Lower Duwamish Waterway Group

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

QUALITY ASSURANCE PROJECT PLAN: FISH AND CRAB TISSUE COLLECTION AND CHEMICAL ANALYSES

ADDENDUM FOR ADDITIONAL FISH AND CRAB SAMPLING IN THE LOWER DUWAMISH WATERWAY

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

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

August 31, 2005

Prepared by: Wind Ward environmental LLC

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

Table of Contents

Acronyms

ACRONYM	Definition
ARI	Analytical Resources, Inc.
DQI	data quality indicator
DQO	data quality objective
Ecology	Washington Department of Ecology
EPA	US Environmental Protection Agency
FC	field coordinator
GPS	global positioning system
LDC	Laboratory Data Consultants, Inc.
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
PCB	polychlorinated biphenyl
PM	project manager
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
WDFW	Washington Department of Fish and Wildlife
Windward	Windward Environmental LLC

1.0 Introduction

The purpose of this addendum to the fish and crab tissue collection and chemical analysis quality assurance project plan (QAPP) (Windward 2004a) is to document the methods that will be used to collect and chemically analyze additional composite tissue samples of shiner surfperch, English sole, Pacific staghorn sculpin, and Dungeness crab from the Lower Duwamish Waterway (LDW) in 2005. The original QAPP (Windward 2004a) provides background information and describes objectives of the previous 2004 fish and crab tissue sampling.

In combination with existing data, data from this study will be used to support the ecological (ERA) and human health risk assessments (HHRA) and food web modeling for Phase 2 of the LDW Remedial Investigation (RI), as described in the Phase 2 RI work plan (Windward 2004b). This QAPP addendum addresses details that are specific to the 2005 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 – data generation and acquisition
- Section 4 – assessment and oversight
- Section 5 – data validation and usability
- Section 6 – references

The health and safety plan presented as Appendix A of the original QAPP (Windward 2004a) will be followed during sampling.

2.0 Project Management

This section describes overall management of the project, including key personnel, project description, problem definition and background, special training requirements and certification, and documents and record keeping. Data quality objectives (DQOs) and criteria are as described in the original fish and crab QAPP (Windward 2004a).

2.1 Project Organization and Team Member Responsibilities

The Lower Duwamish Waterway Group (LDWG), the US Environmental Protection Agency (EPA), and the Washington Department of Ecology (Ecology) will be involved in all aspects of this project, including discussion, review, and approval of the QAPP addendum, and interpretation of the results of the investigation. This sampling effort will be performed by Windward Environmental LLC (Windward). Overall project organization and responsibilities of project team members are described in Section 2.1

of the original QAPP (Windward 2004a). Kathy Godtfredsen will serve as the Windward project manager (PM), responsible for overall project coordination and providing oversight on planning and coordination, work plans, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The field coordinator (FC), quality assurance/quality control (QA/QC) coordinator and laboratory manager for this sampling and analysis effort are different from those specified in the original QAPP. Matt Luxon will serve as the FC and Marina Mitchell will serve as QA/QC coordinator. Analytical Resources, Inc. (ARI) will perform the chemical analyses, and Sue Dunnihoo will serve as the laboratory manager. The contact information for these individuals is given below.

Kathy Godtfredsen (Windward PM)
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1283
Facsimile: 206.217.0089
Email: kathyg@windwardenv.com

Matt Luxon (Field Coordinator)
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1293
Facsimile: 206.217.0089
Email: mattl@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

Susan Dunnihoo (Laboratory Manager)
Analytical Resources, Inc.
4611 S 134th Place, Suite 100
Tukwila, WA 98168
Telephone: 206.695.6207
Email: sue@arilabs.com

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

2.2 PROBLEM DEFINITION/BACKGROUND

The original fish and crab QAPP (Windward 2004a) described background information and the objectives of the fish and crab tissue sampling in 2004. The 2004 sampling event resulted in the most comprehensive tissue dataset collected to date in the LDW. Most of the polychlorinated biphenyl (PCB) concentrations in tissue samples collected in 2004 were higher than the PCB concentrations in tissue collected in the 1990s when compared on a wet-weight basis (i.e., total amount of PCBs in the tissue).

English sole fillet samples collected in Area T1 (Figure 2-1) were the most elevated (approximately a factor of 8 times higher on a wet-weight basis when average concentrations are compared) relative to historical samples (Table 2-1). Average total PCB concentrations in shiner surfperch were 2.5 to 2.8 times higher by sampling area than average concentrations in this species in the 1990s. The 2004 concentrations were highly variable throughout the LDW, with one shiner surfperch whole-body composite sample having the highest total PCB tissue concentration (based on the sum of Aroclors) ever reported in the LDW (18,400 µg/kg ww). The average total PCB concentrations in Dungeness crab edible meat and hepatopancreas were 1.8 to 2.4 times higher, respectively, than average concentrations measured in that species in the 1990s. Total PCB concentrations in striped perch were 4 times higher than concentrations measured in 1990; only one sample was analyzed in 2004 because few specimens of this species were caught throughout the LDW. Total PCB concentrations in starry flounder and Pacific staghorn sculpin were similar to historical data from 1975 (Miller et al. 1977), although no recent historical data exist. There are no historical data to compare to the 2004 pile perch or slender crab data. Pre-1990s PCB fish tissue data are very limited, but are generally within the range of the 1990s data.

Table 2-1. Phase 1 and Phase 2 concentrations of total PCBs (Aroclor sum) in tissue

TISSUE TYPE	AREA	PHASE 1[a]	COLLECTION DATE	RANGE, AVERAGE (µg/kg-ww)	PHASE 2[a]	RANGE, AVERAGE (µg/kg-ww)	COMMENTS, MEAN RATIO[b]
Dungeness crab edible meat	T1	n=3 (26 crabs)	Apr 97, Oct 98	80-180, 132	n=3 (15 crabs)	206-290, 234	1.8X
	T2	no data			no data		no data for comparison
	T3	no data			n=3	212-300, 246	no data for comparison
	T4	no data			n=1	240	no data for comparison

Tissue Type	Area	Phase 1[a]	Collection date	Range, Average (µg/kg-ww)	Phase 2[a]	Range, Average (µg/kg-ww)	Comments, Mean Ratio[b]
Dungeness crab hepatopancreas	T1	n=1 (3 crabs)	Apr 97, Oct 98	1,700	n=1 (15 crabs)	4,000	2.4X, only one sample
	T2	no data			no data		no data for comparison
	T3				n=1	4,500	no data for comparison
	T4				n=1	5,500	no data for comparison
English sole fillet	T1	n=12 (66 fish) – skin off	May 92, 95, 97, Dec 95,	79-360, 182	n=2 (10 fish) – skin on	1,330-1,600, 1,465	8X; only two samples; skin on/off
	T2 (and outside)	n=1 (3 fish), skin off	Oct 98	300	n=2 (10 fish)	1,840-2,010, 1,925	6X, only two samples, skin on/off
	T3	n=1 (3 fish), skin off	Oct 98	280	n=2 (10 fish)	850-1,640, 1,245	4X, only two samples, skin on/off
	T3-T4	n=1 (3 fish), skin off	Oct 98	530	n=1 (3 fish), skin on	710	Similar, only one sample
English sole whole body	T1	n=3 (60 fish), altered	Jul 97	730-2,400, 1,520	n=6 (30 fish)	2,700-4,700, 3,650	2.4X
	T2	no data			n=6 (30 fish)	3,300-4,200, 3,850	no data for comparison
	T3	no data			n=6 (30 fish)	1,320-4,300, 2,570	no data for comparison
	T4	no data			n=6 (30 fish)	1,640-1,800, 1,700	no data for comparison
Shiner surfperch	T1	n=3 (30 fish)	Apr 97	350-620, 497	n=6 (60 fish)	970-1,830, 1,387	2.8X
	T2	no data			n=6 (60 fish)	1,260-18,400, 4,320	no data for comparison
	T3	n=2 (2 fish)	Jul 00	940-2,100, 1,520	n=6 (60 fish)	1,280-8,800, 3,832	2.5X; 1 of 2 samples within range
	T4	no data			n=6 (60 fish)	640-960, 800	no data for comparison
Pacific staghorn sculpin	T1	n=1 historical data	Jun-Sept 75	840	n=6	580-860, 730	similar
	T2	no data			n=6	620-1,260, 770	no data for comparison
	T3	no data			n=6	810-2,800, 1500	no data for comparison
	T4	no data				510-1,330, 780	no data for comparison

Tissue Type	Area	Phase 1[a]	Collection date	Range, Average (µg/kg-ww)	Phase 2[a]	Range, Average (µg/kg-ww)	Comments, Mean Ratio[b]
Starry flounder, fillet	T1	no data			no data		no data for comparison
	T2	no data			no data		no data for comparison
	T3	n=12 "specimens" without skin, historical data	monthly 76-77	160-2,100, 410 (median)	no data		no data for comparison
	T4	no data			n=1, with skin	450	no data for comparison

[a] The mean ratio is the ratio of the Phase 2 mean concentration to the Phase 1 mean concentration

[b] n represents the number of composite samples.

When historical and Phase 2 data are lipid-normalized, there appears to be little difference in PCB concentrations in English sole over time (Table 2-2). Lipid-normalized PCB concentrations in perch and Dungeness crab tissue were higher on average in 2004 than in historical samples. Although wet weight values are used for risk assessment, lipid normalization is relevant because the fat content of organisms varies over time and PCB concentrations can co-vary with lipids. Variability in lipid content of tissue may therefore help explain any observed variability in PCB residues.

Table 2-2. Average lipid-normalized total PCB concentrations in tissue samples with historical data for comparison

Area	Tissue Type	Event	Lipid (%)	Total PCBs (mg/kg-lipid)
English sole				
T1	Fillet with skin	Phase 2	2.9	51
T1	Fillet without skin	EVS 95	10.9	2
T1	Fillet without skin	KC WQA	0.3	74
T1	Fillet without skin	PSAMP	0.4	46
T1	Whole body	KC WQA	2.1	69
T1	Whole body	Phase 2	5.6	65
Dungeness crab				
T1	Edible meat	KC WQA	2.0	8
T1	Edible meat	Phase 2	0.3	72
T1	Hepatopancreas	KC WQA	13	13
T1	Hepatopancreas	Phase 2	4.6	87
Shiner surfperch				
T1	Whole body	KC WQA	2.8	20
T1	Whole body	Phase 2	3.4	44

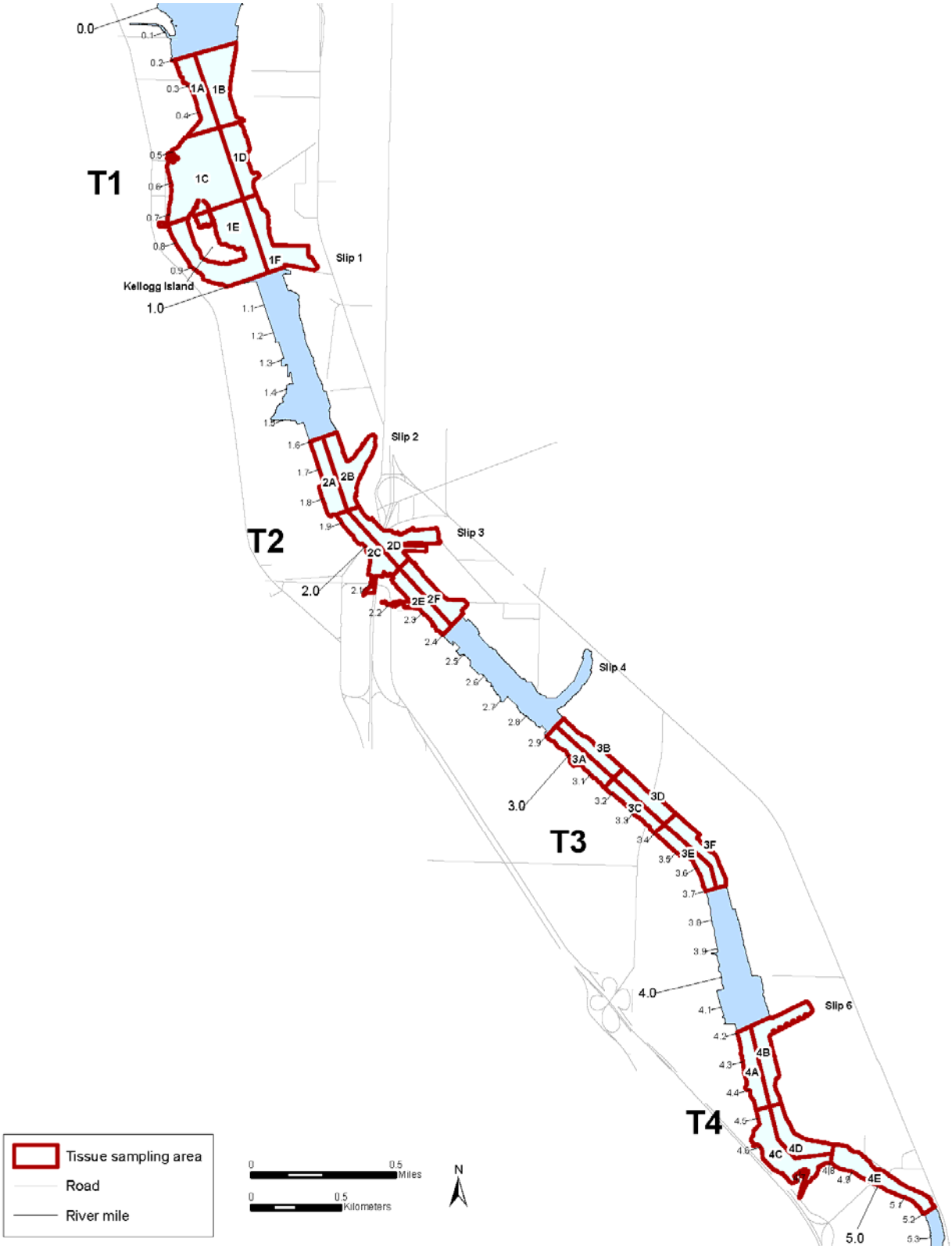

Figure 2-1. LDW Phase 2 fish and crab tissue collection areas

Although the 2004 tissue PCB concentrations were generally higher than historical concentrations, there are differences between the historical and 2004 datasets that limit the conclusions that can be drawn from comparisons.

- Small sample sizes: Most comparisons discussed above are based on a small number of composite samples (either in the 2004 data or in the historical data). Thus, it is unknown whether PCB concentrations in the fish populations are increasing or are just highly variable.
- Paucity of historical data: Several tissue types and/or collection areas have no historical data for comparison.
- Differences in timing of sampling: Much of the historical tissue data come from sampling conducted in the spring and fall/winter whereas the 2004 data were collected in late summer/fall. This difference in the season of collection may account for differences in the 2004 lipid data versus that from the historical data. Furthermore, differences in wet weight PCB concentrations between the datasets may reflect seasonal differences in fish diets.
- Differences in sample processing: English sole fillets were analyzed with skin on in 2004; historical samples were analyzed without skin, which may affect the lipid content of the samples and thus the PCB concentrations. LDWG conducted a study in 2004 to evaluate this issue. Lipid and PCB analyses were performed on 10 individual fish from which both skin-on and skin-off fillets were prepared. The mean wet weight PCB concentration of the 10 skin-on fillets was slightly higher than that of the skin-off fillets (849 vs. 716 µg/kg ww); the mean lipid-normalized PCB concentrations of the two fillet preparations were similar (40.6 vs. 41.3 mg/kg lipid). No significant differences in PCB concentrations were observed between the fillet preparations. Thus, the contribution of lipids (and PCBs) in skin is unlikely to be the cause of the differences in the wet weight PCB concentrations between the Phase 1 and Phase 2 datasets.

There are at least four potentially important factors that may contribute to observed differences in tissue PCB concentrations over time. These factors include natural inter-annual variability in fish tissue, seasonal variability in fish tissue, short-term perturbations to the system, and changes in loading from sources within and adjacent to the river. These factors are not mutually exclusive and distinguishing among them would likely require multiple years of investigations over various seasons. The proposed study will not provide definitive data to discriminate among the factors that may have contributed to the differences in total PCB concentrations between 2004 fish tissue data and historical fish tissue data.

Upon examination of the 2004 and historical PCB tissue data, it is apparent that concentrations are variable throughout the waterway and between years for at least some of the key receptors. Recognizing the importance of these data for the ERA and HHRA, and for bioaccumulation modeling, additional tissue data are being collected,

as described in this addendum, to better characterize the fish and crab data from which important decisions will be made. LDWG, EPA, and Ecology will discuss how data collected as part of this effort will be used in combination with the Phase 1 and 2004 data in the Phase 2 risk assessments and RI.

There is also a need for additional data relating PCB concentrations and lipid concentrations in English sole fillets to those in the whole fish because bioaccumulation modeling focuses on whole-body chemical concentrations. In order to relate modeled whole-body chemical concentrations to concentrations in fillets (an important human health seafood dietary component), an empirical relationship between the two is needed. Meeting this need was not an explicit component of the 2004 fish collections so it is also a reason for conducting additional sampling in 2005.

Thus, the objectives of this study are:

- to supplement the existing dataset to better characterize PCB concentrations in fish and crab for assessing human health and ecological risks and for modeling relationships between fish tissue and sediment in order to make remedial decisions at the site
- to assess the relative concentrations of total PCBs in English sole fillet and whole-body samples

2.3 PROJECT/TASK DESCRIPTION AND SCHEDULE

To meet the objectives presented in Section 2.2, English sole, shiner surfperch, Pacific staghorn sculpin, and Dungeness crab[1] will be collected from the LDW, as described in Section 3. Samples will be collected from multiple areas in the LDW; these areas were selected to be comparable to the 2004 fish tissue collection areas.

Fish sampling in the LDW will take place August 29 to September 6, 2005. This sampling period was selected to match the main 2004 collection period, when trawling was conducted from August 30 to September 8, 2004.[2] Crab sampling will take place August 30 and 31, 2005. Chemical analyses of the samples should be completed approximately 30 days after compositing and homogenization is completed. A draft data report will be submitted to EPA and Ecology approximately 45 days following receipt of validated data.

2.4 SPECIAL TRAINING/CERTIFICATION

A scientific collection permit is being obtained from the Washington Department of Fish and Wildlife (WDFW). Fishing will also be conducted under the same U.S. Fish and Wildlife Service and National Marine Fisheries Service permits as in 2004 as documented in the original QAPP (Windward 2004a). Training requirements for

[1] Slender crab will be collected in areas where a sufficient number of Dungeness cannot be obtained
[2] Shiner surfperch were also collected from August 2nd through August 6th, 2004.

personnel participating in sample collection can be found in the original QAPP (Windward 2004a).

2.5 DOCUMENTATION AND RECORDS

Procedures for documenting field observations, laboratory records, and data reduction can be found in the original QAPP (Windward 2004a). ARI will generate a data package in the format described in Section 2.6.2 of the original QAPP(Windward 2004a). Data reduction procedures will be as described in the original QAPP (Windward 2004a). A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples. See the Section 2.6.4 of the original QAPP (Windward 2004a) for details.

3.0 Data Generation and Acquisition

This section describes the collection and processing of fish tissue samples for chemical analyses. 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 Sections 3.3 and 3.5 through 3.10 of the original QAPP (Windward 2004a).

3.1 SAMPLING DESIGN

Samples of shiner surfperch (whole-body composite samples) and English sole (whole-body and fillet composite samples) will be collected in LDW Areas T1, T2, T3, and T4 (Figure 2-1, Table 3-1). English sole and shiner surfperch will be sampled in 2005 because these species are important for both the ERA and HHRA. English sole are a priority also because whole-body-to-fillet total PCB concentration relationships are needed. Shiner surfperch are a priority because 2004 shiner surfperch tissue showed the greatest variability in total PCB concentrations. The number of composite samples is based on generating total PCB tissue data comparable to 2004 data, and for calculating ratios of English sole whole body and fillet total PCB concentrations.

Dungeness crab samples will also be collected to supplement the existing dataset for the ERA and HHRA. Because Phase 2 PCB concentrations did not vary substantially throughout the LDW in 2004, attempts will be made to collect a sufficient number of Dungeness crab for one composite sample of edible meat from each of the four areas. If Dungeness crabs are not caught in an area, slender crabs will be collected as a surrogate species. Collection of a sufficient number of either species of crab may be difficult in Area T4, the most upstream sampling area.

Pacific staghorn sculpin will also be collected. One composite sample will be collected from one subarea per sampling area. These data will supplement the existing data for the ERA.

Additional information regarding the rationale for the sampling design will be provided to EPA and Ecology in a separate technical memorandum. This memorandum, to be submitted in November, will provide rough risk estimates to assess the likely significance of the 2005 tissue data in the risk assessments and a basic discussion of how the fish and crab tissue data will be used in the food web modeling effort.

The methods for combining the Phase 1, 2004, and 2005 datasets for use in the risk assessments and in food web modeling will be determined in consultation with EPA and Ecology. No data will be extrapolated between species, and no data will be collected to replace existing data.

Table 3-1. Number of composite samples for 2005 sampling

Area	English Sole Fillet	English Sole Whole Body [a]	Shiner Surfperch Whole Body	Dungeness Crab Edible Meat	Pacific Staghorn Sculpin Whole Body
T1	3	6	6 (one from each subarea)	1	1
T2	3	6	6 (one from each subarea)	1	1
T3	3	6	6 (one from each subarea)	1	1
T4	1	3	4 (one each from subareas a, b, c, and d)	1	1

[a] Three of the six composite samples from areas T1, T2, and T3 and one of three composite samples from area T4 will be analyzed according to the procedure described in Section 3.4

The target fish and crab size will be the same as that specified in Section 3.1.5 of the original QAPP (Windward 2004a); however, the compositing scheme will follow what was actually used for the 2004 samples (rather than what was specified in the original QAPP).[3] To the extent possible, composite samples will be created such that the size distribution of specimens in each composite sample will be similar across all tissue samples for a given species, and also similar to the size distribution observed in the total population for that species collected from the LDW. Fish will be distributed into size categories based on the overall size distribution of the 2005 specimens of a given species and a targeted number of fish will be randomly selected from each size category based on the proportion of fish in that category.

Five English sole (> 200 mm) will be included in each English sole composite sample; subarea will not be a key consideration in their collection, although each entire sampling area will be trawled. Ten shiner surfperch (> 80 mm) will be included in each shiner surfperch composite sample; one composite sample will be collected from each subarea (Figure 2-1). If sufficient numbers of target fish cannot be collected, the compositing scheme will be determined in consultation with EPA and Ecology. Note that Subarea 4E will not be sampled in 2005 because only one shiner surfperch of

[3] The compositing scheme specified in the original QAPP could not be achieved with the numbers of fish collected in 2004.

target size was collected in 2004, no English sole were captured in this subarea in 2004, and trawling is not practicable in this subarea because of submerged logs and debris.

Ten Pacific staghorn sculpin (> 120 mm) will be included in each sculpin composite sample; one composite sample will be collected from one subarea per area. In Area T3, the order of subarea preference is 3F, 3D, 3E, and 3B (in order of decreasing sediment total PCB concentration). In Area T2, subarea 2E is preferred. . These preferences were selected to provide a range of PCB concentrations in tissue and sediment, if possible. If a sufficient number of sculpin are not available in these subareas during trawling and in crab traps (see Section 3.2.2.2), a different subarea will be selected for the composite sample. Sculpin from more than one subarea will not be composited. EPA and Ecology will be advised of the catch in each subarea before any sculpin of acceptable size are released each day if there is any question regarding which fish to retain.

Five Dungeness crab (> 90 mm) will be included in each composite sample of Dungeness crab edible meat. One composite sample will be collected from each area. Crab traps will be placed in subareas with the greatest Dungeness crab catch rate in 2004 (see Section 3.2.2.1).

To assess the relative concentrations (ratio) of total PCBs in English sole fillet and whole-body samples, three of the six whole-body samples will be analyzed as composite skin-on fillet and composite remainder samples, as described in Section 3.4. The PCB and lipid concentrations in these three "whole-body" composite samples will be calculated based on the weighted mean, as follows:

reconstructed concentration (µg/kg ww) for a whole-body composite sample

$$= (W_f x C_f + W_r x C_r)/(W_f + W_r)$$

where:

W_f and W_r are the total weights (in kg ww tissue) for the fillet and remainder samples, respectively

C_f and C_r are the concentrations (µg/kg ww, or percent lipid) for the fillet and remainder samples, respectively

The remaining three whole-body English sole composite samples in each area will be formed from five whole fish.

3.2 SAMPLING METHODS

Fish will be collected from the LDW using a high-rise otter trawl. Crabs will be collected in crab traps. Methods for sample identification, tissue sampling, and sample processing, as well as an equipment list are discussed in this section. Sample packaging and decontamination procedures are presented in Section 3.3 of the original QAPP (Windward 2004a).

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 PM, the boat captain, and the EPA or Ecology representative in the field, if applicable. LDWG, EPA, and Ecology will be consulted if modifications to sampling and processing methods are required. All modifications will be recorded in the protocol modification form (Windward 2004a, Appendix A).

3.2.1 Fish samples

3.2.1.1 Fish collection

Fish will be collected by trawling the LDW in late August/early September 2005 using the same trawling methods outlined in Section 3.2.3 of the original QAPP (Windward 2004a).

Trawling methods, described in this section, are based on systematic sampling of the four sampling areas and their subareas. The expected maximum daily effort is approximately 20 trawls, depending on site conditions and number of fish processed (Eaton 2004). Trawling will be conducted using the vessel *R/V Kittiwake*, captained by Charlie Eaton of Bio-Marine Enterprises, as described in the original QAPP (Windward 2004a).

Sampling areas are the same as those specified in the original QAPP (Windward 2004a); i.e., Areas T1, T2, and T3, with each being divided into six subareas (A-F), and T4 being divided into four subareas (A-D) as shown in Figure 2-1. At least one trawl will be conducted within each subarea, as described below. Each trawl line will be conducted within the bounding coordinates of the sampling subareas. The specific trawl line and order in which the subareas will be sampled will be determined by the boat captain based on logistical considerations. Within each subarea, an attempt will be made to conduct all trawls outside the navigation channel to capture fish using shallower habitats, although trawling within the channel may be necessary if a sufficient number of fish (e.g., English sole) are not caught outside the channel. Trawling will not be conducted in waters shallower than 6 ft deep (at the time of trawling), because the high-rise otter trawl is impractical in shallower areas (Eaton 2004). Tidal charts will be consulted to optimize the ability to trawl in shallower areas. Subsequent trawls in each subarea may follow the first trawl line or a different trawl line at the discretion of the boat captain in consultation with the FC. The date, time, and location of the trawl will be recorded on the fish tissue collection form (Windward 2004a, Appendix A) after each trawl is hauled out of the water.

Trawl start and end points will be recorded using a Trimble NT300D differential global positioning system (GPS) with 1-2 m accuracy. When the trawl is deployed on the bottom, GPS and clock readings will be recorded to mark the starting point of the trawl. Final GPS and clock readings will be recorded when net retrieval begins.

The maximum trawling effort will be 6 days. If target numbers of fish from Areas T1, T2, and T3 have not been obtained by the end of day 5, LDWG will consult with EPA and Ecology regarding priorities for day 6.

The order that sampling areas and subareas will be trawled over the course of the project and within a given day will be determined by both the FC and the trawl boat captain. Leaving this decision to the discretion of the field personnel maximizes their ability to respond to field conditions and exercise their professional judgment on fishing conditions. The trawl results will be reported each day to the Windward PM.

3.2.1.2 Fish tissue processing

Trawling will be conducted from the *R/V Kittiwake* using a live sampling technique, which will minimize the number of non-target species mortalities through species sorting and processing prioritization. All species captured using the methods outlined above will be placed in decontaminated bins filled with LDW water. Target fish of similar size will be preferentially selected and sorted. Dungeness crab of target size (> 90 mm) will also be retained if collected in trawls.

Specimens of target species that do not meet size requirements will be counted, lengths approximated, and returned to the LDW. As required by WDFW, specimens of non-target species will be identified to the lowest practical taxon and their numbers estimated. Special care will be taken to ensure that non-target organisms are returned to the LDW quickly, with minimal handling.

Pacific staghorn sculpin will be specially handled to minimize the number of sculpin taken from the LDW. As Pacific staghorn sculpin are sorted, they will be distributed to individual, clean bins filled with LDW water and marked with "A" through "F," corresponding to subareas in each sampling area. No sculpin will be bagged until a decision, per the subarea preferences given in Section 3.1, is made regarding the selection of the subarea in each area for the composite sample. Once the subarea is selected for a given sampling area, all sculpin in the remaining subareas for that area will be returned to the area from which they were collected.

Individual fish of the selected target species will be rinsed in LDW water to remove any foreign material from the external surface. Large target fish will be killed by placing the fish in a Ziploc bag, grasping the fish by the tail, and forcibly hitting its head on the processing table. Small fish will be killed by placing them on ice, as recommended by EPA (1995). Individual specimens of the target species will be grouped by species and general size class, and placed in clean holding trays to prevent contamination. All fish will be inspected carefully to ensure that their skin has not been damaged by the sampling equipment. The FC will discard specimens with broken skin. Each fish within the selected target species will be measured to determine total length (nearest mm) and weight (nearest 0.5 g). Fish will be weighed and measured by Windward personnel at ARI.

Individual specimens of the same species from a particular sampling area will be kept together in one large resealable plastic bag with the date, time, effort number, species, and collection method recorded on the outside in indelible ink. All other pertinent information will be traceable through the field notebook and collection forms

(Windward 2004a, Appendix A). The bagged and iced fish will be transported in coolers to Windward for final processing. Specimens will be processed at Windward within 48 hours of collection and shipped to ARI within 24 hours of processing. Fillets will be prepared at ARI.

3.2.2 Crab samples

3.2.2.1 Crab collection

Twelve crab traps will be deployed at locations outside of the navigation channel within each sampling area, three per area. Traps will be deployed until target numbers of each target species are obtained or the maximum level of trapping effort is reached (two days). The specific locations to be targeted will be based initially on where the most Dungeness crabs were captured in 2004. Specifically, subareas T1B, T1C, T2E, T3E, T3F, and T4B had the highest catch rate for Dungeness crab, per area, in 2004.

Crab trap sample locations will be recorded using a Magellan SporTrak GPS unit, upgraded to include the latest Wide Area Augmentation System (WAAS) technology, providing accuracy within 3 m. Coordinates will be taken at the deployment location. The FC will ensure that specimens are collected within the specified tissue sampling areas. Washington State Plane coordinates North (NAD 83) will be used for the horizontal datum.

Crabs will be collected using Ladner 30-in. stainless-steel rubber-wrapped crab traps. One trap will be attached to a float at each of the chosen sampling locations. Traps will be baited with a mixture of fish scraps and squid. Crab bait will be placed in mesh bait bags and tied to the inside of the trap so the bag cannot be opened and its contents consumed. All traps will soak for approximately two hours[4] before retrieval. All traps will be retrieved in the same order as they were deployed. The field crew will monitor the traps, to the extent possible, when fishing in areas of high vessel traffic. Any trap(s) determined by the FC to be a hazard to navigation will be moved to a new location within the same sampling subarea away from impending vessel traffic. Any traps lost during sampling will be replaced, and all traps will be outfitted with a degradable latch to ensure that escape holes will open if the trap is lost. The degradable latch will ensure that lost traps will not continue to fish indefinitely, thereby harming local crab, shrimp, or fish. The date, time, and location of the trap will be recorded during both trap deployment and retrieval.

During the retrieval phase, captured organisms will be sorted by species into decontaminated bins filled with LDW water. All non-target species will be identified to the lowest practical taxon and their number estimated. More sensitive species and

[4] The quarterly crab/shrimp surveys used a 4-hr soak time as a standard for assessing relative abundance at different locations, but a 2-hr soak time should be sufficient to capture the target specimens and still provide the field crew with enough flexibility for multiple deployments of the same trap during a single day.

life stages (i.e., juvenile salmonids, Pacific herring, smelt, juvenile tomcod) will be handled minimally and returned to the water as quickly as possible.

3.2.2.2 Crab tissue processing

Crabs will be inspected to ensure that their exoskeletons have not been cracked or damaged during the sampling process; damaged crabs will be discarded (EPA 2000). After crab traps have been retrieved, captured crabs will be rinsed with LDW water, and individual specimens will be grouped by target species and placed in clean holding trays to prevent contamination. Target crab specimens will be identified to species, measured to the nearest 1 mm, and weighed to the nearest 0.5 g. Crabs may be weighed and measured in the field or in the Windward laboratory at the discretion of the FC. Prior to processing, crabs will be placed on ice.

Crab carapace width measurements will be obtained using stainless-steel calipers and a measuring board, respectively. Crabs will be weighed using a handheld scale suited for the weight of the species (Pesola® 100 g x 1 g, Pesola® 300 g x 2 g, and Pesola® 1000 g x 10 g). Individual specimens of the same species from a particular sampling area and gear deployment (i.e., a single trap) will be kept together in one large resealable plastic bag with the date, time, effort number, species, and collection method recorded on the outside in indelible ink. All other pertinent information will be traceable through the field notebook and collection forms (Appendix B in the QAPP). The bagged and iced crabs will be transported in coolers to ARI for final processing. The edible meat will be removed from the crabs in the laboratory, not in the field.

Pacific staghorn sculpin of target size (> 120 mm) will also be retained if captured in crab traps. Crabbing personnel will coordinate with trawling personnel via cell phone to optimize the ability to meet sample size requirements in preferred subareas for sculpin without sacrificing more sculpin than necessary.

3.2.3 Identification scheme for all locations and samples

Unique alphanumeric identification (ID) numbers will be assigned to each individually wrapped fish and crab specimen in the field and recorded on the target fish collection form. Organisms other than the targeted fish and crab species will be recorded on the non-target species collection form, but no specimen ID will be assigned. The first three characters will be LDW to identify the project area. The next two characters will be 05 to indicate that the sample was collected in 2005. The next two characters will identify the specific tissue sampling area: T1, T2, or T3. The next character will identify the specific sampling subarea: A, B, C, D, E, F. The next five characters will identify the collection method and effort number: TR representing trawl or CT representing crab trap followed by a three-digit number representing the effort number (numbered sequentially over all areas) (e.g., the 15th trawl after the start of sampling would be TR015). The next two characters will identify the individual species type: English sole (ES),shiner surfperch (SS), Pacific staghorn sculpin (PS),

Dungeness crab (DC), or slender crab (SC). The next identifier will be numeric and indicate the sequential number of the specimen captured. As an example, the 11th English sole captured in Area T1, subarea C, in the 15th trawl would be identified as LDW-05-T1-C-TR015-ES-11. All relevant information for each individually wrapped and labeled target specimen, including specimen ID, length, weight, external abnormalities, sample date, time, and location number will be recorded on the target fish collection form (Windward 2004a, Appendix A) and included as an appendix to the data report. Therefore, all pertinent data associated with each individual fish or crab specimen can be tracked.

Composite samples will be identified using a similar convention, with the following changes. Effort number will not be indicated because specimens from multiple efforts may be included in each composite sample. Tissue type will be indicated as whole body (WB), remainder (RM), skin-on fillet (FL), or edible meat (EM); each sample for a given species and sampling area combination will be numbered sequentially following the letters "comp." If specimens from multiple subareas are included in the composite sample, the subarea designation would be replaced with an M. Corresponding remainder and fillet samples will be assigned the same composite number. For example, the 1st fillet composite English sole sample in Area T1, multiple subareas would be identified as LDW-05-T1-M-ES-WB-comp1 and the corresponding remainder sample would be identified as LDW-05-T1-M-ES-RM-comp1. Information will be compiled regarding the specific number of fish or crab from each subarea that were composited in each sample.

3.2.4 Field equipment

The items needed in the field for each sampling method are identified in Table 3-2. The FC will check that all equipment is included and in working order each day before sampling personnel go in the field.

Table 3-2. Field equipment for fish tissue collection

Necessary Field Equipment	High-Rise Otter Trawl	Crab Traps
QAPP and QAPP addendum	X	X
Key personnel contact information list	X	X
Field sample collection forms	X	X
Field notebooks (Rite in the Rain®)	X	X
Chain-of-custody forms	X	X
Pens, pencils, Sharpies	X	X
Tide tables	X	X
Study area maps	X	X
Fish identification guides	X	X
GPS (w/ extra batteries)	X	X
Digital camera	X	X
Cellular phone	X	X
Marine radio	X	X

Necessary Field Equipment	High-Rise Otter Trawl	Crab Traps
Alconox® detergent	X	X
Distilled water	X	X
Garden sprayer (for distilled water)	X	X
Scrub brushes	X	X
Paper towels	X	X
Garbage bags	X	X
Buckets (5 and 2 gallon)	X	X
Coolers	X	X
Ice (wet and/or dry)	X	X
Heavy duty aluminum foil	X	X
Ziploc® freezer bags (quart and gallon size for individual fish/crabs)	X	X
Ziploc® freezer bags (larger size)	X	X
Ziploc® sandwich bags (for individual sample labels)	X	X
Plastic bins for specimen sorting	X	X
Dip nets	X	
Calipers	X	X
Measuring boards	X	X
Scales	X	X
Crab traps (complete with floats, line, bait bags/jars, and weights)		X
Bait for crab/fish traps		X
Pike pole (for dislodging nets hung on underwater debris and trap retrieval)	X	X
High-rise otter trawl	X	
Cutting board		X
Knife		X
Powder-free nitrile exam gloves	X	X
Rubber work gloves	X	X
Rubber boots	X	X
Raingear	X	X
Waders		X
Personal flotation devices	X	X
Hard hats	X	
Head lamps	X	X
First aid kit	X	X
Duct tape	X	X

3.3 Sample Handling and Custody Requirements

This section summarizes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analysis. Additional details are presented in Sections 3.3.1 and 3.3.5 of the original QAPP (Windward 2004a).

Fish and crab processing will be conducted by Windward personnel at ARI. Fish and crab from each trawl or trap will be kept separate from one another and processed one at a time to ensure that individual specimens are tracked properly. Each individual of the target species will be weighed using an analytical scale accurate to 0.5 g, measured,

individually wrapped in heavy duty aluminum foil (shiny side out), enclosed in individual resealable plastic bags with an identification label (also enclosed in a resealable bag) (Windward 2004a, Appendix A), and immediately stored in coolers with wet ice. Total fish length will be measured as the length from the anterior-most part of the fish to the tip of the longest caudal fin ray (when the lobes of the caudal fin are compressed dorsoventrally). In keeping with EPA guidance, crab carapace width measurements will be made laterally across the carapace from tip of spine to tip of spine (EPA 2000). Additional observations of fish or crabs collected for chemical analysis will include general observations of individual specimen health, such as any visible signs of gender, morphological abnormalities, external lesions, parasites, or fin erosion. If time allows, photographs of external abnormalities will also be taken.

The FC will be responsible for reviewing count, length, weight, and external abnormality information of all species, and will correct any improperly recorded information. Within 24 hr of capture, all fish will be packed into coolers as described in the QAPP with ice and delivered to ARI to be held frozen until they are composited and homogenized. Specimen labels will be included with each shipment. Homogenization will not occur until EPA, Ecology, and LDWG have agreed on the final compositing scheme, which may depend on the specimens collected.

Sample labels will contain the project number, sampling personnel, date, time, specimen ID, and comments (Windward 2004a, Appendix A). The specimens included in each composite sample will be tracked using a composite specimen tracking form (Windward 2004a, Appendix A). This form will include the project number, the composite sample ID, the sample ID of each specimen included in the composite sample, and the length and weight of each specimen.

ARI will assign a unique sample identifier to each sample (using either project ID or laboratory ID). The laboratory will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The sample tracking record must contain, at a minimum, the name/initials of responsible individuals performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed.

Custody procedures will be used for all samples throughout the collection, transport, and analytical process, and for all data and data documentation, whether in hard copy or electronic format. Custody procedures will be initiated during sample collection. A chain-of-custody form will accompany samples to the analytical laboratory. Each person who has custody of the samples will sign the chain-of-custody form and ensure that the samples are not left unattended unless properly secured.

3.4 ANALYTICAL METHODS

Filleting, homogenization, and chemical analyses will be conducted at ARI. This section provides a brief summary of the analytical methods. See the original QAPP (Windward 2004a) for details involving QA/QC; instrument/equipment testing,

inspection, maintenance, and calibration; non-direct measurement; and data management.

Thawed or partially thawed whole fish will be homogenized as composite samples or individual fish, depending on the size of the fish. Large fish may need to be homogenized individually and then the individual homogenates combined to form the composite sample. Smaller fish may be composited prior to homogenization. For fillet samples, partially-thawed whole fish will be filleted (skin-on) and the fillets will then be homogenized. Prior to homogenization, Windward will review procedures with ARI to ensure that they will result in comparable data between the 2004 and 2005 sampling events. Any significant differences in methods will be discussed with EPA prior to homogenization.

Homogenates may be frozen; however, frozen homogenates from each individual fish comprising a composite sample must be re-homogenized before compositing for analysis. Any remaining homogenates or whole fish will be archived frozen for one year from collection.

Three of the six English sole whole-body composite samples from each area will be prepared according to the following procedure:

- Five fish will be selected for each composite sample
- Each of these fish will be filleted. The skin-on fillets from each of these five fish will be weighed and then combined into a single composite sample. The fillet composite sample will be analyzed for PCB Aroclors, lipids and moisture content.
- The remainder of each of these five fish (i.e., all tissues left after filleting) will be weighed individually and then combined into a single composite sample. Care will be taken to preserve all fluids that are released when fish are filleted. These fluids will be included in the remainder tissue to be homogenized.

The remaining three whole-body English sole composite samples from each area will be formed from five whole fish.

All composite samples collected from the LDW in 2005 will be analyzed for PCBs as Aroclors, lipids, and moisture content (Table 3-3). Analytical methods and laboratory sample handling requirements for all measurement parameters are presented in Table 3-4.

Table 3-3. Numbers of composite samples per LDW sampling area to be analyzed for each analyte group

Analyte	English Sole		Shiner Surfperch	Dungeness Crab	Pacific Staghorn Sculpin	Total per Area
	WB	Fillet	WB	EM	WB	
PCBs as Aroclors	6	3	6	1	1	17
Lipids	6	3	6	1	1	17
Moisture content	6	3	6	1	1	17

WB - whole body

EM – edible meat

Table 3-4. Analytical methods and sample handling requirements

Analyte	Method	Reference	Sample Holding Time	Container	Preservative
PCBs as Aroclors	GC/ECD	EPA 8082	1 year to extract, 40 days to analyze	aluminum foil (whole fish) glass jar (homogenate)	freeze/-20°C
Lipids	DCM extraction gravimetric	NOAA (1993)	1 year	aluminum foil (whole fish) glass jar (homogenate)	freeze/-20°C
Moisture content	Oven or freeze-dried	NOAA (1993) or PSEP (1997)	6 months	aluminum foil (whole fish) glass jar (homogenate)	freeze/-20°C

DCM – dichloromethane

GC/ECD – gas chromatography/electron capture detector

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Table 3-5 lists specific data quality indicators (DQIs) for tissue analyses. Interferences in individual samples may result in an increase in the reported quantitation limits. To achieve the required low quantitation limits, some modifications to the methods may be necessary. Composite samples for analysis will weigh at least 20 grams. The remaining homogenate will be archived frozen at ARI. Table 3-6 summarizes the QC procedures to be performed by the laboratory.

Table 3-5. Data quality indicators for tissue analyses

Parameter	Units	Precision	Accuracy	Completeness	Sensitivity (Method Detection Limit / Reporting Limit)
PCBs as Aroclors	µg/kg ww	±50%	38-150%	95%	3.9 / 20
Lipids	%	±30%	na	95%	0.1
Moisture content	%	±20%	na	95%	0.1

ww – wet weight

Table 3-6. Laboratory quality control sample analysis summary

Analysis Type	Initial Calibration	Continuing Calibration	Matrix Replicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Standard reference material	Surrogate Spikes
PCBs as Aroclors	prior to analysis	Every 10-20 analyses or 12 hrs	na	1 per batch or SDG	1 per batch or SDG	Each batch or SDG	na[a]	Each sample
Moisture content	na	na	1 per 20 samples	na	na	na	na	na
Lipids	na	na	1 per 20 samples	na	na	na	na	na

[a] A laboratory control sample will be used to assess accuracy because no tissue standard reference material is available for Aroclors

na – not applicable or not available

4.0 Assessment and Oversight

Details of compliance assessment and response actions are presented in the original QAPP (Windward 2004a).

5.0 Data Validation and Usability

Data are not considered final until validated. Data validation will be conducted following EPA guidance (EPA 1999). The project QA/QC coordinator is responsible for ensuring that all analyses performed by the laboratory are correct, properly documented, and complete, and that they satisfy the DQIs specified in Table 3.5.

Independent third-party data review and summary validation of the analytical chemistry data will be conducted by Laboratory Data Consultants, Inc. (LDC). A minimum of 10% or a single sample delivery group will undergo full data validation.

If no discrepancies are found between reported results and raw data in the set that undergoes full data validation, then validation can proceed as a summary validation on the rest of the data using all of the QC forms submitted in the laboratory data package. As part of the summary validation, all summary forms for calibrations, instrument performance, and internal standard summaries 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 data quality objectives

(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

Eaton C. 2004. Personal communication (LDWG, EPA and Ecology fish tissue experts meeting: discussion of English sole, shiner perch, pacific staghorn sculpin, and rockfish in the LDW with Matt Luxon, Windward Environmental). LDWG, Seattle, WA. 3/31/04.

EPA. 1995. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 1: Fish sampling and analysis. Second ed. EPA 823-R-95-007. US Environmental Protection Agency, Washington, DC.

EPA. 1999. USEPA contract laboratory program national functional guidelines for organic data review. EPA-540/R-99/008. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

Miller BS, McCain BB, Wingert RC, Borton SF, Pierce KV, Griggs DT. 1977. Ecological and disease studies of demersal fishes in Puget Sound near METRO-operated sewage treatment plants and in the Duwamish River. FRI-UW-7721. Fisheries Research Institute, University of Washington, Seattle, WA.

NOAA. 1993. Sampling and analytical methods of the National Status and Trends Program national benthic surveillance and mussel watch projects, 1984-1992. Vol 2: Comprehensive descriptions of complementary measurements. NOAA technical memorandum NOS ORCA 71. National Status and Trends Program, National Oceanic and Atmospheric Administration, Silver Spring, MD.

PSEP. 1997. Recommended guidelines for measuring organic compounds in Puget Sound water, sediment and tissue samples. Prepared for Puget Sound Estuary Program, US Environmental Protection Agency Region 10. Puget Sound Water Quality Action Team, Olympia, WA.

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