Quality Assurance Project Plan

Post Point, Bellingham Bay
Sediment Sulfide and Toxicity Assessment

by
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Approvals

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Abstract

This project will investigate sediments in Bellingham Bay for sulfide levels and sediment toxicity to aquatic life in the vicinity of the City of Bellingham's Post Point Wastewater Treatment Plant outfalls and the Harris Avenue Shipyard. The study is intended to help establish whether discharges from the treatment plant may be a current or historical contributor to elevated sulfide levels in sediment at the shipyard.

Sediment samples will be analyzed for total organic carbon, ammonia, and sulfides. Sediment toxicity will be evaluated using Microtox®, amphipod, and larval marine invertebrate bioassays. Field measurements will include water column temperature, pH, and dissolved oxygen concentration. Sample collection will be conducted during the month of October 2004.

Results from this study will be used by the Washington State Department of Ecology (Ecology) Sediment Management Unit, Northwest Regional Office Toxics Cleanup Program and Bellingham Field Office to make recommendations for cleanup of Bellingham Bay sediments near the Harris Avenue Shipyard.

Background

Bellingham Bay is a large urban bay bordered by the city of Bellingham in northwest Washington (Figures 1 and 2). The bay is approximately 7 miles wide, 7 miles long, and reaches a depth of 108 feet in a central basin that extends southwest as a narrow trough into the Strait of Georgia.

The bay has a history of pollution and there is an ongoing program, the Bellingham Bay Comprehensive Strategy (Ecology, 2000), to investigate and remediate contaminated sediments, soil, and groundwater in the area. Sediment contaminants vary with location but include mercury and other metals, polycyclic aromatic hydrocarbons (PAHs), dioxins, furans, and a variety of other organic compounds.

A recent Remedial Investigation at the Harris Avenue Shipyard near Post Point found elevated concentrations (up to 3,800 mg/kg dry wt.) of sulfide in the sediment. This investigation was conducted under an Agreed Order with the Port of Bellingham (owner of the Shipyard) and built on earlier sampling that was conducted as part of the Bellingham Bay Comprehensive Strategy.

The draft Remedial Investigation and Feasibility Study (RI/FS) report for the Harris Avenue Shipyard (RETEC, 2004) notes that Ecology will conduct a study of potential ongoing sources of sulfide that could recontaminate remediated shipyard sediments. Specifically, the draft report proposes that the nearby Post Point Wastewater Treatment Plant outfall may be a source of sulfides. Elevated sulfide concentrations have been found in the vicinity of the current (*main)* treatment plant outfall (up to 2,110 mg/kg dry

wt.). At the former (*alternate)* outfall, which is now only rarely used, concentrations up to 4,970 mg/kg dry wt. have been found.

Sulfide concentrations in the vicinity of the Harris Avenue Shipyard and the Post Point Wastewater Treatment Plant outfalls are shown in Figure 3. Since little sampling has been conducted between the outfalls and the shipyard, it is unclear whether these findings represent two distinct areas of elevated sulfide levels or are simply two parts of one larger area. The latter scenario would be consistent with the draft RI/FS proposal that the treatment plant discharges have contributed to elevated sulfide levels in shipyard sediments. Moreover, an increasing sediment sulfide concentration gradient centered on the current outfall might be expected if it is an ongoing source. If the treatment plant was a historical source, a gradient centered on the former outfall might be expected.

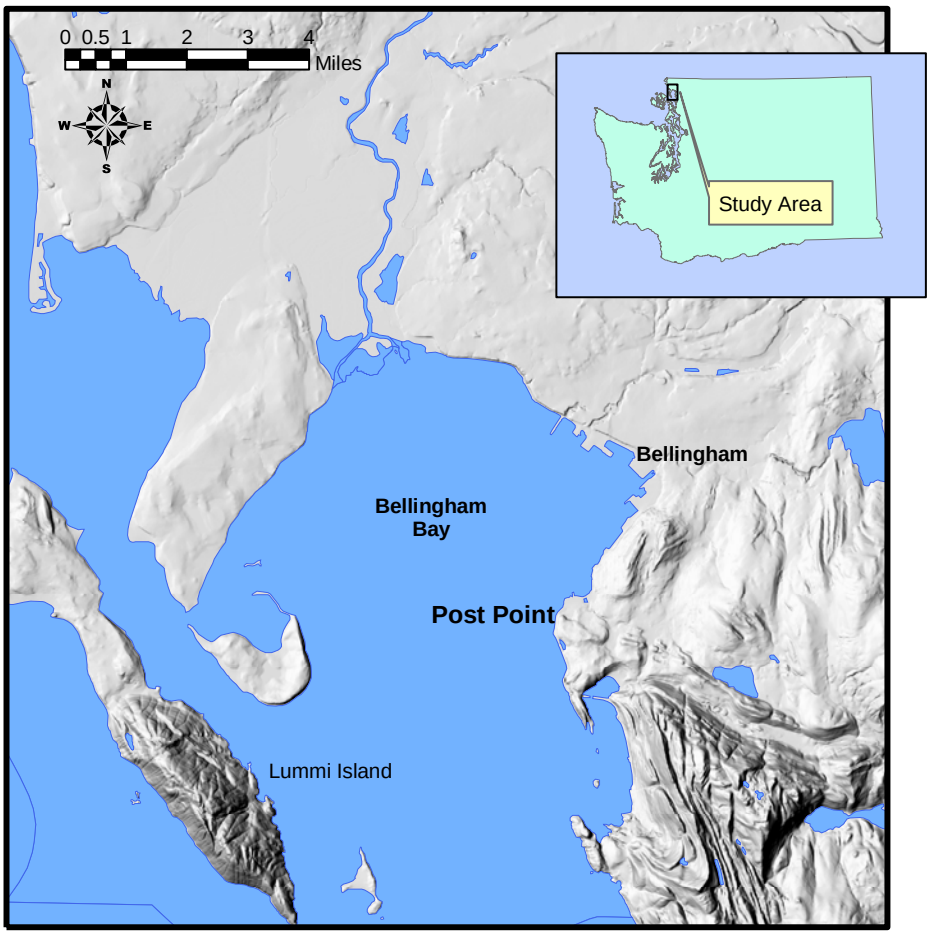

Figure 1. General Location of Post Point and Bellingham Bay.

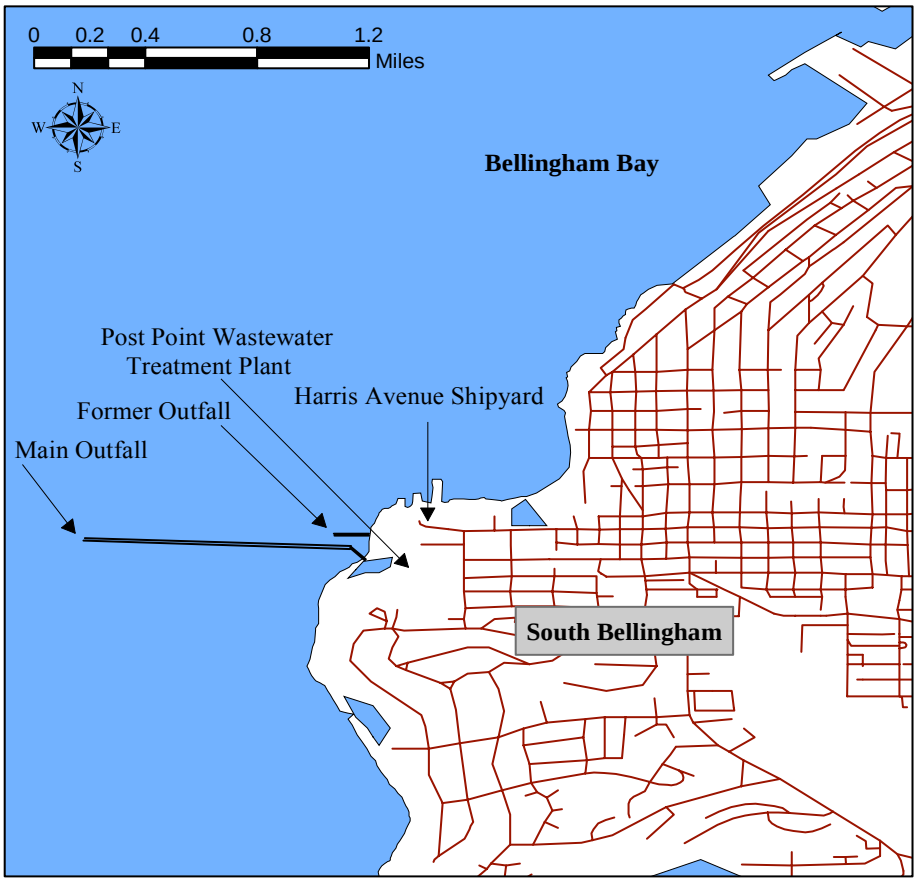

Figure 2. Location of City of Bellingham Post Point Wastewater Treatment Plant and Harris Avenue Shipyard.

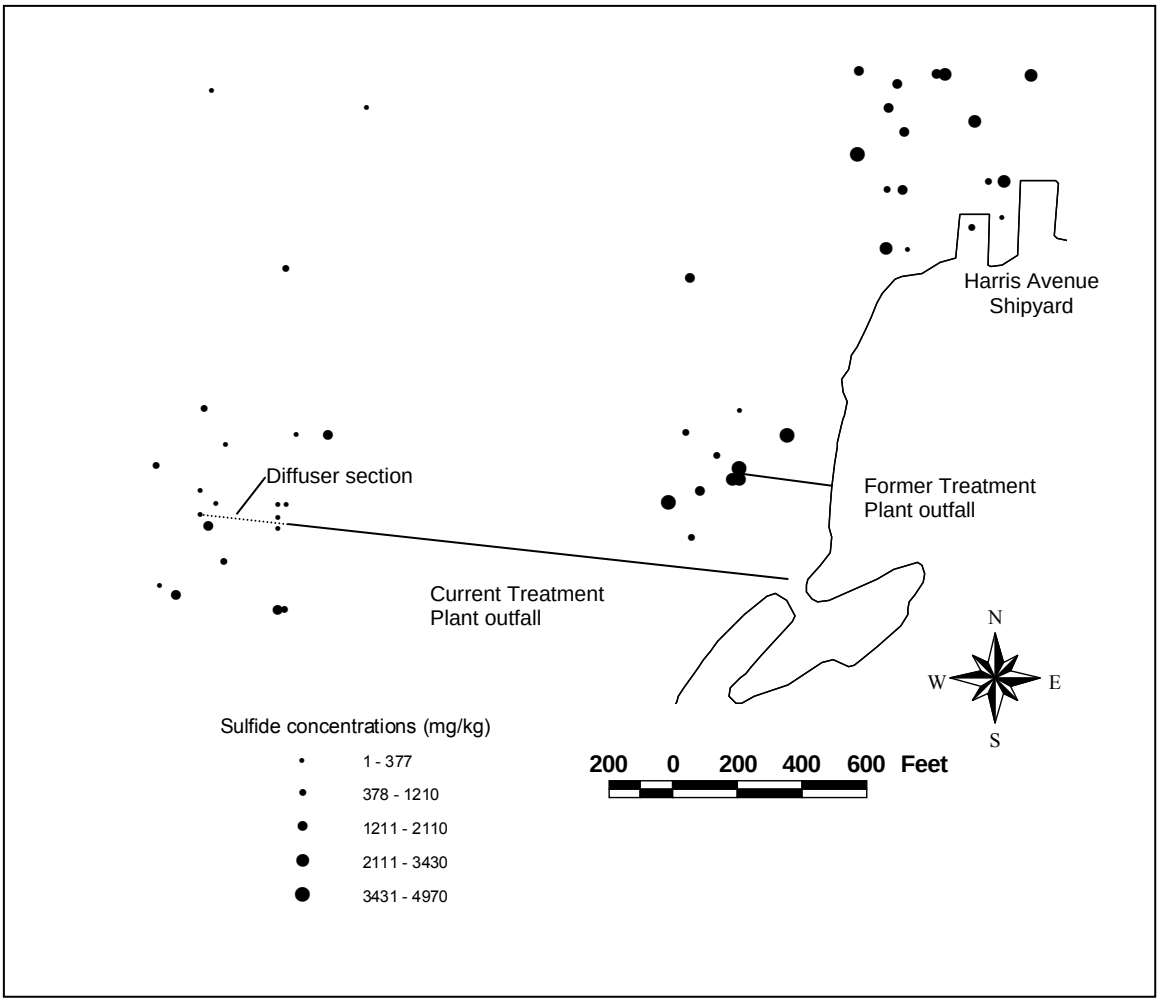

Figure 3. Sulfide Concentrations (mg/kg dry wt.) at Previously Sampled Locations in the Study Area.

Project Description

The primary goal of this project is to characterize the area between the Post Point Wastewater Treatment Plant outfalls and the Harris Avenue Shipyard regarding sediment sulfide levels. This information is intended to help clarify the potential historical or current role of the treatment plant outfalls as a contributor to elevated sulfide levels in the Harris Avenue Shipyard sediments.

The secondary goal of this project is to characterize the area between the Post Point Wastewater Treatment Plant outfalls and the Harris Avenue Shipyard, based on regulatory criteria for sediment toxicity. Although Washington State Sediment Management Standards (Chapter 173-204 WAC) do not include numerical criteria for sulfide, they do provide criteria for using bioassays to evaluate sediment toxicity. Toxic levels of sulfide could, therefore, be indirectly regulated under Sediment Management Standards if they cause an exceedance of biological criteria (Appendix A).

Results from this study will be used by Ecology's Sediment Management Unit, Northwest Regional Office Toxics Cleanup Program, and the Bellingham Field Office to make decisions regarding the management of contaminated sediments near Post Point in Bellingham Bay.

The project objectives are:

- To determine sulfide levels at sampling points that will provide an understanding of the spatial relationship between the known areas of contamination.
- To evaluate the toxicity of the sediment samples, using the Washington State Sediment Management Standards (Chapter 173-204 WAC) bioassay procedures.
- To compare sulfide levels and bioassay responses.

The Sediment Management Standards require the use of two acute biological tests and one chronic-effects biological test to determine whether regulatory criteria are exceeded.

The two applicable acute tests include a 10-day bioassay to assess mortality in amphipods and a test to assess mortality and/or abnormality of larvae of various marine invertebrates (oyster, mussel, sea urchin, or sand dollar). Three available chronic-effects tests include a 20-day sublethal test to assess biomass of the juvenile polychaete worm *Neanthes* sp., a 15-minute test to assess decreased bacterial bioluminescence (Microtox®), and an assessment of alterations in the naturally occurring abundances of major invertebrate taxa (Crustacea, Mollusca, and Polychaeta).

For this project, sediment toxicity will be evaluated using the 10-day amphipod (*Ampelisca abdita*) test, the larval test and the Microtox® test. Sulfide concentrations

will also be measured and other relevant field parameters such as depth-specific temperature and dissolved oxygen levels will be recorded at each station.

Sampling will focus on areas where there are data gaps from previous sediment investigations conducted in the Post Point area. In particular, these include 1) the area between the Post Point Wastewater Treatment Plant outfalls and the Harris Avenue Shipyard and 2) the area between the current and former treatment plant outfalls.

Sediment samples will be obtained using a grab sampler operated from Ecology's R.V. *Skookum*. At each sampling location, three-to-five grab samples will be collected for use in chemistry analysis, bioassay toxicity testing, and characterization of physical properties such as grain size.

Organization and Schedule

Participants in this study are listed below:

Project Manager	Nigel Blakley (360) 407-6770	Project management, report preparation.
Project Assistant	Erika Wittmann (360) 407-6530	Assist with project planning, Quality Assurance (QA) Project Plan, data analysis and sampling.
Client (TCP-NWRO/BFO)	Mary O'Herron (360) 738-6246	Review QA Project Plan and report.
TSU Supervisor	Dale Norton (360) 407-6765	Project review, boat operator, supervise collection of grab samples.
Lab analyses	Pam Covey (360) 871-8827	Laboratory contracts.
Lab Quality Assurance	Karin Feddersen (360) 871-8829	Assistance in QA Project Plan preparation, data review.
EIM Data Entry	Erika Wittmann (360) 407-6530	Data entry.

Schedule and Budget

Field Sample Collection	October 2004
Laboratory Analysis Complete	December 2004
Draft Report	October 2005
Final Report	December 2005
EIM Data Entry	July 2005
Data Transfer to SEDQUAL Templates	July 2005

Summary of Estimated Laboratory Cost (FY04)*

Analysis	# Samples	# QA Samples	Total	Unit Cost	Subtotal
Conventionals					
Percent solids	10		10	$10	$100
Grain size	10	1	11	$100	$1,100
Total Organic Carbon	10	1	11	$39	$429
Toxicity					
Amphipod bioassay	11		11	$600	$6,600
Larval bioassay	11		11	$480	$5,280
Pore water ammonia and sulfides	11		11	$30	$330
Microtox bioassay	11		11	$250	$2,750
Other					
Total sulfides (bulk sediment)	10	1	11	$40	$440
Ammonia (bulk sediment)	10	1	11	$50	$550
				Subtotal	$17,579
				Contracting fee (25%)	$4,395
				TOTAL	$21,974

* Includes field QA samples and is based on 50% discount rate for analysis at Manchester Environmental Laboratory (MEL).

Quality Objectives

Quality Assurance/Quality Control (QA/QC) requirements for the biological tests included in this investigation are specified in the Sediment Sampling and Analysis Plan Appendix, Section 7.2 and Table 14 (Ecology, 2003). The laboratory procedures for these bioassays include positive and negative controls, and they establish quantitative criteria for control data for bioassay results to be considered valid (PSEP, 1995; Ecology, 2003).

For all other analyses (conventional and chemical analytes), the Measurement Quality Objectives (MQOs) are shown in Table 1. They are taken from Ecology's guidance for developing sediment sampling and analysis plans to meet requirements of the Sediment Management Standards (Ecology, 2003).

Table 1. Quality Control Samples and Measurement Quality Objectives (MQOs).

	Lowest Measurement of Interest	QC Samples									
		Blind field Duplicates[1]		Method Blank		Analytical Replicates[2]		Laboratory Control Sample[3]		Matrix Spike	
Parameter	MQO[4]	Number	MQO	Number	MQO	Number	MQO	Number	MQO	Number	MQO
Grain size	1%	1	See footnote 1	--		1 triplicate analysis[5]	RSD ≤ 20 %[5]	--		--	
TOC	0.1%	1	See footnote 1	1/batch	Analyte concentration < 0.1%[6]	1 triplicate analysis[5]	RSD ≤ 20 %[5]	--		--	
Total Sulfides	10 mg/kg	1	See footnote 1	1/batch	Analyte concentration < 10 mg/kg[6]	1 triplicate analysis[5]	RSD ≤ 20 %[5]	1/batch	135-65% recovery[5]	1	135-65% recovery[5]
Ammonia	100 ug/kg	1	See footnote 1	1/batch	Analyte concentration < 100 ug/kg[6]	1 triplicate analysis[5]	RSD ≤ 20 %[5]	1/batch	120-80% recovery[5]	1	125-75% recovery[5]

Notes:
RSD Relative standard deviation.

[1] Field duplicates: For this project, defined as aliquots taken from the same mixing bowl after compositing sediment taken from 3-5 grab samples at one station and homogenized by mixing. In the case of Total Sulfides and Ammonia: two aliquots taken from the first grab sample without compositing or mixing, to minimize volatilization losses. Ecology sediment sampling and analysis guidance (Ecology, 2003) does not provide quality control criteria for Relative Percent Differences (RPD) for field duplicates. RPD values will be reported but no Method Quality Objectives will be used for these values.

[2] Synonymous with Laboratory Replicates or, if applicable, Laboratory Duplicates.

[3] A known matrix spiked with analytes representative of the target analytes used to document laboratory performance. A Fortified Blank or a commercially available Certified Reference Material containing the analytes of interest may be used.

[4] Based on recommended practical quantitation limits in Sediment Sampling and Analysis Plan Appendix (Ecology, 2003), Table 5. As noted in this Appendix, achievement of these values will generally allow comparison with the numerical SQS and CSL for sediments with a normal range of TOC values.

[5] Source: Sediment Sampling and Analysis Plan Appendix (Ecology, 2003), Table 13.

[6] Source: Sediment Sampling and Analysis Plan Appendix (Ecology, 2003), Table 11. PQLs from Table 5.

Sampling Process Design

The sampling locations chosen for this investigation are listed in Table 2 and shown in Figure 4, except for the reference station in Carr Inlet (about ten miles northwest of Tacoma).

The objectives in the selection of sampling locations are:

1. To characterize sulfide concentrations and sediment toxicity between the regions of high sulfide levels previously found at the Post Point Wastewater Treatment Plant outfalls and the Harris Avenue Shipyard.

2. To establish whether there may be a sulfide concentration gradient centered on the current or former treatment plant outfall discharge points. For the current outfall, discharge is through a 425 foot diffuser section (Figure 4).

Constraints on the sampling design include:

1. Ten sampling locations to be selected.

2. Include one location likely to have high sulfide levels, based on previous sampling data.

3. Include one location north of existing Harris Avenue Shipyard sampling points. This will help to better define the northerly extent of elevated sulfide levels near the shipyard.

4. Broad coverage is needed to characterize the areas of interest while narrower coverage is preferable to map possible sulfide gradients.

The grid-based systematic sampling design shown in Figure 4 was selected to meet the sampling plan objectives within the constraints listed.

Table 2: Sediment Sampling Locations in Bellingham Bay and Carr Inlet Reference Area.

		Coordinates (NAD 1983)*			
Area	Station ID	Latitude		Longitude	
Bellingham Bay	BBY01	48	43.380	122	31.140
Bellingham Bay	BBY02	48	43.380	122	31.008
Bellingham Bay	BBY03	48	43.296	122	31.272
Bellingham Bay	BBY04	48	43.296	122	31.140
Bellingham Bay	BBY05	48	43.296	122	31.008
Bellingham Bay	BBY06	48	43.212	122	31.272
Bellingham Bay	BBY07	48	43.212	122	31.140
Bellingham Bay	BBY08	48	43.212	122	31.008
Bellingham Bay	BBY09	48	43.128	122	31.272
Bellingham Bay	BBY10	48	43.128	122	31.140
Carr Inlet	CR02	47	20.150	122	39.855

* Degree and decimal minutes.

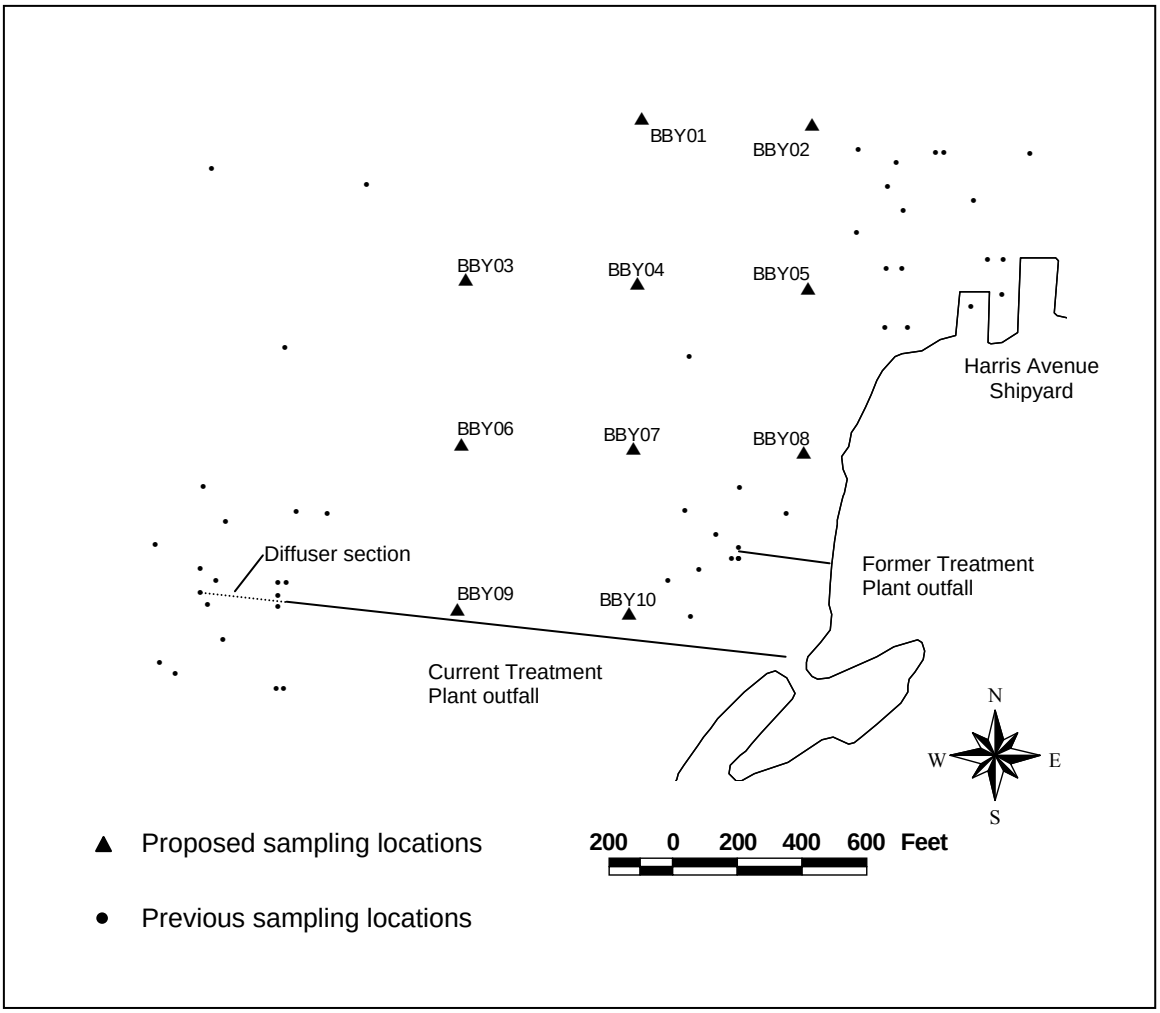

Figure 4. Proposed Sediment Sampling Locations.

After reviewing the range in grain size data for sediment samples from the Post Point area of Bellingham Bay, an appropriate station in Carr Inlet (CR02) was selected as a reference location. This station near Raft Island in South Puget Sound has been tested numerous times in the past for toxicity and performed well. Sediment has been recently collected from CR02 for analysis as part of another Ecology study. The analysis will provide all reference values needed for the present study, including sulfide and ammonia concentrations and biological test results for amphipod, larval, and Microtox® bioassays.

Comparability in the data from this study is supported by the use of standard Puget Sound Estuary Protocols sampling methods. Stations will be located and positions recorded using a differentially corrected global positioning system (GPS). Because procedures for bioassay testing of sediments are highly specific (Ecology, 2003), data from this testing should be within the regulatory framework for comparability with previous bioassay results. The criteria used in bioassay data interpretation are summarized in Appendix A.

The objective for completeness is 100% valid sulfide data for the ten sampling locations and reference location, and 100% valid data from bioassay testing at all locations.

Sampling Procedures

Where applicable, sampling methods will follow Puget Sound Estuary Protocols (PSEP, 1996) and requirements of Ecology's Sediment Management Standards (Chapter 173-204 WAC; Ecology 2003).

Samples will be collected from Ecology's 26-foot research vessel R.V. *Skookum* using a 0.1 m^2 stainless steel van Veen grab. To be considered acceptable, a grab should not be over-filled with sediment, there should be overlying water on the sediment that is not excessively turbid, and the sediment surface should be relatively flat.

Each sample will consist of a composite containing a minimum of three individual grabs. For each grab, the overlying water will be siphoned off. The top 10-cm layer of sediment, not in contact with the sidewalls of the grab, will then be removed with a stainless steel scoop, placed in a stainless steel bucket, and homogenized by stirring.

Subsamples of the homogenized sediment will be transferred to glass jars cleaned to EPA QA/QC specifications (EPA, 1990). Containers and holding times for the subsamples are shown in Table 3.

An exception to this procedure is required for the sulfide subsample, where disturbance of the sediment should be minimized to avoid the loss of sulfide gases (PSEP, 1997). This subsample will be taken directly from the first grab sample prior to homogenization of the remaining sediment. The same precaution will also be used for the ammonia sample to minimize volatilization losses.

Table 3: Containers, Preservatives, and Holding Times for Sediment Samples.

Analyte	Container	Preservation Techniques	Holding Time
TOC	2 oz glass jar	Cool to 4 °C	2 weeks
Grain Size	8 oz plastic jar	Cool to 4 °C	6 months
Percent Solids	2 oz glass jar	Cool to 4 °C	7 days
Total Sulfides	8 oz glass jar or as specified by contract lab	Cool to 4°C No headspace	7 days See footnote
Ammonia	8 oz glass jar or as specified by contract lab	Cool to 4°C No headspace	7 days
Amphipod Bioassay (*Ampelisca abdita*)	1/2 gallon glass jar or as specified by contract lab	Cool to 4 °C	2 weeks
Larval Bioassay (acute)	1/2 gallon glass jar or as specified by contract lab	Cool to 4 °C	2 weeks
Microtox® Bioassay	0.5 liter glass jar or as specified by contract lab	Cool to 4 °C	2 weeks

Total Sulfides 28-day holding time: Requires 250 ml sample and 5 ml 2N zinc acetate preservative. For this project, preservative will not be used.

All utensils used to manipulate the samples (stainless steel scoops and mixing bowls) will be precleaned by washing with Liquinox® detergent, followed by sequential rinses with tap water, deionized water, and pesticide-grade acetone. The equipment will then be air-dried and wrapped in aluminum foil until used in the field. The grab sampler will be precleaned with Liquinox® detergent and rinsed with onsite-seawater before beginning sampling. Between stations, cleaning of the grab sampler will consist of thoroughly brushing with on-site seawater. If oil or visible contamination is encountered, the grab will be cleaned between samples with a detergent followed by a rinse with on-site seawater.

All samples will be stored in coolers on ice at 4°C and transported to the Ecology Manchester Environmental Laboratory (MEL) or contract laboratories within 72 hours of collection. Storage temperatures and holding time requirements specified by PSEP and other sources are listed in Table 4. Chain-of-custody will be maintained.

At each station, vertical profiles of salinity, temperature, DO (dissolved oxygen), and depth will be recorded with a Seabird CTD. Water samples, collected at the surface and at one foot above the bottom with a Van Dorn bottle, will be used to measure pH with a pH meter.

Measurement Procedures

A field log (Appendix B) will be maintained during sampling to record information for each location including GPS coordinates. For each grab sample judged acceptable, the following observations will be entered in the field log:

- Date and time.
- Station location at the time of bottom contact.
- Station depth.
- Visual characteristics of the surficial sediment.
  - Texture.
  - Color.
  - Biological structures (e.g., shells, tubes, macrophytes).
  - Presence of debris (e.g., wood chips, wood fibers, human artifacts).
  - Presence of oily sheen.
  - Obvious odor (e.g., hydrogen sulfide, oil, creosote).
- Gross characteristics of the vertical profile (determined after the surficial sediments have been collected).
  - Vertical changes in sediment characteristics.
  - Presence and depth of any apparent redox potential discontinuity layer.
- Penetration depth of sampler.
- pH (at water column surface and bottom).

Laboratory measurement methods to be used are listed in the following table and Measurement Quality Objectives are listed in Table 1.

Table 4: Measurement Methods.

Parameter	Sample Matrix	Range of Reported Results[1]	Analytical Method
TOC	Sediment	0.33-3.2%	PSEP-TOCM (reported on a dry weight basis at 70°C)
Grain Size	Sediment	4-95% fines	Plumb (1981)
Percent Solids	Sediment	24.2-70.5%	EPA Method 160.3
Ammonia	Sediment	5.8-88.5 mg/kg dw	Plumb (1981)
Total Sulfides	Sediment	0.9-4970 mg/kg dw	PSEP (1986)
Amphipod Bioassay[2] (*Ampelisca abdita*)	Sediment	—	PSEP (1995) 10-day acute
Larval Bioassay[2,3]	Sediment	—	PSEP (1995) Acute
Microtox Bioassay[4]	Sediment	—	Ecology (2003)

Analytical methods for sediment porewater sulfide and ammonia analyses conducted in conjunction with bioassay testing will be determined with the contract bioassay lab.

[1] Anchor (2004).
[2] Test requirements include monitoring of water in the test chambers for sulfides and ammonia.
[3] Test to be conducted with one of the following species:

Pacific oyster, Crassostrea *gigas*

Blue mussel, *Mytilus galloprovincialis*

Purple sea urchin, *Strongylocentrotus purpuratus*

Green sea urchin, Strongylocentrotus *droebachiensis*

Sand dollar, Dendraster *excentricus*

[4] Microtox 100 percent sediment porewater extract.

Quality Control Procedures

Table 1 lists the quality control samples for this project and shows how the information from these samples will be used. Additional laboratory quality control procedures for sediment bioassays are listed in Ecology (2003), Table 14. For other laboratory analyses, quality control procedures are provided in the method protocol and laboratory Standard Operating Procedures.

Data Management Procedures

Prior to completion of the project, all project data will be entered into Ecology's Environmental Information Management System (EIM). The sediment data will also be processed into validated electronic SEDQUAL templates for inclusion into the SEDQUAL database.

Audits and Reports

The Manchester Environmental Laboratory participates in performance and system audits of their routine procedures. Results of these audits are available on request. The Environmental Assessment (EA) Program Quality Assurance Unit must accredit all contract laboratories performing work for Ecology. The accreditation process includes performance and system audits.

A draft report will be completed on or before May 2005. The report will include the following:

- Site maps showing sampling locations and locations of past samples.
- Description of field and laboratory methods.
- Sample information (dates, times, depths, coordinates, etc.).
- Discussion of data quality and the significance of any problems encountered in the sampling or analysis.
- Analysis of spatial distribution of sulfide, using tables and maps.
- Analysis of bioassay results regarding compliance with Sediment Management Standards, using tables and maps.
- Statistical comparison between bioassay and sulfide results.
- Summary of all laboratory analyses results. The summary will include descriptive statistics.

A final report will be prepared on, or before, July 2005. Upon completion of the project, all project data will be entered into Ecology's EIM system and processed for entry into SEDQUAL. Public access to electronic versions of the data and reports generated from this project will be available via Ecology's internet homepage (http:\\www.ecy.wa.gov).

Data Verification and Validation

The Manchester Environmental Laboratory will conduct a review of all laboratory analysis for the project including contract laboratory's data and case narratives. MEL will verify that the methods and protocols specified in the QA Project Plan were followed; that all calibrations, checks on quality control, and intermediate calculations were performed; and that the data are consistent, correct, and complete, with no errors or omissions. Evaluation criteria will include the acceptability of instrument calibration, procedural blanks, spike sample analysis, precision data, laboratory control sample analysis, and appropriateness of the data qualifiers assigned. MEL will prepare a written report on the results of their data review.

The project manager will review the contract laboratory's data package and MEL's data QA report and verify that MQOs were met. The project manager will check these data and reports for completeness and reasonableness. Based on these assessments, the data will either be accepted, accepted with appropriate qualifications, or rejected.

Data Quality Assessment

Once the data have been reviewed, verified, and validated, the EA Program project manager will make a determination whether they are usable for characterizing sediment toxicity and chemistry. If the results are satisfactory, each station will be evaluated for compliance with the Sediment Management Standards based on results from the bioassay testing.

References

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Appendix A

Biological Effects Criteria for Puget Sound Marine Sediments (from Ecology, 2003)

Biological Test	Sediment Quality Standards [a]	Cleanup Screening Levels [b]
Amphipod	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 25 percent greater, on an absolute basis, than the reference sediment mean mortality.	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30 percent greater, on an absolute basis, than the reference sediment mean mortality.
Larval	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 85 percent of the mean normal survivorship in reference sediment.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 70 percent of the mean normal survivorship in the reference sediment.
Juvenile polychaete	The mean individual growth rate of polychaetes in the test sediment is less than 70 percent of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P≤0.05) from the reference sediment mean individual growth rate.	The mean individual growth rate of polychaetes in the test sediment is less than 50 percent of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P≤0.05) from the reference sediment mean individual growth rate.
Microtox® (porewater)	The mean light output of the highest concentration of the test sediment is less than 80 percent of the mean light output of the reference sediment, and the two means are statistically different (t-test, P≤0.05).	Not applicable

Source: Ecology (1993).

[a] The sediment quality standards are exceeded if one test fails the listed criteria [WAC 173-204-320(3)].

[b] The sediment impact zone maximum level, cleanup screening level, or minimum cleanup level is exceeded if one test fails the listed sediment impact zone maximum level, cleanup screening level, or minimum cleanup level criteria [WAC 173-204-520(3)] or if two tests fail the sediment quality standards criteria [WAC 173-204-320(3)].

Regulatory standards for sediment contamination in Puget Sound have been established in Washington State's Sediment Management Standards (SMS), Chapter 173-204 WAC. The SMS establishes two levels for sediment quality, the Sediment Quality Standards (SQS) and the Cleanup Screening Levels (CSL).

CSLs are "minor adverse effects" levels, used as an upper regulatory level for source control and as minimum cleanup levels. SMS sets criteria for CSLs based on bioassay testing. It also sets numerical CSLs based on chemical concentrations for some substances. Of the two approaches, biological effects CSLs have precedence over

chemistry, and exceedance of a numerical CSL can be overridden by a demonstration that biological effects criteria are not exceeded. Similarly, a finding of no exceedances based on chemical criteria can be overridden by a demonstration of biological effects exceedances.

SQS are "no adverse biological effects" levels and are used as a sediment quality goal for Washington State sediments. Although a single SQS exceedance at a sediment location does not represent a CSL exceedance, SMS imposes a limit by specifying that a location exceeding more than one SQS constitutes a CSL exceedance. A more detailed description of the sediment quality evaluation procedures is provided in Ecology (2003)

Appendix B

Sediment Sample Log

Site: POST POINT, BELLINGHAM BAY, WASHINGTON

Recorder: _____

	Station Coordinates	Station	Grab #	Depth (ft)	Date	Time	Penetration (cm)	pH		Sample Description (texture, color, debris, sheen, odor)
								Surface	Bottom	
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					
LAT LONG					/ /04					