Quality Assurance Project Plan

Cornet Bay Intertidal Contaminant Screening Survey

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June 2005

303(d) Listings Addressed in this Study: None

Waterbody Number: WA-PS-0010

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Approvals

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Abstract

In 1989, a major release of gasoline and diesel, allegedly from severed fuel lines, took place at Cornet Bay Marina on Whidbey Island in Washington State. Contaminated groundwater transported the petroleum products to the bay, where sheen could be seen on the surface for several years. The underground storage tanks were removed, and the current fuel tanks are contained in an underground vault.

Soil and groundwater were analyzed in 1995, 1996, and 2003 and contamination was found to some degree property-wide.

For this current study, intertidal sediment, groundwater seeps, surface water, and shellfish samples will be collected. Data will be used to determine (1) if upland contamination is continuing to migrate off site and adversely impact the adjacent intertidal area and (2) if sediments have been impacted to the extent that cleanup is required.

Background

Cornet Bay is located at the north end of Whidbey Island which lies west of the mainland city of Mt. Vernon, Washington (Figure 1). Cornet Bay Marina, at 200 West Cornet Bay Road North, has existed since the 1960s. A wooden bulkhead about 250 feet long separates the upland area and store from the marina (Figure 2). The site is bound on the east by Cornet Bay Road and a mixture of residential and light commercial land uses. Depth to groundwater is approximately five feet, and groundwater flow is diagonally across the site toward the northwest. Upland soil is a mixture of clay, silt, sand, gravel, and some peat.

Four underground storage tanks were installed next to each other on the site in 1964. Combined, they had a total capacity for 18,000 gallons of gasoline and 3,000 gallons of diesel. There was a major release in 1989, allegedly from ruptured underground fuel lines, in which fuel inundated the groundwater and seeped into the bay along the bulkhead. Sheen was observed emanating from the bulkhead for up to a year after the release, and for several years from the northern-most area on the bulkhead. After the release the tanks were pumped dry, and in March 1990 they were all removed. At that time, the current compartmentalized tank (containing both gas and diesel) was installed in an underground concrete vault.

In 1995 Ecology installed three monitoring wells and also conducted 13 soil borings. The wells were sampled again in 2003, and ten geoprobe borings for soil and groundwater were completed. The 2003 data indicate that since 1996 contaminant levels have attenuated in the well in the center of the site (MW-3), but have significantly increased in the well at the north end of the site (MW-2). This well is downgradient of the location of the current and historical underground storage tanks. The range of detected values for water samples from the site appear in Table 1.

Soil contaminant levels found in 2003 are generally about the same as those found in 1996, and do not appear to be attenuating over time. Significant soil and groundwater contamination was discovered in the 2003 geoprobe borings in the southern part of the site. This is an area that is upgradient from known sources of contamination on the property, and had not previously been investigated. The range of detected values for all soil samples at the site are in Table 2. Intertidal sediments have never been evaluated for petroleum contamination.

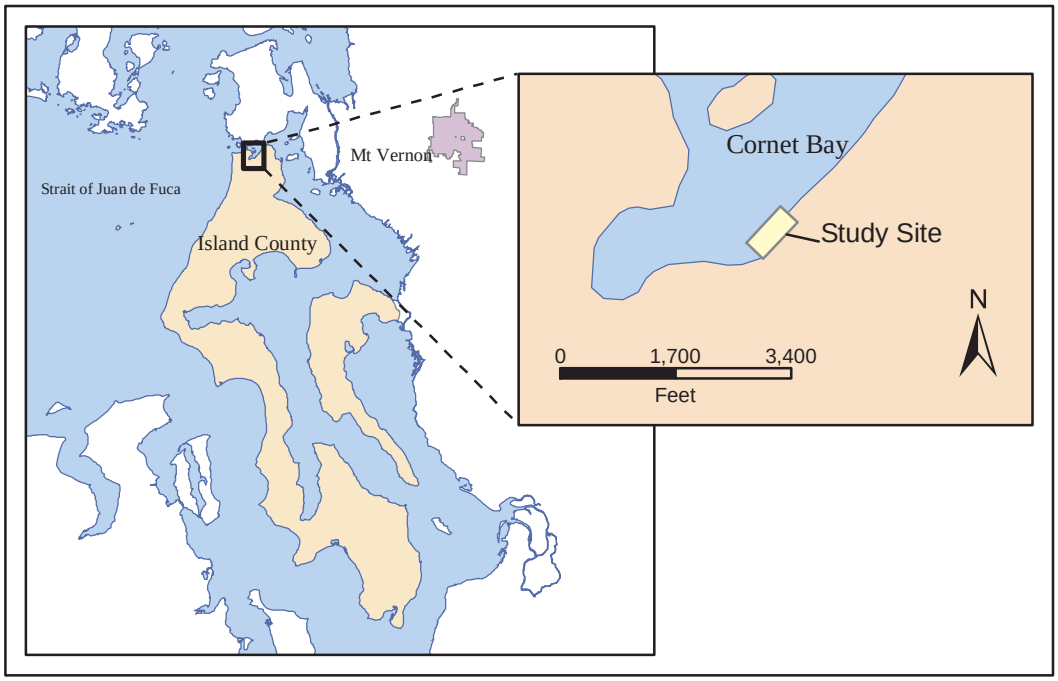

Figure 1. Location of Cornet Bay and study site.

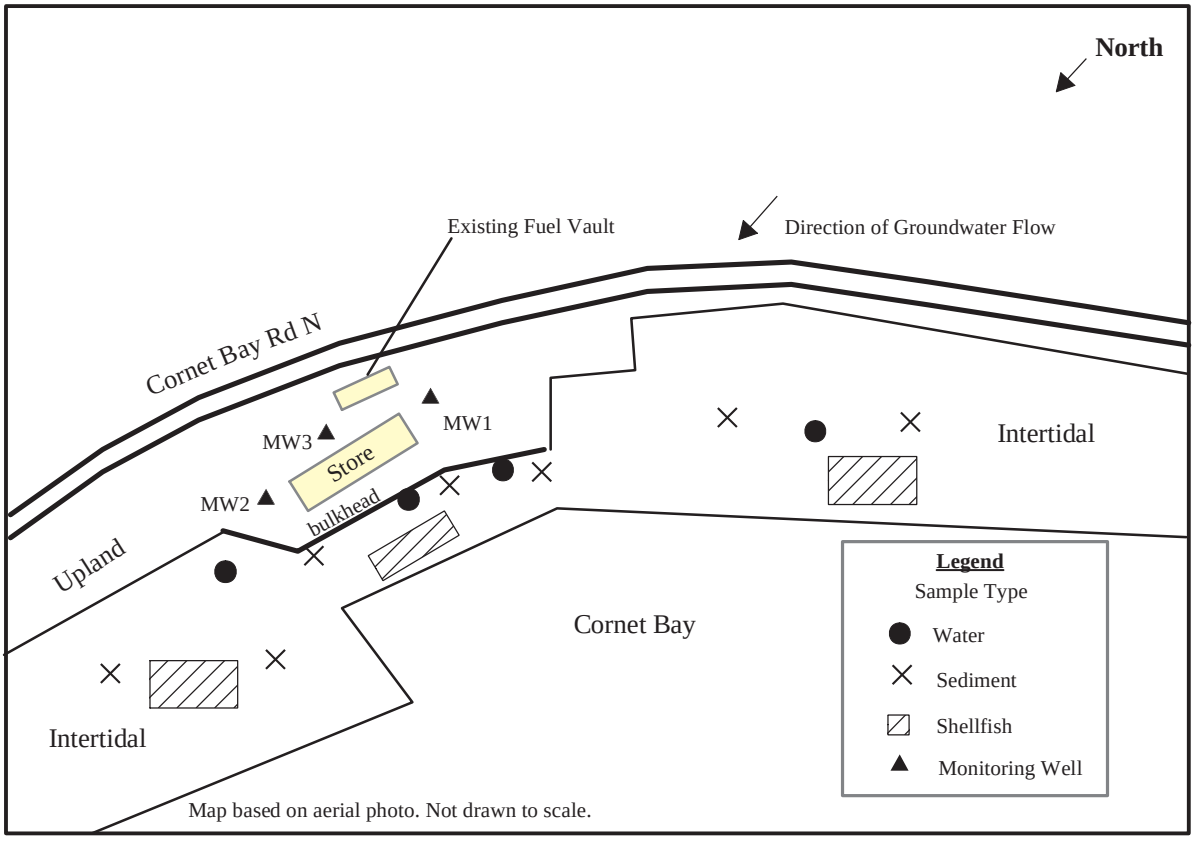

Figure 2. Study site, proposed sediment, tissue, and water sampling stations.

Table 1. Range of detected values for water samples at Cornet Bay Marina, 1995, 1996, and 2003.

Parameter	Monitoring Wells		Groundwater from Geoprobe Borings		Surface Water	
	1996 (ug/L)	2003 (ug/L)	1995 (ug/L)	2003 (ug/L)	1995 (ug/L)	2003
Benzene	8500-16400	185-9000	1700-4200	2.39 - 803	nd	---
Toluene	23-130	4.63	510-1000	2.04 - 781	nd	---
Ethylbenzene	170-1300	86.7-354	1800-2400	3.13 - 613	nd	---
Xylene	98-3400	29.4	7600-10400	10.3 - 2210	nd	---
Methyl Tertiary Butyl Ether	---	3.91	---	2.04 - 37.6	---	---
Gasoline Range Organics	1900-24000	1170 - 21300	41000-130000	689 - 40700	860	---
Diesel Range Organics	98000	294 - 127000	2800-65000	343 - 4570	1400	---
Heavy Oils	---	nd	---	758	---	---
Lead	2.2-9.9	---	32-134	---	---	---

--- - not analyzed for
nd - not detected

Table 2. Range of detected values for soil samples at Cornet Bay Marina, 1995 and 2003.

Parameter	Soil from Geoprobe Borings	
	1995 (mg/Kg, dw)	2003 (mg/Kg, dw)
Benzene	0.347 - 35.5	0.0668 - 10.7
Toluene	0.029 - 55 E	0.0612 - 202
Ethylbenzene	.066 - 44.9	0.100 - 47.6
Xylene	0.049 - 208 E	0.239 - 219
Methyl Tertiary Butyl Ether	---	nd
Gasoline Range Organics	11 - 4900	7.67 - 5310
Diesel Range Organics	48 - 7400	13.4 - 7050
Heavy Oils	---	27.6 - 54.9
Lead	2 - 7	---

--- - not analyzed for
E - estimate because reported value exceeds calibration
nd - not detected

Project Description

The primary goal of this project is to conduct an evaluation of the nearshore intertidal area to determine if upland contamination presents a significant ongoing source of petroleum products. This will be accomplished by collecting and analyzing intertidal sediments, shellfish, surface water, bank seepage, and groundwater. The data collected will be used by the Washington State Department of Ecology (Ecology) Toxics Cleanup Program (TCP) to determine the need to include remediation and/or institutional controls of sediments in the total site cleanup.

The objectives of the study are to:

- Determine if ongoing migration of contaminants into intertidal areas of Cornet Bay is occurring.
- Evaluate the significance of intertidal contaminant levels present by comparing them to applicable environmental and human health standards.

The contaminant concentrations in the surface sediments will be compared to Ecology's Sediment Management Standards (SMS), Sediment Quality Standards (SQS), and Cleanup Screening Levels (CSLs). Results from groundwater and seeps will be compared to MTCA Method A Cleanup Levels for Groundwater listed in WAC 173-340-900 Table 720-1 (Table 3).

Study results will be evaluated by Ecology's Northwest Regional Office sediment specialist and site manager to determine the need for remediation of contaminated sediments adjacent to the marina. If contaminant concentrations are above the SQS or CSL, the site manager could request confirmatory biological testing be conducted in a future assessment, by use of sediment bioassay in accordance with the SMS. If contaminant levels are found above the CSL, design of a remedial action plan would be necessary.

Shellfish will be collected and analyzed for PAH contamination. The results will be compared to 303(d) edible tissue criteria and made available to the Washington State Department of Health (Table 3).

Table 3. Chemical criteria for sediments, water, and tissue.

Chemical Parameter	Sediment Management Standards[f]		MTCA [e] groundwater (ug/L)	303(d) Edible Tissue Criteria [g] (ug/Kg) ww
	SQS	CSL		
Metals (mg/Kg, dw)				
Lead	450	530	15	----
Total Petroleum Hydrocarbons				
TPH-Gx	----	----	800-1000	----
TPH-Dx	----	----	500	----
Nonionizable Organic Compounds (Polynuclear Aromatic Hydrocarbons) (mg/Kg, organic carbon[a])				
Total LPAH[b]	370	780	----	----
Naphthalene	99	170	160	----
Acenaphthylene	66	66	----	----
Acenaphthene	16	57	----	----
Fluorene	23	79	----	420,000
Phenanthrene	100	480	----	----
Anthracene	220	1200	----	3,300,000
2-Methylnaphthalene	38	64	----	----
Total HPAH[c]	960	5300	----	----
Fluoranthene	160	1200	----	425,500
Pyrene	1000	1400	----	330,000
Benz[a]anthracene	110	270	----	0.93
Chrysene	110	460	----	0.93
Total benzofluoranthenes[d]	230	450	----	0.93[d]
Benzo[a]pyrene	99	210	0.1	0.93
Indeno[1,2,3-c,d]pyrene	34	88	----	0.93
Dibenzo[a,h]anthracene	12	33	----	0.93
Benzo[g,h,i]perylene	31	78	----	----
Volatile Monoaromatic Hydrocarbons				
Benzene	----	----	5	na
Toluene	----	----	1000	na
Ethylbenzene	----	----	700	na
Xylene	----	----	1000	na

na Not analyzed

-- No numerical criteria of this type exists for this chemical.

a The listed values represent concentrations in ppm "normalized" on a total organic carbon (TOC) basis. To normalize to TOC, the dry-weight concentration for each parameter is divided by the decimal fraction representing the percent TOC content of the sediment.

b The total LPAH criteria represents the sum of the concentrations of the following compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. 2-Methylnaphthalene is not included in the LPAH definition under the SMS. The total LPAH criterion is not the sum of the corresponding criteria listed for the individual LPAH compounds.

c The total HPAH criteria represents the sum of the concentrations of the following compounds: fluoranthene, pyrene, benzo[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, and benzo[g,h,i]perylene. The total HPAH criteria is not the sum of the corresponding criteria listed for the individual HPAH compounds.

d Criterion represents the sum of the concentrations of the b, j, and k isomers of benzofluoranthene.

e Model Toxics Control Act (Method A) Tables (WAC 173-340)

f Sediment Sampling and Analysis Plan Appendix (WAC 173-204)

g National Toxics Rule, U.S. Environmental Protection Agency

Organization and Schedule

Responsibilities

The following Ecology staff will be involved in this project:

Toxics Cleanup Program, Northwest Regional Office

Roger Nye: Site manager, client, and staff contact. Reviews the Quality Assurance (QA) Project Plan and draft study report, and coordinates with the study site owners. (425-649-7251).

Grant Yang: Sediment specialist. Reviews the QA Project Plan and draft study report. (425-649-7126).

Environmental Assessment Program, Headquarters

Kristin Kinney: Project manager. Develops the project objectives, scope, and study design. Manages project, prepares the QA Project Plan, conducts field sampling, writes the study findings, and enters project data into the EIM database system. (360-407-7168).

Dale Norton: Supervisor, Toxics Studies Unit. Reviews the QA Project Plan and draft study report and provides field assistance. (360-407-6765).

Pam Marti: Hydrogeologist 3, Watershed Ecology Section. Provides groundwater sampling support. (360-407-6768).

Will Kendra: Section manager, Watershed Ecology Section. Reviews the QA Project Plan and draft study report. (360-407-6698).

Cliff Kirchmer: Quality Assurance Officer. Reviews the QA Project Plan and is available for technical assistance on QA during implementation and assessment. (360-407-6455).

Stuart Magoon and Manchester Environmental Laboratory Personnel: Reviews the QA Project Plan pertaining to laboratory analyses and analyzes/reports project data to the principal investigator. (360-871-8801).

Schedule

Preparation and approval of QA Project Plan	April 2005
Field Sample Collection	April 27-29, 2005
Laboratory Analysis Complete	May 2005
Draft Report	August 2005
Final Report	September 2005
EIM Data Entry	September 2005

Quality Objectives

Measurement quality objectives (MQOs) for this study are shown in Table 4. The MQOs for this project are listed below in terms of maximum acceptable error and were taken from Ecology's guidance document to meet requirements of the Sediment Management Standards (Ecology, 2003) and Manchester Environmental Laboratory Lab User's Manual (MEL, 2003).

Sampling bias should be low by use of standardized procedures for sampling, preservation, transportation, and storage. Precision and bias routinely achieved by the proposed analysis methods for target analytes will be acceptable for this project.

Table 4. Measurement quality objectives for the Cornet Bay investigation.

Analysis	Check Standards (LCS) and Surrogates[1]	Replicate Samples	Matrix Spikes	Matrix Spike Duplicates	Lowest Concentrations of Interest
	% recovery limits	RPD[2]	% recovery limits	RPD	
Sediment					
BTEX	70-130%	50%	25-150%	35%	50 *u*g/Kg
TPH-G	70-130%	50%	25-150%	35%	20 mg/Kg
TPH-D	50-150%	50%	25-150%	35%	25 mg/kg
PAH	50-150%	50%	50-150%	40%	10-20 *u*g/Kg
Lead	85-115%	20%	75-125%	20%	0.10 mg/Kg
Hydrocarbon ID	NA	NA	NA	NA	20-100 mg/Kg
Percent Solids	NA	20%[3]	NA	NA	0.10%
Grain Size	NA	20%[3]	NA	NA	0.10% per fraction
TOC	80-120%	20%[3]	NA	NA	0.1%
Water					
BTEX	50-150%	50%	50-150%	50%	1 *u*g/L
TPH-G	50-150%	50%	50-150%	50%	0.14 mg/L
TPH-D	50-150%	50%	50-150%	50%	0.25 mg/L
Hydrocarbon ID	NA	NA	NA	NA	0.25-0.63 mg/L
PAH's	50-150%	50%	50-150%	50%	0.08 ug/L
Lead	85-115%	20%	75-125%	20%	0.10 *u*g/L
pH[4]	±0.2 pH units	±0.1 pH units	NA	NA	NA
Conductivity[4]	±10 *u*mhos/cm	10%	NA	NA	NA
Temperature[4]	±0.2°C	5%	NA	NA	NA
Tissue					
PAH's	50-150%	50%	50-150%	50%	0.8 ug/Kg
% lipids	NA	20%	NA	NA	0.10%

[1]- Surrogates for NWTPH-Gx, NWTPH-Dx, BTEX, and PAHs, as per Manchester Laboratory Standard Operating Procedure

[2]- Relative percent difference

[3]- RSD (relative standard deviation) is used for parameters using triplicate analysis.

[4]- pH, conductivity, and temperature are measured in the field. Accuracy is ensured by pre- and post-calibration and standard checks.

NA- Not applicable

Sampling Design

Sediment, surface water, groundwater, and shellfish sample locations are shown in Figure 2. Locations were chosen to bracket the site and concentrate on the bulkhead area. Water samples will be collected from seeps as available. Clams will be collected from approximately 100-foot stretches in three sample locations.

The hydrocarbon identification and chemical data gathered from the wells and seeps will be compared to determine if the source of contamination in the seeps is coming directly from the groundwater. The sediment samples will be used to evaluate possible contamination of the intertidal sediments. Shellfish data will provide an indication of nearshore contamination, as they integrate contaminants over time. The shellfish data also will be useful to the Washington State Department of Health for determining the need for consumption advisories.

Sediment samples will be analyzed for total petroleum hydrocarbons (NWTPH-GX and NWTPH-DX), benzene, toluene, ethylbenzene, xylene (BTEX), polynuclear aromatic hydrocarbons (PAHs), lead, hydrocarbon ID (HCID), percent solids, grain size, and total organic carbon (TOC). Surface water samples will be analyzed for NWTPH-GX, NWTPH-DX, BTEX, PAHs, HCID, and lead, but with the addition of pH, conductivity, and temperature field measurements. Groundwater will be analyzed for TPH-Gx, TPH-Dx, BTEX, and HCID. Field measurements also will be made for pH and conductivity in groundwater. Tissue samples will be analyzed for PAHs and percent lipids.

Sampling Procedures

Sediments

To the extent possible, sediment collection methods will follow PSEP (1996) protocols and requirements of Ecology's Sediment Management Standards (Chapter 173-204 WAC; Ecology, 2003). Sediments will be collected once at seven stations. At each sampling location, sediments to a depth of 10cm will be transferred to a pre-cleaned mixing bowl using a stainless steel spoon. The top 10cm represents the biologically active zone (Ecology, 2003). In order to minimize volatilization, samples for TPH-Gx, TPH-Dx, and BTEX will be immediately placed into their respective sample containers before being placed in the bowl. The sediment in the bowl will be homogenized, and subsamples of the homogenate for grain size, percent solids, TOC, HCID, lead, and PAHs will be placed in appropriate sample containers as listed in Table 5. All sediment samples from each station will be placed in ziplock bags, put into coolers with ice, and taken to Ecology headquarters where they will be stored at 4° C until being transported to Manchester Laboratory the next day.

Sample containers will be cleaned to EPA (1990) QA/QC specifications and certified for trace organic analyses. Stainless steel spoons and mixing bowls will be precleaned with Liquinox® detergent, followed by sequential rinses with tap water, 10% nitric acid, deionized water, acetone, and hexane. All equipment will be air-dried and then individually wrapped completely in foil.

Water

Surface water grab samples for NWTPH-GX, NWTPH-DX, PAHs, BTEX, HCID, and lead analysis will be collected from seeps as available. Temperature, pH, and conductivity will be measured at the time of sampling, and flow will be estimated. Recommended collection containers, preservation, and holding times are listed in Table 5. Temperature and pH will be measured using an Orion Model 250 temperature-compensating pH meter. Conductivity will be measured using a Beckman conductivity meter. Exact sample location coordinates will be determined in the field by using a hand-held Magellan GPS 320 global positioning system.

Immediately after collection, sample containers from each station will be sealed in ziplock plastic bags and placed in a cooler filled with ice. Samples will be transported to Ecology headquarters, stored at 4° C, and then taken to Manchester Laboratory the next day. Chain-of-custody will be maintained throughout the process.

Table 5. Sample containers, preservation, and holding times.

Parameter	Sample Container	Preservation	Holding Time
Sediment			
BTEX & NWTPH-Gx	(2) 2 oz septa jars, per field station	Cool to 4° C	14 days[1]
NWTPH-Dx	4 oz glass jar	Cool to 4° C	14 days
PAH's	8 oz glass jar	Cool to 4° C	14 days
Lead	4 oz glass jar	Cool to 4° C	6 months
Hydrocarbon ID	8 oz glass jar	Cool to 4° C	14 days until extraction
% Solids	2 oz glass jar	Cool to 4° C	7 days
Grain Size	8 oz plastic jar	Cool to 4° C	6 months
TOC	2 oz glass jar	Cool to 4° C	14 days
Water			
BTEX & NWTPH-Gx	(3) 40 mL VOA vials w/ septum, per field station	1:1 HCl pH<2, Cool to 4° C	14 days if preserved with HCl
NWTPH-Dx	1 gal glass jar	Cool to 4° C	14 days
PAH	1 gal glass jar	Cool to 4° C	7 days
Lead	500 mL HDPE bottle	HNO3 to pH < 2 (by lab within 24 hours of arrival)	6 months
Hydrocarbon ID	1 gal glass jar	Cool to 4° C	7 days until extraction
Tissue			
PAH	8 oz glass jar	Cool to 4° C	14 days *
Lipids	8 oz glass jar	Freeze	NA

*Frozen tissue can be held for one year, at -18°C or lower, before analysis per PSEP Guidelines.
[1] – Samples must be delivered to lab within 48 hours

Groundwater

Prior to sampling the three monitoring wells, static water levels will be measured using a commercial electric probe. Measurements will be recorded to 0.01 feet and will be accurate to 0.03 feet. The probe will be rinsed with deionized water and wiped clean between measurements. The monitoring wells will be purged and sampled using a Grundfos Redi-Flo2 stainless steel submersible pump with dedicated tubing. The pump intake will be placed at the middle of the screened interval in each monitoring well and purged at a pump rate of 0.5 to 1-liter/minute. Wells will be purged through a continuous flow cell until pH, conductivity, and temperature readings stabilize or a minimum of three well volumes have been purged. Purge water from the wells will be stored on-site in a 55-gallon drum. This waste will be transported and disposed of in accordance with State of Washington regulations (Chapter 173-340-400 WAC).

Samples will be collected from the monitoring wells directly from the pump discharge line after purging. Samples from each well will be placed into appropriate containers, as listed in Table 5, sealed in ziplock bags, and placed on ice for transport to Ecology headquarters. Field

measurements will be made for pH and conductivity. The pump will be decontaminated between each well by circulating laboratory grade detergent/water through the pump followed by a tap water rinse, with each cycle lasting five minutes.

Tissue

Clam sampling and sample preparation procedures are based on unpublished guidelines prepared by Glen Patrick, Office of Toxic Substances, Washington State Department of Health (Johnson, 1997). These are modifications of procedures used for the Puget Sound Ambient Monitoring Program shellfish monitoring. The target organism will be clams; however, the species selected will be the one of greatest abundance at the site based on initial digs. Shellfish samples will be collected during the lowest tide from individual digs within a 100-foot stretch of beach. On April 27 the lowest portion of the tidal cycle (-2.3) occurs at 2:11 p.m.

Shellfish will be collected at three sites. One composite sample for each site will be collected, consisting of 30 clams per composite. They will be dug using clean rakes or shovels, uncontaminated with grease or oil, placed into a precleaned stainless steel bucket, and rinsed thoroughly with seawater to remove adhering mud and sand. Clams will not be allowed to depurate. Rakes, shovels, buckets, and gloves will be washed with seawater between sampling sites. Only legal size, unbroken clams will be retained for analysis. Each composite will consist of an equal number (approximately 10) of small, medium, and large individuals. The selected clams for each composite will be placed in one-gallon glass jars with teflon lid-liners, cleaned to EPA specifications.

Each jar will be labeled with the date and location of collection, wrapped in bubble-wrap to avoid breakage, and placed in coolers containing ice. The samples will be transported to the Ecology headquarters chain-of–custody room within one day of collection, where they will be frozen at -18°C until being processed in the headquarters laboratory.

In the laboratory, only non-corrosive stainless steel instruments will be used, non-talc polyethylene gloves will be worn, and the work done on aluminum foil. Gloves and foil will be changed between samples. Cleaning of resecting instruments and blender parts will be done by washing in tap water with Liquinox® detergent, followed by sequential rinses with tap water, de-ionized water, pesticide-grade acetone, and hexane. The items will be air dried on aluminum foil in a fume hood before use.

The range of clamshell widths for the organisms included in each composite will be recorded to the nearest millimeter. After rinsing the shellfish with tap water and de-ionized water to remove any remaining debris, the entire soft parts will be removed and homogenized to uniform color and consistency in a plastic and stainless steel Kitchen-Aid blender. Subsamples of the homogenates will be split into appropriate samples containers (as shown in Table 5), refrozen, and sent to Manchester Laboratory.

Laboratory Procedures

All project samples will be analyzed at Manchester Laboratory or a contractor arranged by the Manchester Laboratory. A summary of laboratory methods for project samples appears in Table 6.

Table 6. Analytical methods and reporting limits for the Cornet Bay investigation.

Analytes	Preparation Method	Method	Reference	Reporting Limit
Sediment				
BTEX		EPA SW-846 Method 8260	EPA 1996	50 µg/Kg
TPH-G		NWTPH-Gx	Ecology 1997	20 mg/Kg
TPH-D		NWTPH-Dx	Ecology 1998	25 mg/kg
PAHs	EPA 3540C	EPA 8270C*	EPA 1996	10-20 ug/Kg
Lead	EPA 3050B	EPA 6020	EPA 1996	0.10 ug/Kg
Hydrocarbon ID		HCID[1]	Ecology 1997	----
% Solids		EPA 160.3	EPA 1996	0.10%
Grain Size		Plumb 1981	EPA/CE81-1	1%
TOC		Combustion/ CO_2 Measurement @ 70 °C	PSEP 1997	0.10%
Water				
BTEX		EPA SW-846 Method 8021B	EPA 1996	1 µg/L
TPH-G		NWTPH-Gx	Ecology 1997	0.12 mg/L
TPH-D		NWTPH-Dx	Ecology 1998	0.1 mg/L
Hydrocarbon ID			Ecology 1997	0.25-0.63 mg/L
PAHs	EPA 3510	SW 8270C*	EPA 1996	0.067 ug/L
Lead	EPA 200.8	EPA 200.8	EPA 1997	0.1 ug/L
Tissue				
PAHs		NOAA 130.31		0.8 ug/Kg
% lipids		EPA 608.5		± 0.1%

* as modified by Manchester Laboratory using isotope dilution

[1] – Manchester Laboratory method, Ecology 1997

Budget Information

Price estimates include field QA samples and are based on a 50% discount rate for analysis at Manchester Laboratory.

Table 7. Estimated costs for analyzing Cornet Bay sediment, water, and tissue samples.

Parameter	Stations	QC Samples		Total	Cost per Unit	Contracting Fee	Total
Sediment							
BTEX & TPH-Gx	7	1		8	$140	----	$1,120
TPH-Dx	7	1		8	$135	----	$1,080
PAH	7	3	[1]	10	$304	----	$3,040
Lead	7	2	[3]	9	$42	----	$378
Hydrocarbon ID	7	0		7	$88	----	$616
Percent Solids	7	1		8	$10	----	$80
Grain Size	7	1		8	$100	$225	$1,025
TOC	7	1		8	$39	----	$312
						Sediment Subtotal	$7,651
Water							
BTEX & TPH-Gx	4	2	[2]	6	$100	----	$600
TPH-Dx	4	1		5	$125	----	$625
Hydrocarbon ID	4	0		4	$75	----	$300
PAHs	4	3	[1]	7	$200	----	$1,400
Lead	4	1		5	$35	----	$175
pH	4	1		5	NA	----	----
Conductivity	4	1		5	NA	----	----
Temperature	4	1		5	NA	----	----
						Water Subtotal	$3,100
Well Water							
pH	3	0		3	NA	----	----
Conductivity	3	0		3	NA	----	----
HCID	3	0		3	$75	----	$225
BTEX & TPH-Gx	3	1	[2]	4	$100	----	$400
TPH-Dx	3	1	[2]	4	$125	----	$500
						Well Water Subtotal	$1125
Tissue							
PAHs	3	3	[1]	6	$358	----	$2,148
% lipids	3	1		4	$31	----	$124
						Tissue Subtotal	$2,272
						PROJECT TOTAL	$14,148

[1] – Includes matrix spike, matrix spike duplicate [2] – Includes blank (sampling or transfer) [3] – Includes matrix spike

Quality Control Procedures

Field

Analysis of duplicate field samples provides an estimate of the overall variability of analysis. Field quality control (QC) will entail collection and analysis of duplicate samples and duplicate meter measurements. A complete set of duplicate samples for surface water will be collected from one of the sampling locations by filling two sets of sample containers sequentially. A complete set of sediment and tissue duplicate samples will be taken by splitting a single homogenized sample into two separate samples (duplicate split). Relative percent difference (RPD) will be calculated from the results of duplicate pairs as an estimate of the overall variability of each analysis.

One transfer blank and one sampling blank will be supplied by Manchester Laboratory. Water in the transfer blank will be poured into a receiving jar while in the field, and will be analyzed for BTEX and TPH-Gx. The sampling blank will be run through the submersible pump and then transferred to the receiving jar. The sampling blank will be analyzed for BTEX, TPH-Gx, and TPH-Dx. The blanks will be taken to and from the field along with the other study sample containers and will be treated as other study samples. Results from the blanks may indicate contamination from the sample containers, cross-contamination during shipment, surroundings, or sampling equipment (MEL, 2001).

Field meters will be calibrated at the start of the sample day according to the manufacturer's instructions. Duplicate field measurements will be taken once during the sample day for temperature, pH, and conductivity to estimate precision. A check standard will also be measured once during the sample day for pH and conductivity to evaluate accuracy. All sampling equipment will be cleaned prior to going into the field according to protocols (see Field Procedures).

Laboratory

Quality control procedures should conform to requirements provided by Manchester Laboratory (MEL, 2001) and the Ecology Sediment Management Unit (Ecology, 2003). The routine laboratory quality control procedures will be adequate to allow estimates of laboratory precision and accuracy for the study. The laboratory does the following types of quality control analyses: blanks, check standards (LCS), surrogates, duplicate samples, matrix spikes, and matrix spike duplicates (MEL, 2003).

Laboratory duplicate and triplicate analysis will be used to estimate analytical precision. Matrix spikes will be used as an indicator of bias due to matrix interference for PAH samples, while laboratory control samples will be used as an indicator of bias due to calibration. Laboratory blanks are analyzed to determine the analytical response at zero concentration of the analyte and whether there may be any contamination affecting the blanks and samples. Manchester Laboratory's Quality Assurance Manual (MEL, 2001) provides a detailed discussion of the quality control samples and procedures.

Information on the quality control requirements to meet Sediment Management Standards (Chapter 173-204 WAC) for related organic, metals, and conventional analyses can be found in Ecology (2003), Tables 11-13. Guidance on control limits and performance standards are provided. The required quality control samples to meet Sediment Management Standards for lead and conventional analyses are listed in Table 8.

Table 8. Quality control samples.

Parameter	Laboratory Blanks	Laboratory Duplicates	Laboratory Control Samples	Matrix Spikes
Lead	1/batch	1/batch	-	1/batch
Percent Solids	-	1 triplicate	-	-
Grain Size	-	1 triplicate	-	-
TOC	1/batch	1 triplicate	-	-

Data Management Procedures

Manchester Laboratory and any contract laboratories will be required to submit results electronically in a form suitable for entry into Ecology's Environmental Information Management (EIM) database. All data will be entered into EIM according to the *Organization and Schedule* section above. Results shall include a case narrative discussing any problems with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. The laboratory data package should also include all quality control results associated with the data including results for all blanks, surrogate compounds, and check standards included in the sample batch, as well as results for analytical duplicates and matrix spikes prepared from the samples.

Audits and Reports

Manchester Laboratory conducts performance and system audits for routine analytical procedures. Results of these audits can be obtained by request. Any Manchester Laboratory contract laboratory conducting analysis must be accredited by Ecology's Laboratory Accreditation Section. As part of the accreditation process, performance and system audits are included.

A draft study report will be completed in August 2005. The draft report of study findings will include the following, at a minimum:

- A study area map showing the sampling sites.
- Latitude and longitude and other information describing the sampling sites.
- Descriptions of field and laboratory methods.
- A data quality synopsis and discussion of the significance of any analytical problems.
- Summary tables of chemical and biological data.
- An evaluation of significant findings.
- A comparison to applicable environmental quality guidelines.

A final report will be prepared in September 2005. Following a final peer review, project data will be entered into the Ecology EIM database. Electronic versions of the final report or data will be available to the public through Ecology's internet site at: http:\\www.ecy.wa.gov.

Data Verification and Validation

Manchester Laboratory will review the Quality Assurance (QA) Project Plan as well as all sample and quality control data. Manchester Laboratory is responsible for verifying the data and providing a verification report (results and case narrative), and the project lead is responsible for validating the data. Manchester Laboratory reviews will be sent to the project lead in the form of case narratives and will include an assessment of the laboratories' performance in meeting the conditions and requirements set forth in this sampling plan. On receipt of the data, the project lead will review the results for completeness and reasonableness as well as to determine whether the MQOs have been met.

Data validation involves detailed examination of the complete data package using professional judgment to determine whether the procedures in the methods, standard operating procedures, and QA Project Plan were followed. The data from the laboratory's quality control procedures and duplicate field samples will provide information to determine if MQOs have been met. A data validation report will be prepared and included or referenced in the final project report.

Data Quality Assessment

After the project data have been reviewed, verified, and validated, the project lead will determine if the data are of sufficient quality and quantity to make decisions for which the study was designed. Laboratory and quality assurance staff familiar with assessment of data quality may be consulted. The final report will discuss data quality and whether the project objectives have been met. If limitations in the data are identified, they will be noted. Study results will be evaluated by Ecology's Northwest Regional Office sediment specialist and site manager to determine the need for remediation of contaminated sediments adjacent to the marina.

References

Ecology, 1997. *Analytical Methods for Petroleum Hydrocarbons.* Washington State Department of Ecology, Olympia, WA. Publication No. 97-602. www.ecy.wa.gov/biblio/97602.html.

Ecology, 2003. *Sediment Sampling and Analysis Plan Appendix – Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards (Chapter 173-204 WAC).* Publication No. 03-09-043. www.ecy.wa.gov/biblio/0309043.html. Revised April 2003.

Ecology, 2004. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies.* Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-030. www.ecy.wa.gov/biblio/0403030.html.

EPA, 1990. *Specifications and Guidance for Obtaining Contaminant-Free Sample Containers.* U.S. Environmental Protection Agency. OSWER Directive #93240.0-05.

EPA, 1996. SW-846 On-line. Method 8021B. Method 6010B. Method 8270C. Method 3540C. U.S. Environmental Protection Agency.
www.epa.gov/epaoswer/hazwaste/test/pdfs/8021b.pdf.
www.epa.gov/epaoswer/hazwaste/test/pdfs/6010b.pdf.
www.epa.gov/epaoswer/hazwaste/test/pdfs/8270c.pdf.
www.epa.gov/epaoswer/hazwaste/test/pdfs/3540c.pdf.

Johnson, A., 1997. *Quality Assurance Project Plan: Chemical Contaminants in Clams and Sediments from Jackson Park and Vicinity, Dyes Inlet*. Washington State Department of. Ecology, Olympia, WA.

MEL, 2001. *Quality Assurance Manual*, Manchester Environmental Laboratory, Environmental Assessment Program, Washington State Department of Ecology, Manchester, WA.

MEL, 2003. *Manchester Environmental Laboratory Lab User's Manual, Seventh Edition*, Manchester Environmental Laboratory, Environmental Assessment Program, Washington State Department of Ecology, Manchester, WA.

Plumb, R.H., Jr., 1981. *Procedure for handling and chemical analysis of sediment and water samples.* Technical Report EPA/CE-81-1. U.S. Environmental Protection Agency and U.S. Corps of Engineers, Waterways Experimental Station, Vicksburg, MS.

PSEP, 1995. *Puget Sound Estuary Program (PSEP): Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments.* U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

PSEP, 1996. *Puget Sound Estuary Program (PSEP): Recommended Protocols for Measuring Selected Variables in Puget Sound.* U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

WAS, 1993. *Field Sampling and Measurement Protocols for the Watershed Assessments Section.* Washington State Department of Ecology, Olympia, WA. Publication No. 93-e04. www.ecy.wa.gov/biblio/93e04.html.