and document geographic patterns in sediment condition.
2. Document natural and human-caused changes over time in Puget Sound nearshore sediments.
3. Identify existing nearshore sediment problems and, where possible, provide data to help target sources.
4. Provide nearshore sediment data and indicators to assist the SWG, the PSP, and others in measuring the success of stormwater and other environmental management programs.
5. Support nearshore sediment-related research activities by making available scientifically valid sediment quality data.

Objectives

Specific objectives of the Nearshore Sediment Quality Monitoring Program include:

1. Characterize the spatial extent of nearshore sediment quality both inside and outside the shallow, nearshore, UGA sampling frame.
2. Track changes in nearshore sediment quality over time both inside and outside the shallow, nearshore, UGA sampling frame. Is sediment quality improving, deteriorating, or remaining the same?
3. Compare nearshore UGA and nonUGA sediment quality with deeper nearshore and offshore (i.e., > 1.8m depth) sediment quality measured by the PSAMP Sediment Component.

Sediment Quality Indicators for Environmental Management

Ecology's Sediment Quality Triad of indicators (Long, et al., 2003, 2005), updated in 2011 to include a: 1) Sediment Chemistry Index (SCI), 2) Sediment Toxicity Index (STI), 3) Sediment Benthos Index (SBI), and 4) revised Sediment Quality Triad Index (SQTI), will be used to provide environmental managers with regular updates of sediment quality in the nearshore. These indicators are described in detail on the MSMT website: http://www.ecy.wa.gov/programs/eap/psamp/index.htm). A subset of these indicators have recently been adopted for the Puget Sound Partnership's (PSP) *Toxics in Sediments* Dashboard

Indicator (http://www.psp.wa.gov/vitalsigns/index.php) and for the WA State Government Management, Accountability and Performance (GMAP).

Organization and Schedule

Key staff and their responsibilities for the Nearshore Sediment Monitoring Program are indicated in **Table 1**. Schedules for completing field and laboratory work, EIM data entry, and reports are indicated in **Table 2**. The analytical costs will vary from year to year, based on parameters selected for analysis and the number of samples collected. Cost estimates will be generated and provided to managers separately for each sampling event.

Table 1. Organization of Ecology project staff and responsibilities.

Name/unit & section/ phone	Title	Responsibilities
Nearshore Sediment Quality Monitoring Program staff		
ES-3 level FTE Marine Monitoring Unit Western Operations Section Ecology – EAP	Lead scientist for Nearshore Sediment Monitoring Program	Plan and implement all field work; lab contract generation and oversite; data review, analysis, interpretation; report writing/editing
ES-1 level FTE Marine Monitoring Unit Western Operations Section Ecology – EAP	Field and lab assistant scientist for the Nearshore Sediment Monitoring Program	Assist lead scientist with all field work and other responsibilities for this sampling event
Marine Sediment Monitoring staff available to assist Nearshore Monitoring staff as needed and integrate Nearshore Sediment Monitoring Program activities and data with those of the existing PSAMP Sediment Monitoring Element:		
Margaret Dutch Marine Monitoring Unit Western Operations Section Ecology – EAP (360) 407-6021	PSAMP Sediment Component Principal Investigator/ Project Manager, Report Writer	PSP Toxics Workgroup member; Marine Sediment Monitoring Team lead; QAPP preparation/editing; field work and lab contract oversight; data review, analysis, and interpretation; report writing/editing.
Sandra Weakland Marine Monitoring Unit Western Operations Section Ecology – EAP (360) 407-6980	Data Manager, Field Logistics, Report Preparation	Database management, EIM data entry, data analysis, report preparation, field sampling preparation and conduct.

Name/unit & section/ phone	Title	Responsibilities
Edward Long Marine Monitoring Unit Western Operations Section Ecology – EAP (503) 763-0263	Data Analyst, Report Writer	Data analysis and report writing/editing.
Valerie Partridge Marine Monitoring Unit Western Operations Section Ecology – EAP (360) 407-7217	Statistician, Data Analyst, Report Writer	Database management, statistical analysis of data, report writing/editing, field sampling preparation and conduct.
Kathy Welch Marine Monitoring Unit Western Operations Section Ecology - EAP (360) 407-6035	Taxonomic Coordinator, Annelid Taxonomist	Contracting and coordination of all taxonomic work, primary and QA taxonomy of polychaete annelids, report writing/editing.
Carol Maloy Marine Monitoring Unit Western Operations Section Ecology - EAP (360) 407-6742	Unit Supervisor	Review and approval of QAPP, budget tracking and management
John Weakland Ecology - EAP, Manchester Environmental Laboratory (360) 871-8820	Organics Unit Supervisor	Delivery and quality control of all organic sediment chemistry data.
Dean Momohara Ecology - EAP, Manchester Environmental Laboratory (360) 871-8808	Inorganics Unit Supervisor	Delivery and quality control of all inorganic sediment chemistry data.
Stuart Magoon Ecology - EAP, Manchester Environmental Laboratory (360) 871-8801	Director	Approves the final QAPP.
William R. Kammin Ecology - EAP (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

Table 2. Proposed schedule for completing the Nearshore Stormwater Sediment Component Spatial/Temporal Monitoring field and laboratory work, data entry into Ecology's Environmental Information Management (EIM) database, and reports.

Field and laboratory work		
Field work completed		June 20XX
Laboratory analyses completed		TOC – July 20XX Grain size – September 20XX Toxicity – March – of next year Taxonomy – March – of next year Chemistry – March – of next year
Environmental Information System (EIM) system		
Product	Due date	Lead Staff
EIM data loaded	April – of next year	To be determined
EIM QA	May – of next year	To be determined
EIM complete	June – of next year	To be determined
Final report		
Author lead		To be determined
Schedule		
Summary statistics, graphics, and text generated and posted to web		August – of next year
Draft due to supervisor		September – of next year
Draft due to client/peer reviewer		October – of next year
Draft due to external reviewer		November – of next year
Final (all reviews done) due to publications coordinator		December – of next year
Final report due on web		December – of next year

Quality Objectives

Quality objectives for the Nearshore Sediment Quality Monitoring Program described here are to obtain and analyze sufficient numbers of high quality sediment chemistry, toxicity, and benthos samples to meet the goals and objectives of this program. Data quality indicators of precision, bias, sensitivity, representativeness, comparability, and completeness, defined in Lombard and Kirchmer (2004), and established for the PSAMP Sediment Component's Measurement Quality Objectives for field measurements, sediment grain size, total organic carbon, chemistry, toxicity, and benthic infaunal invertebrates (Dutch et al., 2009) will be adopted for the Nearshore Sediment Quality Monitoring Program.

Sampling Process Design (Experimental Design)

Nearshore Sediment Quality Monitoring: A Probabilistic Random Stratified Sampling Design for Nearshore Urban and Non-urban Growth Areas

A spatially-balanced, generalized random tessellation stratified (GRTS) multi-density survey design, developed by EPA (http://epa.gov/nheerl/arm/designing/design_intro.htm) and described by Stevens (1997), and Stevens and Olsen (1999, 2003, 2004), was generated for the Nearshore Sediment Quality Monitoring Program. This design was used for the PSAMP Spatial/Temporal Sediment Monitoring Element and Urban Waters Initiative focus studies, and is detailed in Appendix D-1 and Appendix D, Table 1 of Dutch et al., 2009.

Nearshore Sampling Frame

A new nearshore sediment sampling frame, including shallow/deep and UGA/nonUGA sub-frames, was defined by the Subgroup.

For the purpose of conducting sediment quality monitoring, the new nearshore sampling frame 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 sampling frame's landward and seaward boundaries were defined from 0m Mean Lower Low Water (MLLW) to -30m MLLW, respectively. The intertidal zone, defined as elevations above 0m MLLW, was excluded from the nearshore sampling frame. Sediment and biota samples collected from the intertidal zone would not be comparable to the nearshore subtidal zone due to exposure to different suites of environmental stressors.

The nearshore sampling frame was also restricted to intersect or lay immediately adjacent to the existing PSAMP Sediment Component sampling frame, which has been refined over many years to exclude hard bottom habitats which cannot be sampled with a vanVeen grab sampler. Such habitats lack fine-grained sediments which are required for sediment chemical analyses.

This new nearshore sampling frame was next divided into 1) a shallow nearshore area ranging from 0m MLLW to -1.8m (1 fathom) MLLW, and 2) a deeper area ranging from -1.8m MLLW to -30m MLLW. The shallower sampling frame has never been routinely sampled, while the deeper area lies within the PSAMP Sediment Component sampling frame which has been extensively and routinely sampled since 1997. The shallow and deep nearshore subframes were then further divided into 1) UGA and 2) nonUGA subframes based on proximity to land-based Urban Growth Area boundaries within the Puget Sound basin (**Figures 1-8**)(**insert from pdf**).

It was determined by the Subgroup that the shallow nearshore frame, divided into UGA and nonUGA subframes, would be sampled for the new Nearshore Sediment Quality Monitoring Program. Data collected for the ongoing PSAMP Sediment Component would be used to determine sediment quality in the deeper nearshore sampling frame. As a preliminary study, existing PSAMP sediment quality data falling in this deeper sampling frame were examined to determine differences in sediment quality from samples collected from 1997-2009 within the UGA and nonUGA frames. Statistically significant differences were found between data from the two sampling frames (**Appendix B**).

Target Population

A set of over 1 million random sampling points were generated to populate the nearshore sampling and sub-sampling frames using the GRTS design. Fifty points, and their corresponding latitudinal and longitudinal coordinates, will be drawn as stations for both the 0m MLLW to -1.8m MLLW UGA and nonUGA sampling frames. They serve as replicate samples within each study area. Sampling is scheduled to occur on a 5-year cycle.

The top 2-3cm of sediment will be collected from each station for chemistry and toxicity analysis. Benthic invertebrate samples will be collected from sample grabs up to 17cm in depth.

Parameters Measured

The list of sampling parameters used for the PSAMP Sediment Component, including sediment grain size, percent total organic carbon (TOC), and the Sediment Quality Triad parameters of over 140 metal and semivolatile organic chemical contaminants, laboratory bioassays measuring sediment toxicity, and the abundance of infaunal invertebrates identified to the lowest taxonomic level will be measured for this program (**Table 3**).

Field measurements recorded at each station include measures of sediment temperature, salinity of the overlying water, station depth, penetration depth of the grab sampler, and visual sediment quality characteristics (color, odor, texture, presence of organic matter, and sheen).

It is recognized that due to budget limitations, only one sampling frame (0m MLLW to -1.8m MLLW, UGA) and only a limited number of parameters may be collected during a given sampling event.

Table 3. Parameters measured in Puget Sound sediments for the Nearshore Sediment Quality Monitoring Program.

Field Measurements

Sediment temperature
Salinity of overlying water

Toxicity Parameters

Amphipod Survival (solid phase)
Urchin Fertilization (porewater)

Macroinvertebrate Abundance

Total Abundance
Major Taxa Abundance
Taxa Richness
Pielou's Evenness
Swartz's Dominance Index

Related Parameters

Grain Size
Total organic carbon

Metals

Priority Pollutant Metals

Arsenic
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Zinc

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
2-Chloronaphthalene
Hexachlorobenzene

Chlorinated Pesticides

2,4'-DDD
2,4'-DDE
2,4'-DDT
4,4'-DDD
4,4'-DDE
4,4'-DDT
Aldrin
Cis-Chlordane (Alpha-Chlordane)
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Endrin Ketone
Gamma-BHC (Lindane)
Heptachlor
Heptachlor Epoxide
Mirex
Oxychlordane
Toxaphene
Trans-Chlordane (Gamma)

Polynuclear Aromatic Hydrocarbons

LPAHs

1,6,7-Trimethylnaphthalene
1-Methylnaphthalene
1-Methylphenanthrene
2,6-Dimethylnaphthalene

2-Methylnaphthalene
2-Methylphenanthrene
Acenaphthene
Acenaphthylene
Anthracene
Biphenyl
Dibenzothiophene
Fluorene
Naphthalene
Phenanthrene
Retene

calculated values:

total LPAHs

HPAHs

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
Pyrene

calculated values:

total HPAH
total Benzofluoranthenes

Miscellaneous Extractable Chemicals

Benzoic Acid
Benzyl Alcohol
Beta-coprostanol
Carbazole
Cholesterol
Dibenzofuran
Isophorone

Organonitrogen Chemicals

Caffeine
N-Nitrosodiphenylamine

Phenols

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

Phthalate Esters

Bis(2-Ethylhexyl) Phthalate
Butylbenzylphthalate
Diethylphthalate
Dimethylphthalate
Di-N-Butylphthalate
Di-N-Octyl Phthalate

Polybrominated Diphenylethers

PBDE- 47
PBDE– 49
PBDE- 66
PBDE- 71
PBDE- 99
PBDE-100
PBDE- 138
PBDE-153
PBDE-154
PBDE- 183
PBDE- 184
PBDE-191
PBDE-209

Polychlorinated Biphenyls

PCB Aroclor 1016
PCB Aroclor 1221
PCB Aroclor 1232
PCB Aroclor 1242
PCB Aroclor 1248
PCB Aroclor 1254
PCB Aroclor 1260
PCB Aroclor 1262
PCB Aroclor 1268
PCB congener 8
PCB congener 18
PCB congener 28
PCB congener 44
PCB congener 52
PCB congener 66
PCB congener 77
PCB congener 101

PCB congener 105
PCB congener 118
PCB congener 126
PCB congener 128
PCB congener 138
PCB congener 153
PCB congener 169
PCB congener 170
PCB congener 180
PCB congener 187
PCB congener 195
PCB congener 206
PCB congener 209

Additional

Bisphenol A
Tri(2-chloroethyl) phosphate (TCEP)
Triclosan
Triethyl citrate

Use of Established PSAMP Protocols

All sampling, measurement, quality control, and data management procedures; and all audits and reports, data verification, and data quality assessment for the Nearshore Sediment Monitoring Program will follow the protocols described in the PSAMP Sediment Component QAPP (Dutch et al., 2009). A Nearshore Sediment Monitoring Program QAPP addendum will be published for each year of sampling outlining details specific to that year (e.g., target station locations, parameter list).

Literature Cited

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Abbreviations/Acronyms

EAP – Environmental Assessment Program
Ecology – Department of Ecology
EIM – Environmental Information Management system
GRTS - Generalized Random Tessellation Stratified
m – meter(s)
MLLW – Mean Lower Low Water
MSMT – Marine Sediment Monitoring Team
NonUGA – NonUrban Growth Area
PSAMP – Puget Sound Assessment and Monitoring Program
PSP – Puget Sound Partnership
QAPP – Quality Assurance Project Plan
Subgroup – Marine Nearshore Status and Trends Subgroup
SWAMPPS – Stormwater Assessment and Monitoring Program for Puget Sound
SWG – Stormwater Work Group
UGA – Urban Growth Area

Appendices

Appendix A

Marine Nearshore Sediment Quality Monitoring Options and Recommendations
by
Nearshore Status and Trend Monitoring Subgroup of the Stormwater Work Group
Jim Simmonds, Maggie Dutch, Jim West, Jennifer Lanksbury, Kim Stark, Jonathan Frodge, Tom Putnam, Heather Trim, Kit Paulsen, Tim Determan, Shayne Cothern, Karen Dinicola
September 2, 2011

The Nearshore Status and Trends Monitoring Subgroup of the Stormwater Work Group (Nearshore Subgroup) has begun to refine options and recommendations for implementing nearshore sediment quality monitoring. This monitoring will be a part of the regional stormwater monitoring program to be implemented as a component of the municipal stormwater NPDES permits and also as part of a comprehensive stormwater monitoring program.

1. The Nearshore Subgroup agrees that nearshore sediment quality monitoring is an important component of the monitoring program and continues to recommend that it be included in the regional monitoring program as a permit requirement.

2. The Nearshore Subgroup recommends that to best characterize nearshore sediment quality, the regional monitoring program should characterize the sediment quality triad of parameters, including chemical contamination, toxicity, and condition of sediment-dwelling invertebrates, from 0 to ~2 meters (1 fathom) MLLW within the Urban Growth Area (UGA).

3. The Nearshore Subgroup recommends that nearshore sediment quality monitoring occur once every five years.

4. The Nearshore Subgroup recommends that the sampling and analysis protocols closely mirror those currently conducted for the Puget Sound Assessment and Monitoring Program (PSAMP) for offshore sediments collected from > 2 meters depth. The nearshore sediment monitoring program will address the following objectives:

    a. Characterize the spatial extent of sediment quality inside the nearshore Urban Growth Area sampling frame.

    b. Track changes in sediment quality over time inside the nearshore Urban Growth Area sampling frame.

    c. Compare nearshore UGA sediment quality with offshore (i.e., > 2 m depth) sediment quality.

5. The Nearshore Subgroup recommends that sampling sites in the nearshore UGA sampling frame be randomly selected to allow for extrapolation of the results to the whole UGA sampling frame. A Generalized Random Tessellation Stratified (GRTS) spatially-balanced survey design, developed by EPA (Stevens (1997), and Stevens and Olsen (1999, 2003, 2004)) and adopted for the PSAMP sediment monitoring program (Dutch, et al., 2009) is recommended for the nearshore sediment monitoring program. This design allows for characterization of the spatial extent of sediment quality in the nearshore UGA sampling frame, comparison of conditions with the deeper (>2 meter depth) PSAMP sediment sampling frame, and when resampled periodically, determination of change over time.

6. The Nearshore Subgroup recommends that 50 samples be collected and analyzed for the same suite of chemical, bioassay, and benthos parameters analyzed by Ecology's PSAMP sediment monitoring program. This sample size was determined and recommended for this design by EPA based on assumptions of the proportion of the data meeting established criteria with desired precision and confidence levels (see EPA sampling design website: http://www.epa.gov/nheerl/arm/surdesignfaqs.htm#samplesize50).

7. The Nearshore Subgroup recommends that the budget for the monitoring program be revised based on estimates necessary to implement the monitoring program as per the recommended design, including data analysis and report writing. Initial cost estimates from Ecology staff in the Environmental Assessment Program (EAP) are that the cost will include hiring 2 FTEs for a full year for each sampling event, plus other program costs. Some members of the Nearshore Subgroup have requested a cost estimate based on level of efforts needed for each task to implement the recommended program. If the project extends across multiple years, then the budget per year is to be estimated.

8. The Nearshore Subgroup identified three possible options for reducing the level of effort to minimize the cost of the recommended nearshore sediment quality monitoring program. It should be noted that none of these options are currently recommended. The three options, in our preferred order, include:

    a. Limit the analyte list to include grain size, total organic carbon, metals, and PAHs from 50 sites. Archive extra sediment from each site for possible future analyses of BNAs, Pest/PCBs, PBDEs, and other organic chemicals. Similarly, collect, rescreen, and store benthic samples, delaying sorting and taxonomic identification until additional funding is secured. Toxicity testing would be eliminated, as samples cannot be stored for long periods of time.

    b. Collect samples from 50 sites, but conduct the full suite of sediment quality triad analyses on only a portion of the sites (e.g., 40 or 30 "Tier 1" sites) to assess spatial extent of sediment quality measures and variability. Decide whether to analyze remaining sites ("Tier 2" sites) based on results from Tier 1 analyses. Again, toxicity testing would be eliminated, as samples cannot be stored for long periods of time.

c. Conduct only chemical analyses on sediment collected from 50 sites. Eliminate collection of sediments for analysis of sediment toxicity and benthos.

9. The Nearshore Subgroup recommends that cost savings be estimated for the three possible options suggested above for reducing the level of effort for this sampling.

10. The Nearshore Subgroup recommends that funding be sought to complete generation of the new GIS sampling frame, populate the sampling frame with randomly generated sampling sites, prepare budgets for all sampling options, and prepare a Quality Assurance Project Plan for the monitoring program prior to finalizing the next municipal NPDES stormwater permit in July 2012.

11. The Nearshore Subgroup recommends that a sample draw occur, and sites be scouted in advance if necessary to identify all sampleable nearshore locations.

12. The Nearshore Subgroup supports efforts by the Stormwater Work Group, the Department of Ecology, the Department of Fish and Wildlife, and others to seek additional funding for more complete sampling of nearshore sediments, including sampling in the nearshore outside of the UGA, additional chemical parameters, and additional elevations (e.g., the intertidal).

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------. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262-278.

Appendix B

Statistical comparison of Puget Sound Nearshore Sediment Quality Data – 1997-2009, -1.8m to -30m MLLW, UGA vs nonUGA … to be created from existing Power Point presentation to the SWG 7-20-11).