Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

QUALITY ASSURANCE PROJECT PLAN:
BENTHIC INVERTEBRATE SAMPLING OF THE LOWER DUWAMISH WATERWAY

ADDENDUM: ADDITIONAL CLAM SAMPLING IN BACKGROUND AREA
FINAL

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

August 1, 2005

Prepared by: Wind/Ward environmental LLC

200 West Mercer Street, Suite 401 ♦ Seattle, Washington ♦ 98119

Table of Contents

Acronyms

ACRONYM	Definition
COC	chain of custody
CPUE	catch per unit effort
CSCS	Confirmed and Suspected Contaminated Site
Ecology	Washington Department of Ecology
EPA	US Environmental Protection Agency
FC	field coordinator
GPS	global positioning system
LDW	Lower Duwamish Waterway
NAD	North American Datum
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
WGS	World Geodetic System
Windward	Windward Environmental LLC

1.0 Introduction

This addendum to the Benthic Invertebrate Sampling of the Lower Duwamish Waterway (LDW) quality assurance project plan (QAPP) (Windward 2004b) provides guidelines for additional collection and analysis of clam tissue samples and co-located sediment samples from a background area not previously sampled in 2004. This work is being performed to target the eastern soft-shell clam *(Mya arenaria),* which was not found during previous sampling in background areas, but was the most common clam species found in the LDW (Windward 2004b). The clams collected from the additional background locations will be analyzed for total and inorganic arsenic. These results will then be compared to total and inorganic arsenic concentrations in clams collected from the LDW and other background areas sampled in 2004 (Windward 2005).

Data from this study will be used to support the ecological and human health risk assessments for Phase 2 of the LDW Remedial Investigation (RI), as described in the Phase 2 RI work plan (Windward 2004d). This benthic invertebrate QAPP addendum addresses details that are specific to the background sampling activities. The original QAPP is referenced, as appropriate, for details that remain unchanged from the original sampling design.

This addendum is organized into the following sections:

- Section 2 – project management
- Section 3 – study design
- Section 4 – assessment and oversight
- Section 5 – data validation and usability
- Section 6 – references

This addendum contains two appendices, Health and Safety Plan and Field Forms, Appendix A and B, respectively. The health and safety plan presented as Appendix A of the original QAPP (Windward 2004b) will be followed during sampling. An addendum to that health and safety plan is included as Appendix A of this document.

2.0 Project Management

This section describes the overall management of the project, including key personnel, project description, and problem definition/background. Details regarding quality objectives and criteria, special training requirements and certification, and documents and record keeping can be found in the original QAPP, Sections 2.4 through 2.6 (Windward 2004b).

2.1 PROJECT ORGANIZATION AND TEAM MEMBER RESPONSIBILITIES

This sampling effort will be performed by Windward, with assistance from King County field biologist, Kevin Li. Overall project organization and responsibilities of project team members, as well as those of the laboratory project manager, are described in Section 2.1 of the original QAPP (Windward 2004b). Angelita Rodriquez will serve as the field coordinator (FC) for this background clam sampling effort. Marina Mitchell will serve as QA/QC coordinator. Brooks Rand LLC will perform the chemical analyses on clams and co-located sediment, for consistency with the analyses performed on clams collected from the LDW and background areas in 2004. The FC, QA/QC coordinator, and laboratory manager for this sampling and analysis effort are different from those specified in the original QAPP. The contact information for these individuals is given below.

Angelita Rodriquez (Field Coordinator)
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.285.4400
Facsimile: 206.217.0089
Email: angelitar@windwardenv.com

Marina Mitchell (QA/QC Coordinator)
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1295
Facsimile: 206.217.0089
Email: marinam@windwardenv.com

Elizabeth Madonick (Laboratory Manager)
Brooks Rand LLC
3958 6th Avenue NW
Seattle, WA 98107
Telephone: 206.632.3020
Facsimile: 206.632.6017
Email: elizabeth@brooksrand.com

See the original QAPP (Windward 2004b) for additional details on project organization and team member responsibilities that remain unchanged from the original QAPP.

2.2 PROBLEM DEFINITION/BACKGROUND

The benthic invertebrate QAPP (Windward 2004b) described the rationale and methods for the collection and analysis of clams and co-located surface sediment samples in the LDW. Appendix E of the fish and crab tissue QAPP (Windward 2004c) described the rationale for collection of clam tissue from background areas for analysis

of arsenic. LDW clams were analyzed for multiple chemicals of potential concern; clams from background areas sampled in 2004 were analyzed only for total and inorganic arsenic to support the incremental risk assessment approach for arsenic.

All the clams collected in the LDW[1] that were analyzed for both total and inorganic arsenic were *M. arenaria*. In contrast, six clam species (*Saxidomus giganteus*, *Clinocardium nuttallii*, *Macoma nasuta*, *Macoma secta*, *Tresus capax*, and *Protothaca staminea)* were collected from the two background areas (Seahurst Park and Fay Bainbridge State Park). *M. arenaria* were not found in those two background areas. Inorganic arsenic concentrations in LDW clams were a much higher fraction of the total arsenic concentrations compared to data from the technical literature, other Puget Sound sites, and the two background sampling locations, sampled in 2004 (Windward 2005). In comments on the results of the initial sampling event, the U.S. Environmental Protection Agency (EPA) stated their concern that inorganic arsenic concentrations can vary widely among different shellfish species, and that such species differences confound comparison of inorganic arsenic concentrations in clams from the LDW with clams from background areas. To address EPA's concern, LDWG will conduct additional clam tissue collection in background areas, targeting *M. arenaria* only. This QAPP addendum describes the collection and analysis of *M. arenaria* from two additional background areas: Nisqually Reach, an area influenced by the Tacoma Asarco smelter and Dungeness, an area not influenced by the smelter.

2.3 PROJECT/TASK DESCRIPTION AND SCHEDULE

Windward will lead the field effort and will be accompanied by Kevin Li, a field biologist with King County, who will provide local knowledge for harvesting the eastern soft-shell clam during the sampling effort at Nisqually. This fieldwork is tentatively scheduled for the week of August 2, 2005. Nisqually Reach (smelter influenced site) and Dungeness (a non-smelter influenced site) are the two background sampling locations that will be sampled for clam tissue and sediment. If an insufficient number of *M. arenaria* are collected in the Nisqually area (see Section 3.1), then the field crew may elect to return to the Nisqually area for one or more additional days (August 3, 4, or 5) if there are other areas within the Nisqually reach where *M. arenaria* can be found in sufficient numbers, but that could not be sampled on August 2 because of time constraints. Dungeness will be sampled August 4, 2005 to collect the required background samples. If insufficient number of *M. arenaria* are collected at Dungeness, then one or more alternative target areas may be sampled on August 5, 2005. The maximum level of effort for this sampling is four days (August 2-5), although sampling is only feasible for approximately 3 hours (centered around the low tide) each day.

[1] Three composite clam samples from the LDW also contained a few *Macoma nasuta*, but these were not analyzed for inorganic arsenic.

Chemical analyses of these clam and co-located sediment samples, described in Section 3.1, are scheduled to be completed by the end of August 2005. A draft report presenting the results will be submitted to EPA and the Washington Department of Ecology (Ecology) four weeks after data validation is completed, or approximately October 28, 2005.

2.4 SPECIAL TRAINING/ CERTIFICATION

A scientific collection permit will be obtained from the Washington Department of Fish and Wildlife prior to sampling. Training for personnel participating in sample collection can be found in the original QAPP (Windward 2004b).

2.5 DOCUMENTATION AND RECORDS

Procedures for documenting field observations, laboratory records, and data reduction can be found in the original QAPP (Windward 2004b). The following field data collection forms, included in Appendix B, will also be used to record pertinent information associated with sample collection:

- Clam collection form
- Protocol modification form

Brooks Rand will generate a data package in the format described in the original QAPP (Windward 2004b). Data reduction procedures will be as described in the original QAPP (Windward 2004b). A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples. See the original QAPP (Windward 2004b) for details.

3.0 Data Generation and Acquisition

This section describes the collection and processing of clam and co-located sediment samples for chemical analysis. Elements include sampling design, sampling methods, sample handling, and analytical methods. Details regarding custody requirements, quality assurance/quality control, instrument/equipment testing and frequency, inspection and maintenance, instrument calibration, supply inspection/acceptance, non-direct measurements, and data management can be found in the original QAPP, Sections 3.3, and 3.5 through 3.10 (Windward 2004b).

3.1 SAMPLING DESIGN

M. arenaria, commonly known as eastern soft-shell clam, are normally found in sandy, sand-mud, or sandy-clay substrates and are most abundant in the upper half-tide level near river mouths or heads of bays where low salinity water occurs (Cheney and Mumford 1986; Abraham and Dillon 1986). *M. arenaria* can survive in estuarine habitats where salinities can range from 10 to 25 ppt, but are not known to inhabit areas with salinities less than 4-5 ppt (Abraham and Dillon 1986). The background

areas sampled previously do not meet these habitat preferences and apparently do not support this clam species. For this background sampling event, intertidal areas were selected for sampling based on substrate, habitat suitability, and previous abundance surveys for *M. arenaria*. Washington State Departments of Fish and Wildlife and Ecology, and tribal shellfish biologists were consulted to identify suitable locations for *M. arenaria* collection.

Another consideration in selection of the sampling area is the presence of known anthropogenic sources of arsenic unrelated to the LDW. The primary anthropogenic arsenic source outside the LDW is the former Asarco smelter, which operated in Ruston, Washington (near Tacoma) from the 1890s to 1986. The highest arsenic concentrations in soils closely follow the pattern of prevailing winds in the central Puget Sound basin. The wind blows from the southwest to the northeast (toward the LDW) about 60% of the time, and from the northeast to the southwest about 40% of the time (Windward 2004c). The most suitable sampling location, based on the presence of *M. arenaria*, similar physical characteristics to the LDW, and location within the pattern of prevailing winds from the former Asarco smelter (i.e., southwest of Ruston), is the Nisqually Reach area, located in Thurston County in South Puget Sound near the mouth of the Nisqually River (Figure 3-1). The field crew will first sample at this area to obtain the required background samples.

Ecology has conducted extensive soil sampling for arsenic in areas potentially influenced by the Tacoma Smelter, including the LDW watershed and the Nisqually area. With the exception of two samples from the Nisqually area with arsenic concentrations in soil over 100 mg/kg, the arsenic soil concentrations in the LDW and Nisqually watersheds are very similar (see oversize figures attached to this document). The degree to which the two samples with arsenic concentrations over 100 mg/kg influence arsenic concentrations in the sediments where clams will be collected is not known. Ecology's Confirmed and Suspected Contaminated Site (CSCS) database was consulted for the Nisqually area. One location that is located approximately 14 miles south of the Nisqually area was listed with suspected arsenic concentrations of 20 mg/kg.

Additionally, a non-smelter influenced background sampling location (Dungeness, located east of Port Angeles along the Strait of Juan de Fuca) will be sampled (Table 3-1, Figure 3-1). Two alternative locations are listed in Table 3-1 and also displayed in Figure 3-1. If a sufficient number of clams cannot be obtained in the Dungeness area, one or more of the alternative locations will be sampled in the following order until the appropriate number of clams are obtained: Pillar Point (west of Port Angeles along the Strait of Juan de Fuca), East Dabob (at northern end of Hood Canal). The order in which the alternative locations would be sampled was determined by expected abundance and ease of access (i.e., East Dabob sampling would require a boat to access the target beach). The field crew will determine whether to switch to any of the alternative sampling locations after evaluating the catch success in the Dungeness area.

Ecology's CSCS database was searched for arsenic contamination in the Dungeness area and alternative background sampling locations. There are no sites listed in the vicinity of any of these background sampling locations with known or suspected arsenic contamination.

Table 3-1. Target and alternative clam background sampling locations

LOCATION	LATITUDE [a]	LONGITUDE [a]	COUNTY	NOTES
Nisqually Reach	47.0958	122.69498	Thurston	The shellfish growing area extends from the north beginning at Johnson Point and to the southeast to the mouth of the Nisqually River
Dungeness [b]	48.1603 48.1466	123.17037 123.18367	Clallam	
Pillar Point County Park [bc]	48.199 48.1971	124.1024 124.09703	Clallam	
East Dabob [bc]	47.8211 47.8152	122.79396 122.7956	Jefferson	Boat access only

[a] Coordinates are given in decimal degrees using WGS-84 (also known as NAD-83) as a horizontal datum. Coordinates represent the center of a previously surveyed beach, but the survey crew will likely extend the survey beyond these coordinates depending on field conditions.

[b] A non-influenced background location. Two sets of coordinates are given, corresponding to specific beaches previously surveyed by the Washington Department of Fish and Wildlife.

[c] Alternative background location if insufficient number of clams are collected at Dungeness.

Any *M. arenaria* collected during the sampling window of August 2-5 will be retained. In the event that the target study design of 120 clams in the Nisqually Reach or Dungeness and the alternative locations (20 clams for each of 6 composite samples) is not achieved, alternative study designs of fewer clams per sample, fewer samples, or combinations of clams from multiple background areas will be discussed with EPA and Ecology before any analyses are conducted.

Co-located composite sediment samples for analysis of arsenic will be collected with each of the six composite clam samples, as described in Section 3.2.

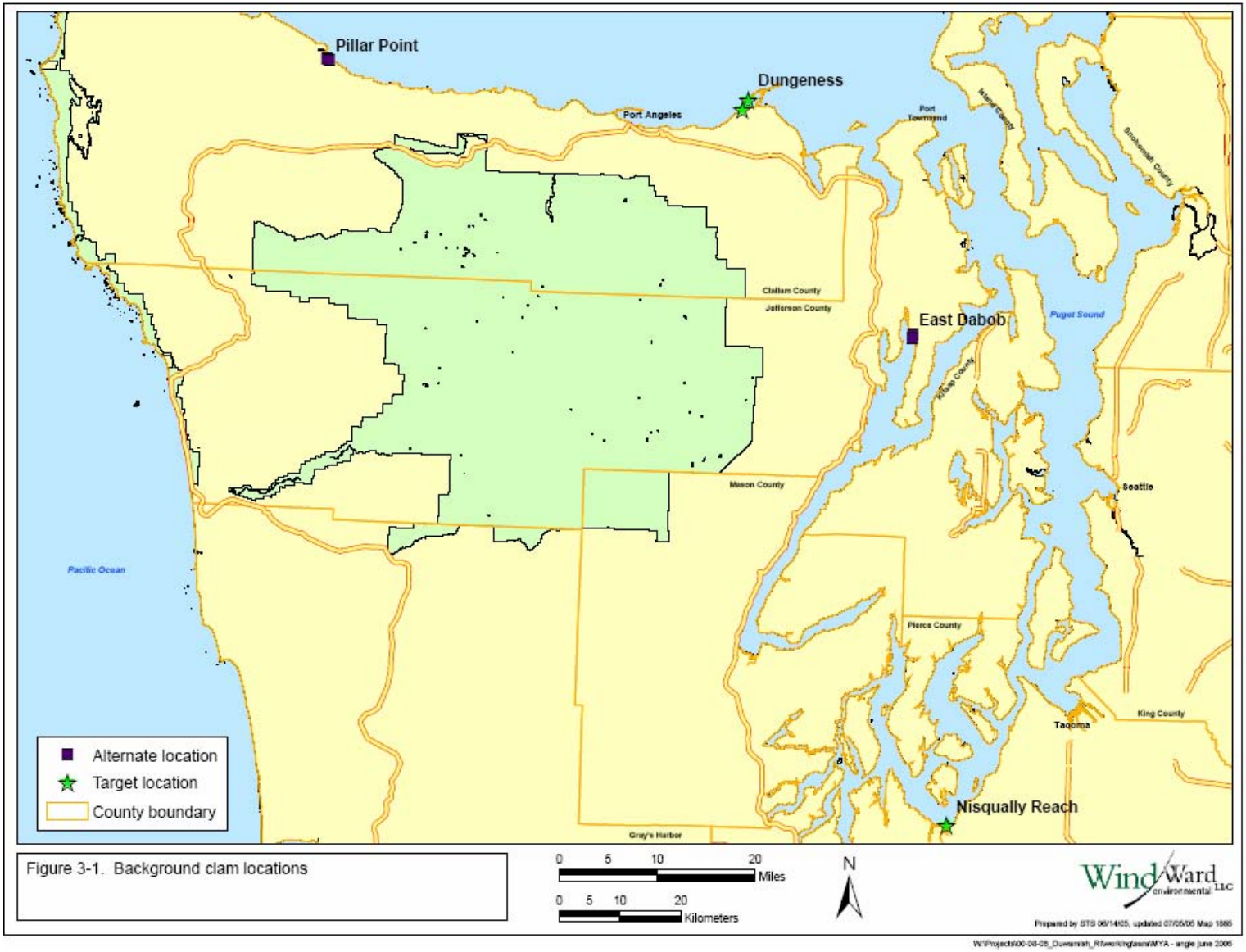


Figure 3-1. Background clam locations

3.2 SAMPLING METHODS

The method for clam sampling is described below. There may be contingencies during field activities that require modification of the general procedures outlined below. Modification of procedures will be at the discretion of the FC after consultation with the Windward project manager and the boat operator, if applicable. EPA and Ecology will be consulted in the event that significant deviations from the sampling design are required. All modifications will be recorded in the logbook.

3.2.1 Identification scheme for all locations and samples

Each sampling location will be assigned a unique alphanumeric location identification (ID) number. The first two characters of the location ID are "NR" to identify the Nisqually Reach project area. The alternative sampling location IDs, in the event these locations are sampled, would start with "DU" for Dungeness, "PP" for Pillar Point, and "ED" for East Dabob. The next characters indicate the type of sampling to be conducted ("C" for clam), followed by a consecutive number identifying the specific location within the sampling area. Sample IDs are similar to location IDs except for the additional designation of sample type – "S" for sediment and "T" for tissue. Two examples of sample and location IDs are provided below:

- NR-C1-T is the clam tissue composite sample collected at location NR-C1 in the Nisqually Reach
- NR-C4-S is the sediment composite sample collected at location NR-C4 in the Nisqually Reach

3.2.2 Location positioning

Locations identified for sampling will be identified by global positioning system (GPS). A handheld GPS unit will be used during sampling in the intertidal areas. The GPS unit will receive GPS signals from satellites to produce positioning accuracy to within 3 m.

3.2.3 Clam tissue and co-located sediment collection

Clams will be collected for chemical analyses at low tide[2]following the catch-per-unit effort (CPUE) method used in 2003 (Windward 2004a). This method involves three field crew members actively searching and collecting clams from areas within the intertidal area with the highest clam abundance, as determined by evidence of shows. Six composite tissue samples, consisting of 20 clams each, will be collected. Only clams with shells at least 2 cm in width (as measured from valve to valve) will be included in the composite samples. Broken clams will not be included in the samples. The clams will be rinsed, placed in a wide-mouth plastic jar, and stored on ice. Removal of the clam tissue from the shell will be performed by the analytical laboratory. The technicians will wear nitrile powder-free examination gloves. All sampling equipment

will be stainless steel, and will be cleaned between samples to avoid contaminating tissue specimens during collection and handling.

At each clam tissue collection location, 50 mL of the first shovelful of sediment will be collected for inclusion in the composite sediment sample that will undergo chemical analyses. If unbroken clams are successfully collected, the sediment will be retained; otherwise it will be discarded. A minimum of twenty 50-mL sediment subsamples will be composited into each 1-L sediment sample per location, corresponding to the 20 holes where clams are obtained for each composite sample. If more than one clam is obtained in a given hole, the sediment subsample size will be increased accordingly (e.g., a 100-mL subsample for two clams) to accurately represent a weighted composite sample. The sediment samples will be collected to a depth of 10 cm.

3.2.4 Field equipment

The necessary field equipment is listed in Table 3-2 for both the clam tissue and sediment collection. Prior to mobilization, this list will be consulted to ensure all equipment is available and pre-cleaned. As part of the mobilization process, each item will be double-checked by the FC.

Table 3-2. Field equipment for clam tissue and sediment collection

NECESSARY FIELD EQUIPMENT		
Original QAPP and QAPP addendum		Stainless-steel bowls and spoons
Key personnel contact information list		200-mL beaker
Field sample collection forms		Coolers and wet ice
Field notebooks (Rite in the Rain®)		Labels
Chain-of-custody forms		Packing tape (for wrapping around jar labels)
Pens, pencils, Sharpies		Bubble wrap
Tide tables		Ziploc® sandwich bags (for individual sample labels)
Study area maps		Sediment sample jars (1-L plastic or glass)
Clam identification guide		Heavy duty aluminum foil
GPS		Ziploc® freezer bags (gallon size for clams)
Batteries		Powder-free nitrile exam gloves
Digital camera		Waders
Cellular phone		Raingear
Shovels		First aid kit
Alconox® detergent		Scrub brushes
Distilled water		Paper towels
Garden sprayer (for distilled water)		Garbage bags

3.3 SAMPLE HANDLING

Sediment and tissue samples for chemical analyses will be placed in appropriately sized, certified-clean, wide-mouth glass jars and capped with Teflon®-lined lids. All sediment sample containers will be filled leaving a minimum of 1 cm of headspace to

prevent breakage during shipping and storage. Prior to shipment, each glass container will be wrapped in bubble wrap and placed in a cooler with wet ice. Each jar will be sealed, labeled, and stored under appropriate conditions. The field crew will deliver the coolers to Brooks Rand on the day of collection. Tissue samples will be frozen upon receipt at Brooks Rand and will be homogenized before analysis according to the laboratory's standard operating procedures. Refer to the original QAPP (Windward 2004b) for details of decontamination procedures, disposal of field-generated wastes, sample custody procedures, and shipping requirements.

3.4 ANALYTICAL METHODS

Clam samples will be frozen at - 15° C in the laboratory prior to analysis and sediment samples will be stored at 4° C prior to analysis. The maximum holding times for the frozen tissue and refrigerated sediment samples are 2 years and 1 year, respectively. Brooks Rand will shuck, composite and homogenize the clam samples. Clam samples will be analyzed for both total arsenic and total inorganic arsenic. Inorganic arsenic in clam samples will be analyzed using EPA Method 1632 (hydride generation atomic fluorescence spectrometry). Sediment samples will be analyzed only for total arsenic to demonstrate that the background sampling area does not contain abnormally high arsenic concentrations that would confound the interpretation of the clam results. Total arsenic in both clam and sediment samples will be analyzed using EPA Method 1638 modified (inductively coupled plasma mass spectrometry). Refer to the original QAPP, Section 3.4.2, (Windward 2004b) for data quality indicators and tissue mass requirements.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

QA/QC is discussed in detail in the original QAPP, Section 3.5 (Windward 2004b). No field QC samples (i.e., blanks or duplicates) will be collected. The laboratory will analyze a standard set of QC samples for both sediment and tissue analyses, including matrix spike/matrix spike duplicate, laboratory control sample, and method blank. In addition, the laboratory will analyze one aliquot of standard reference material NIST 2976 (mussel tissue) for total arsenic.

4.0 Assessment and Oversight

Details of project assessment and oversight are presented in the original QAPP (Windward 2004b).

5.0 Data Validation

Data validation will be conducted following EPA (2002) guidance. The project QA/QC coordinator is responsible for ensuring that all analyses performed by the laboratory are correct, properly documented, and complete, and that the laboratory satisfies the

project data quality objectives (DQOs) specified in the original QAPP (Windward 2004b).

Independent third-party data review and summary validation of the analytical chemistry data will be conducted by Laboratory Data Consultants (LDC). All tissue and sediment results will undergo full data validation. As part of the validation, all forms for calibrations, instrument performance, and internal standards will be reviewed. The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. LDC will prepare a data validation report that will summarize QC results, qualifiers, and possible data limitations. This data validation report will be appended to the data report. Only validated data with appropriate qualifiers will be released for general use.

Data quality assessment will be conducted by the project QA/QC Coordinator in accordance with EPA guidelines. The results of the third-party independent review and validation will be reviewed and cases where the project DQOs were not met will be identified. The usability of the data will be determined in terms of the magnitude of the DQO exceedance.

6.0 References

Abraham BJ, Dillon PL. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic)-softshell clam. US Fish and Wildlife Service Biological Report 82 (11.68). US Army Corps of Engineers, TR EL-82-4.

Cheney DP, Mumford TF Jr. 1986. Shellfish and seaweed harvests of Puget Sound. Puget Sound Books, University of Washington Press, Seattle, WA.

EPA. 2002. USEPA contract laboratory program national functional guidelines for inorganic data review. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

Windward. 2004a. Lower Duwamish Waterway remedial investigation. Intertidal clam survey data report. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2004b. Lower Duwamish Waterway remedial investigation. Quality assurance project plan: Benthic invertebrate sampling of the Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2004c. Lower Duwamish Waterway remedial investigation. Quality assurance project plan: Fish and crab tissue collection and chemical analyses.

Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2004d. Lower Duwamish Waterway remedial investigation. Task 8: Phase 2 RI work plan. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2005. Lower Duwamish Waterway remedial investigation. Data report: Chemical analyses of benthic invertebrate and clam tissue samples and co-located sediment samples. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Appendix A. Health and Safety Plan Addendum

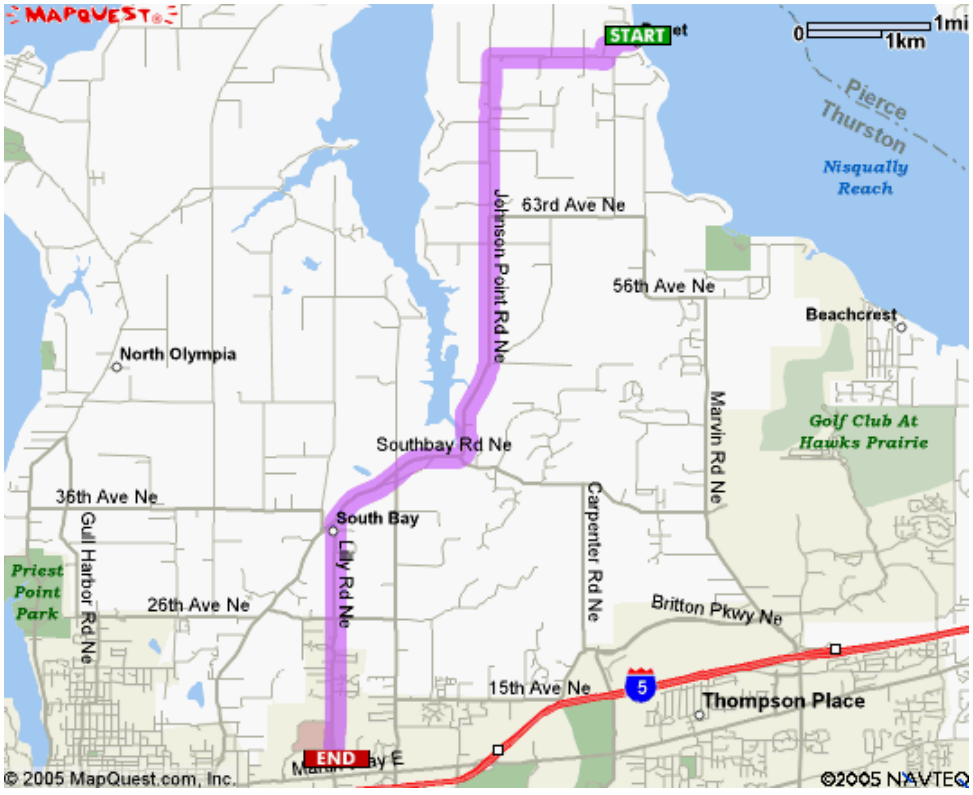
The health and safety plan included with the original QAPP remains in effect for the sampling effort described in this QAPP addendum. This health and safety plan addendum contains directions to the nearest hospital for each potential sampling area. These directions were not included in the original health and safety plan because these sampling areas were not part of the original study design.

NISQUALLY REACH

Providence St Peter Hospital
413 Lilly Rd NE, Olympia, WA
360-491-9480

1:	Start out going WEST on 79TH AVE NE toward WALNUT RD NE.	0.2 miles
2:	Turn LEFT onto WALNUT RD NE.	0.1 miles
3:	Turn RIGHT onto 78TH AVE NE.	0.9 miles
4:	Turn LEFT onto JOHNSON POINT RD NE.	3.8 miles
5:	JOHNSON POINT RD NE becomes SOUTHBAY RD NE.	1.2 miles
6:	Turn LEFT onto LILLY RD NE.	2.1 miles
7:	End at 413 Lilly Rd NE, Olympia, WA 98506-5133	

Total Est. Time: 16 minutes Total Est. Distance: 8.49 miles

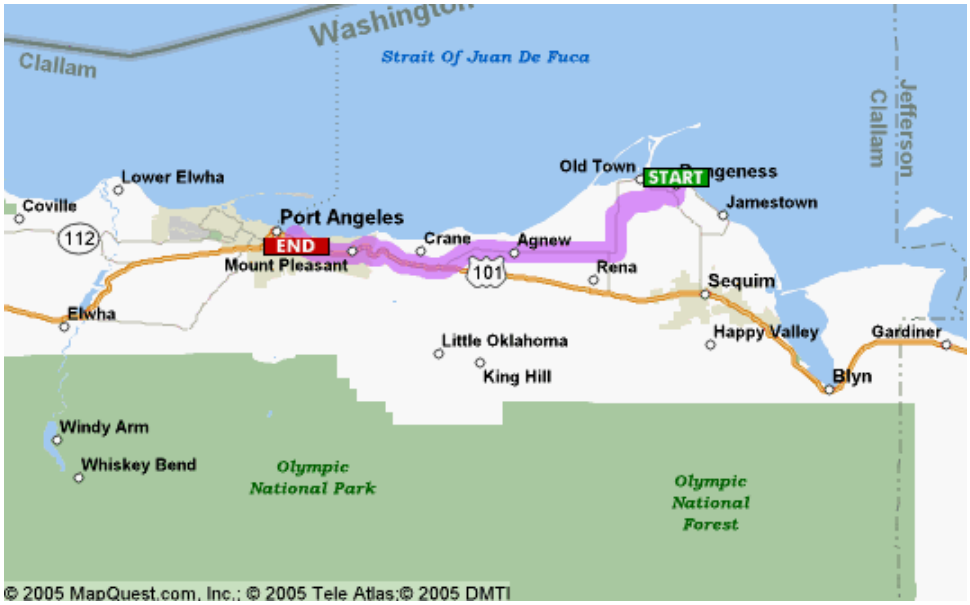


DUNGENESS

Olympic Memorial Hospital
939 Caroline St, Port Angeles, WA 98362
360-417-7000

1:	Start out going WEST on PALMER ST E toward SEQUIM-DUNGENESS WAY.	<0.1 miles
2:	Turn LEFT onto SEQUIM-DUNGENESS WAY.	0.3 miles
3:	Turn RIGHT onto E MARINE DR.	0.7 miles
4:	Turn LEFT onto LOTZGESELL RD.	1.4 miles
5:	Stay STRAIGHT to go onto CAYS RD.	0.6 miles
6:	Turn LEFT to stay on CAYS RD.	1.6 miles
7:	CAYS RD becomes OLD OLYMPIC HWY.	6.3 miles
8:	Turn RIGHT onto US-101 W.	6.1 miles
9:	Turn RIGHT onto N WASHINGTON ST.	0.1 miles
10:	Turn LEFT onto CAROLINE ST.	<0.1 miles
11:	End at Olympic Memorial Hospital 939 Caroline St, Port Angeles, WA 98362	

Total Est. Time: 35 minutes Total Est. Distance: 17.74 miles



PILLAR POINT

Forks Community Hospital
530 Bogachiel Way, Forks, WA 98331
360-374-6271

1:	Start out going NORTHWEST toward PILLAR POINT RD.	<0.1 miles
2:	Turn LEFT onto PILLAR POINT RD.	0.2 miles
3:	Turn RIGHT onto WA-112.	6.6 miles
4:	Turn LEFT onto WA-113 / BURNT MOUNTAIN RD.	9.9 miles
5:	Turn RIGHT onto US-101.	12.3 miles
6:	Turn RIGHT onto B ST S / BOGACHIEL WAY. Continue to follow BOGACHIEL WAY.	0.3 miles
7:	End at Forks Community Hospital 530 Bogachiel Way, Forks, WA 98331	

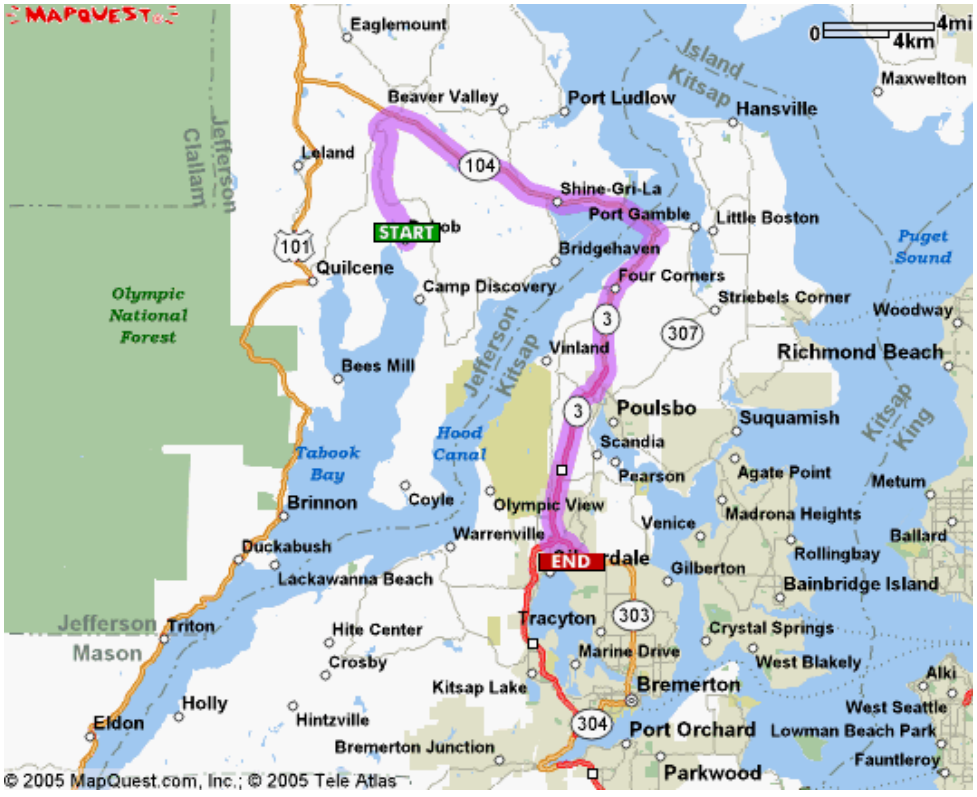
Total Est. Time: 50 minutes Total Est. Distance: 29.69 miles

EAST DABOB

Harrison Hospital
1800 NW Myhre Rd, Silverdale, WA 98383
360-337-8800

1:	Start out going NORTHWEST on DABOB POST OFFICE RD toward BROSHEAR RD.	1.6 miles
2:	DABOB POST OFFICE RD becomes DABOB RD.	3.4 miles
3:	Turn RIGHT to stay on DABOB RD.	0.4 miles
4:	Turn SLIGHT RIGHT onto CENTER RD.	<0.1 miles
5:	Turn SLIGHT LEFT onto S KEESLING RD.	0.3 miles
6:	Turn RIGHT onto WA-104 E.	11.1 miles
7:	Turn SLIGHT RIGHT onto WA-3 S.	13.9 miles
8:	Take the WA-303 S exit toward E BREMERTON.	0.1 miles
9:	Take the ramp toward FAIRGROUNDS / EAST BREMERTON.	0.3 miles
10:	Turn SLIGHT RIGHT onto NW WAAGA WAY / WA-303 S.	0.9 miles
11:	Take the RIDGETOP BLVD ramp.	0.1 miles
12:	Turn RIGHT onto RIDGETOP BLVD NW.	0.2 miles
13:	Turn RIGHT onto NW MYHRE RD.	0.1 miles
14:	End at Harrison Hospital 1800 NW Myhre Rd, Silverdale, WA 98383	

Total Est. Time: 47 minutes Total Est. Distance: 33.23 miles



APPENDIX B. FIELD FORMS

CLAM COLLECTION FORM

Project Name:		Project no.	
Date:		Station:	
Start/Stop time:		X:	
Sampling Method:		Y:	
Weather:		Sample ID:	
Crew:			

Clam species	#	Shell length (cm)		Clam species	#	Shell length (cm)

Comments:

PROTOCOL MODIFICATION FORM

Project Name and Number: _____

Material to be Sampled: _____

Measurement Parameter: _____

Standard Procedure for Field Collection & Laboratory Analysis (cite reference):

Reason for Change in Field Procedure or Analysis Variation:

Variation from Field or Analytical Procedure:

Special Equipment, Materials or Personnel Required:

Initiator's Name: _____ Date: _____

Project Officer: _____ Date: _____

QA Officer: _____ Date: _____

Oversize Figures

Tacoma Smelter Plume - King County Maximum Arsenic Footprint

Map Features

Tacoma Smelter Stack

Maximum Arsenic Concentration (King County Locations)

- ND - 20 ppm
- 20 - 100 ppm
- 100 - 200 ppm
- > 200 ppm

Maximum Arsenic Concentration (Non-King County Locations)

- ND - 20 ppm
- 20 - 100 ppm
- 100 - 200 ppm
- > 200 ppm

ND = Not Detected
ppm = parts per million

Seattle
Bellevue
Issaquah
King County
Renton
Kitsap County
Burien
Kent
Federal Way
Pierce County

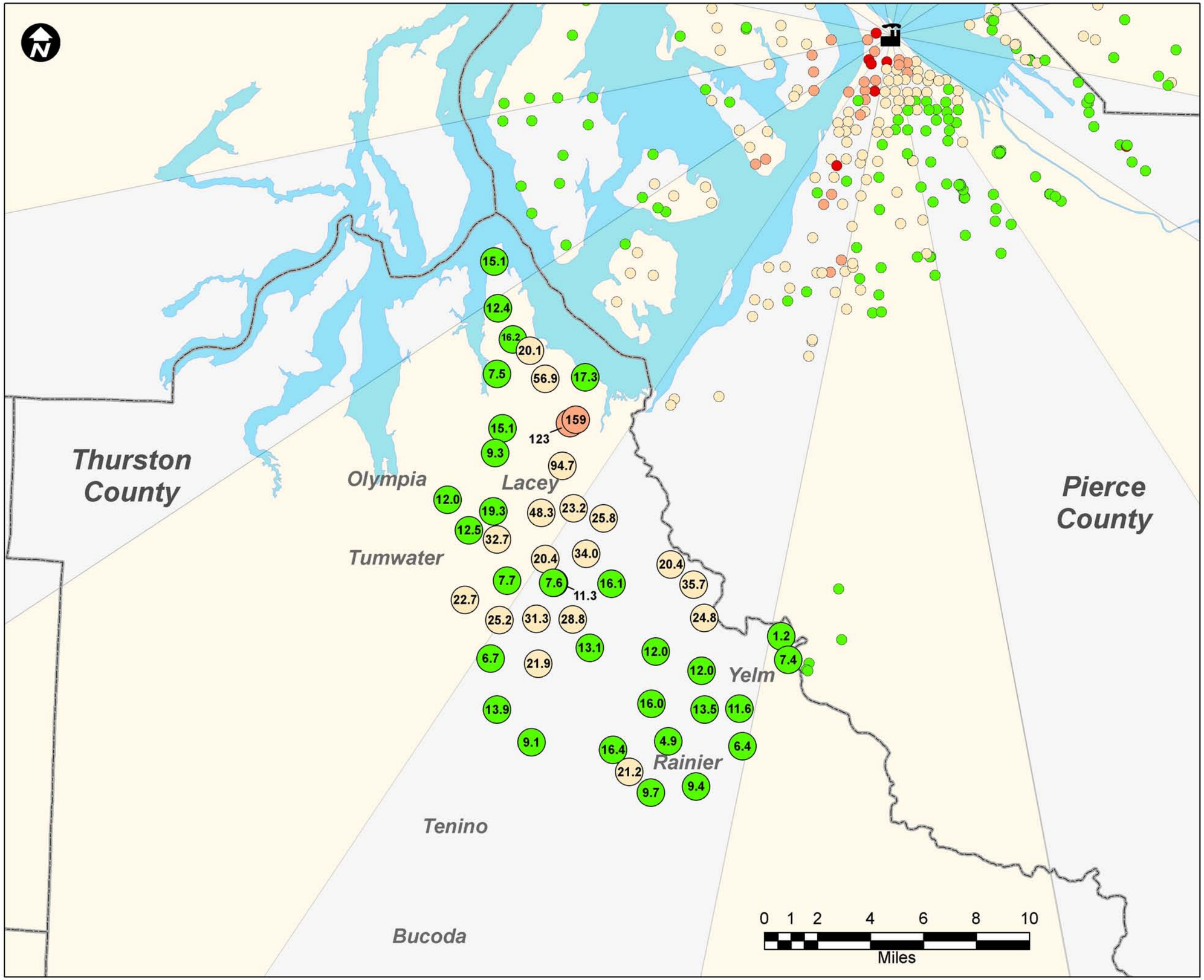
0 1 2 4 6 8 10
Miles

Footprint Location Map

Map Updated: December, 2004

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Tacoma Smelter Plume - Thurston County Maximum Arsenic Footprint



Map Features

Tacoma Smelter Stack

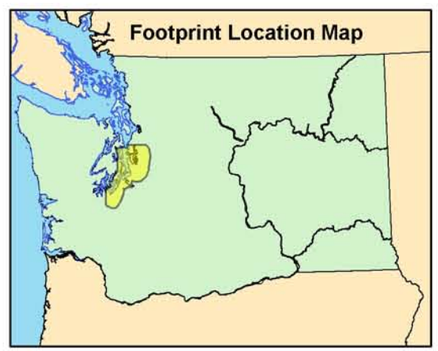
Maximum Arsenic Concentration (Thurston County Locations)

- ND - 20 ppm
- 20 - 100 ppm
- 100 - 200 ppm
- > 200 ppm

Maximum Arsenic Concentration (Non-Thurston County Locations)

- ND - 20 ppm
- 20 - 100 ppm
- 100 - 200 ppm
- > 200 ppm

ND = Not Detected
ppm = parts per million



Map Updated: December, 2004

WASHINGTON STATE DEPARTMENT OF ECOLOGY