ROUND 1 FIELD SAMPLING REPORT
PORTLAND HARBOR RI/FS

March 14, 2003

DRAFT DOCUMENT: DO NOT QUOTE OR CITE
This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

Submitted to:
Lower Willamette Group

Submitted by:
Striplin Environmental Associates, Inc.
Fishman Environmental Services
Ellis Environmental Services
Windward Environmental, LLC
Anchor Environmental, LLC
Kennedy/Jenks Consultants

Formatted

TABLE OF CONTENTS

EXECUTIVE SUMMARY v
SUMMARY OF ROUND 1A FIELD ACTIVITIES v
SUMMARY OF ROUND 1 FIELD ACTIVITIES vii
SEDIMENT SAMPLING viii
BENTHIC INFAUNA/CLAM SAMPLING viii
FISH AND CRAYFISH SAMPLING ix
1.0 INTRODUCTION 1
2.0 CHRONOLOGY OF FIELD OPERATIONS 3
3.0 SEDIMENT SAMPLING 4
3.1 Co-located Surface Sediments 4
3.1.1 Navigation and Station Coordinates 4
3.1.2 Collection Methods 4
3.1.3 Sample Handling and Processing 6
3.2 Beach Sediments 6
3.2.1 Navigation and Station Coordinates 6
3.2.2 Collection Methods 6
3.2.3 Sample Handling and Processing 7
3.3 Other Surface Sediments 7
3.3.1 Navigation and Station Coordinates 7
3.3.2 Collection Methods 8
4.0 BENTHIC INFAUNA/CLAM SAMPLING 9
4.1 Soft-Bottom Benthic Infauna 9
4.1.1 Navigation and Station Coordinates 9
4.1.2 Collection Methods 9
4.1.3 Sample Handling and Processing 9
4.2 Clams 10
4.2.1 Clam Reconnaissance 10
4.2.2 Clam Collection 10
4.2.2 Sample Handling and Processing 11
5.0 FISH AND CRAYFISH SAMPLING 12
5.1 Navigation and Station Coordinates 13
5.2 Target Station Modifications 14
5.3 Equipment Decontamination 15
5.4 Fishing Methods 15
5.4.1 Beach Seine 15
5.4.2 Trot Line 15
5.4.3 Angling 16
5.4.4 Crayfish Traps 17
5.4.5 Boat Electrofishing 17
5.4.6 Backpack Electrofishing 18
5.5 Field Sample Handling and Processing 18
5.5.1 Data Management 19

Formatted

5.6 Analyses of Field Fish Sampling Techniques 20
5.7 Laboratory Sample Handling and Processing 21
5.7.1 Laboratory Location 21
5.7.2 Monitoring of Personnel in Laboratory 21
5.7.3 Laboratory Opening Procedures 21
5.7.4 Fish Processing Procedures 22
5.7.5 Sample Storing Procedures 24
5.7.6 Corrective Actions 24
5.7.7 Data Management 25
5.7.8 Laboratory Closing Procedures 26
5.7.9 Shipping 26
6.0 JUVENILE SALMONID MARK/RECAPTURE PILOT STUDY 28
7.0 REFERENCES 29
APPENDIX A: GRAB SAMPLE LOG SHEETS 31
APPENDIX B: SEDIMENT AND BENTHIC INFAUNA STATION SAMPLING COORDINATES 32
APPENDIX C: TABULATED FISH TISSUE DATA 33

Formatted

LIST OF TABLES

Table 1-1 Index of Field Notebooks
Table 2-1 Chronology of Field Operations
Table 3-1 Field Operation Schedule For Round 1 Sediment, Benthic infauna, and Clam Tissue Collection
Table 3-2 Summary Of Sample Types Composited For Round 1 Sediment, Benthic Infauna, and Clam Tissue Collection
Table 3-3 Summary of Collection Effort for the clam *Corbicula fluminea*
Table 5-1 Fish Catch Effort per Station
Table 5-2 List of Participants During Round 1A and Round 1 of Fish Tissue Collection
Table 5-3 Color Coding Scheme for Storage of Fish Samples

LIST OF FIGURES

Figures 1-1a-b The Willamette River ISA with General Station Locations
Figures 3-1a-b Station Locations for Sediment, Benthos, and Clam Tissue Collection
Figures 5-1a-e Fish Catch Effort per Station in the ISA of the Willamette River.
Figures 5-2a-c Sculpin Samples from the Willamette River ISA.
Figures 5-3a-c Crayfish Samples from the Willamette River ISA.
Figures 5-4a-b Largescale Sucker Samples from the ISA of the Willamette River.
Figures 5-5a-b Smallmouth Bass Samples from the ISA of the Willamette River.
Figures 5-6a-b Carp Samples from the ISA of the Willamette River.
Figures 5-7a-b Subyearling Chinook Salmon Samples from the Willamette River ISA.
Figures 5-8a-b Brown and Yellow Bullhead Samples from the ISA of the Willamette River.
Figures 5-9a-b Northern Pikeminnow Samples from the ISA of the Willamette River.
Figures 5-10a-b Black Crappie Samples from the Willamette River ISA.
Figures 5-11a-b Peamouth Samples from the Willamette River ISA.
Figures 5-12a-b Lamprey Ammocoetes and Walleye Samples from the Willamette River ISA.
Figure 5-13 Lab Sample Storage Log Data Sheet.
Figure 5-14 Species Relabeling Check Sheet.

Formatted

LIST OF ACRONYMS

CORS	Continuously Operating Reference Station
DGPS	Differential Global Positioning System
EES	Ellis Environmental Services
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
FES	Fishman Environmental Services
FSP	Field Sampling Plan
FL	fillet with skin and belly flap
FS	skinless fillet
HHRA	human health risk assessment
ISA	initial study area
GIS	Geographical Information System
GPS	Global Positioning System
MSS	Marine Sampling Systems
MTS	Marine Taxonomic Services, Ltd.
NSTS	National Sample Tracking System
LWG	Lower Willamette Group
RI/FS	Remedial Investigation/Feasibility Studies
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
SEA	Striplin Environmental Associates. Inc.
SOP	standard operating procedure
WE	Windward Environmental, LLC

Formatted

EXECUTIVE SUMMARY

This Round 1 Field Sampling Report (FSP) summarizes the Portland Harbor RI/FS Round 1/1A field sampling and reconnaissance activities that were conducted from June 24 through December 20, 2002.

Except where noted in the FSP or as modified by subsequent correspondence between the Lower Willamette Group (LWG) and the U.S. Environmental Protection Agency (EPA) (e.g., EPA letter dated September 20, 2002), all sample collection activities followed the procedures described in the Round 1A and Round 1 FSPs (SEA et al. 2002a,b) and the Fish Tissue Sampling Standard Operating Procedure (SOP) (SEA et al. 2002c). Fish tissue sample processing, including compositing, homogenization, and shipping, followed the procedures detailed in the Fish Tissue Compositing and Homogenization SOPs (SEA 2002a, SEA et al. 2002d). All laboratory analyses follow the EPA-approved project Quality Assurance Project Plan (QAPP) (SEA 2002b).

SUMMARY OF ROUND 1A FIELD ACTIVITIES

The following tasks were carried out according to the Round 1A FSP, which was approved by EPA on May 5, 2002:

- **Juvenile Salmonid Mark/Recapture Pilot Study**. A pilot study to gather information on mark/recapture methods was conducted July 8-9, 2002. When it was evident that water temperatures in the ISA had increased to levels that were stressful to juvenile salmonids when held in buckets prior to being marked, the study was terminated. There were no agency representatives present as observers during the brief study.
- **Collection of Fish Tissue for Chemical Analysis**. The fish tissue collection program was approved as part of Round 1A. Juvenile salmonids were collected for tissue analysis on June 24-27, 2002. The collection of other fish and crayfish occurred between July 22 and November 10, 2002. Details, including agency observers, are provided below.
- **Hard-bottom Benthos Sampling Using Multiplates**. Multiplates were deployed July 15-16, 2002 and were retrieved August 27-28, 2002. No regulatory agency representatives were present as observers.
- **Aquatic Plant and Amphibian/Reptile Reconnaissance**. The survey was conducted June 26-28, 2002. David Terpening and Joseph Goulet from EPA, Helen Hillman from NOAA, and Jeremy Buck from USFWS, observed the

Formatted

nighttime frog call procedures at one sampling location on the evening of June 26.

- **Adult Lamprey Harvest Reconnaissance Survey.** LWG consultants observed lamprey harvests by the Confederated Tribes of Siletz on June 26, 2002, and by the Yakama Nation on July 22, 2002. Because these harvest dates were not fixed in advance and required attendance on very short notice, neither DEQ nor EPA technical staff were able to observe.
- **Nearshore Deposition/Erosion Monitoring Using Sediment Stakes.** Stakes were installed in July and measured once a month from July 17 to December 12, 2002. No regulatory agency representatives were present as observers.
- **Summer 2002 Bathymetry Survey.** The summer 2002 bathymetric survey was conducted in two phases. RM 2 to 11 were surveyed between July 3 and 18, 2002. Following a review of these data, river mile (RM) 0 to 2.5 and 10.5 to 15.6 were surveyed between September 16 and 20, 2002. This bank-to-bank survey was conducted during the low water season to obtain summertime riverbed elevations for comparison with the riverbed elevation data collected during December 2001 and January 2002. No regulatory agencies were present during the surveys.

In addition, the following two activities were performed:

- **Seep Reconnaissance Survey**. As requested by EPA in a letter dated September 20, 2002, the LWG conducted a seep reconnaissance survey on October 7 and 8, 2002. Eric Blischke from the Oregon Department of Environmental Quality (DEQ) and Renee Fuentes from the EPA accompanied representatives of the LWG on a subsequent tour of the identified seep areas on October 24, 2002.
- **Juvenile Lamprey and Benthic Infaunal Biomass Reconnaissance Surveys**. During the fish tissue sampling program, the LWG became concerned that juvenile lamprey were not being collected using proposed techniques. The LWG conducted a reconnaissance grab sampling survey on September 16 and 17, 2002 for juvenile lamprey at 21 of the 22 co-located sediment and tissue sampling stations originally identified in the June 2002 LWG Field Sampling Plan. Concurrently, the LWG

Formatted

collected benthic samples to assess the potential success of the benthic infauna tissue collection program. On October 8 and 9, 2002, a field team consisting of two lamprey biologists from the Umatilla tribe (Aaron Jackson and Brandon Trelor), Helen Hillman of NOAA, and LWG consultants visited 11 lower Willamette sites for a follow-up reconnaissance using specialized lamprey electroshocking equipment.

Details of the sampling associated with most of the tasks listed above have been described in individual task reports that are being provided to EPA under separate cover. The status of these reports is:

- Aquatic Plant and Amphibian/Reptile Reconnaissance Survey (Windward 2003a)
- Benthic Macroinvertebrate Community Sampling (Windward 2003b)
- Adult Lamprey Reconnaissance Survey Technical Memorandum (Kennedy/Jenks 2003)
- Sediment Stake Erosion/Accretion Analysis (Anchor Environmental in prep.)
- Lower Willamette River Multibeam Bathymetric Survey, Summer 2002 (DEA 2003)
- Results of Seep Reconnaissance Survey RM 2-10.5 Lower Willamette River (GSI 2002)
- Technical Memorandum: Lamprey Ammocoete and Benthic Infaunal Biomass Reconnaissance Surveys of the Lower Willamette River (SEA and Windward 2003).

Fish tissue data will be reported in the Round 1 Site Characterization Report.

SUMMARY OF ROUND 1 FIELD ACTIVITIES

Round 1 field activities included the following tasks, which were approved by EPA in a letter dated September 20, 2002:

- Collection of sediments at sculpin, crayfish, and benthic infauna stations
- Collection of composited beach sediments
- Collection of benthic infauna
- Collection of clams for tissue analysis.

Formatted

Each of these activities is described in more detail in the following section. Results of these tasks will be provided in the Round 1 Site Characterization Report.

SEDIMENT SAMPLING

To support the human health risk assessment (HHRA), composite surface beach sediment samples were collected at 20 beaches in the Initial Study Area (ISA) as described in the Round 1 FSP and EPA's letter of September 20, 2002. Beach sediment sampling occurred from October 9 through 14. At each beach, samples were generated by combining randomly selected, individual 0- to 15-cm surface samples into a single composite. All sediments were collected using stainless-steel hand corers. Mike Poulsen (DEQ) participated in the beach sediment collection and modified the definition (start or end point) of some target beaches during the field sampling.

Surface sediments (0-15 cm) collected for chemical analyses to support the ecological risk assessment (ERA) were collected at two types of stations. First, as described in the FSP, co-located sediments were collected at all nearshore sculpin and/or crayfish tissue sampling stations (12 of these stations also included infauna sampling stations). Second, surface sediments for chemical analysis were also collected at 10 additional benthic infauna stations to provide additional information on the distribution of benthic infauna in the ISA. These stations were situated in both nearshore areas and in the navigation channel to supplement the distribution of the 27 sculpin/crayfish co-located stations. The co-located surface sediment samples were collected from October 16 through 25, with an additional sampling day on November 12, 2002.

All surface sediments were collected using either a 0.1-m^2 van Veen grab sampler provided by SEA or a 0.3-m^2 hydraulic power grab sampler provided by Marine Sampling Systems. Co-located surface sediment sample collection procedures were observed by Dana Davoli (EPA), Helen Hillman (NOAA), and Jennifer Peterson (DEQ).

BENTHIC INFAUNA/CLAM SAMPLING

Soft-bottom benthic samples were collected from 22 stations in the ISA from October 22-25, 2002. Benthic infauna were collected at 12 of the sculpin/crayfish co-located sediment stations and at the 10 additional stations in both nearshore areas and in the navigation channel. Infauna were collected with a 0.1-m^2 van Veen grab sampler and sieved through a 0.5-mm sieve box. For the ecological risk assessment, a single replicate was collected at each location to provide a qualitative indication of the benthic infaunal assemblages throughout the harbor.

Formatted

During the juvenile lamprey/benthic infauna reconnaissance survey conducted in September 2002 (reported under separate cover), it was determined that the non-native bivalve species *Corbicula fluminea* was the largest and most widespread benthic invertebrate in the ISA. In some locations, *Corbicula* appeared to be abundant enough to allow for the collection of sufficient biomass for tissue chemical analyses. In October and November, clam collection was attempted by repeated casts of a 0.1 m^2 van Veen grab sampler at five target locations. Also, at one location, an unsuccessful attempt was made to rake clams from a shallow subtidal beach. Clam collection was attempted over multiple sampling days at each location. After considerable total effort (over 500 van Veen casts), two locations near the center of the ISA yielded more than 150 grams of tissue, which is the minimum biomass required to conduct tissue analyses for a full suite of target analytes. Fifty-three grams were collected at a third station, while the remaining two stations yielded only nominal amounts. Clam sampling occurred from October 29 through November 5, with an additional day on November 12.

FISH AND CRAYFISH SAMPLING

Before fish tissue sampling began, the LWG established a fish sample processing field laboratory and field equipment storage area, located in former laboratory space at the decommissioned ATOFINA plant in Portland. This field laboratory was outfitted with a water de-ionizing unit, venting hood, two sinks, and all laboratory safety equipment listed in the SOP. David Terpening (EPA) visited and approved the use of the field laboratory space. In addition, he observed a "dry run" of the fish processing procedures and approved the methodology being used. EPA project managers Wallace Reid, Chip Humphrey, and Tara Martich conducted a final visit to the laboratory, where the fish processing team from Fishman Environmental Services (FES) clarified any additional questions about fish processing procedures.

For the ERA and the HHRA, 11 fish species and one crayfish species were targeted for tissue analyses. The target species for the ERA were northern pikeminnow, smallmouth bass, sculpin, subyearling chinook salmon, peamouth, largescale sucker, Pacific lamprey ammocoetes, and crayfish. For the HHRA, the target species were carp, black crappie, bullhead, smallmouth bass, and crayfish. In addition, walleye and largescale sucker were collected as alternative species for bullhead and carp, respectively. These alternate species were not used for tissue analyses because adequate numbers of bullhead and carp were collected.

During the Round 1A collection of subyearling chinook salmon from June 24 through June 27, 2002, beach seining and dip netting were the only fishing techniques used. The beach seining procedure was observed by David Terpening and Joseph Goulet from EPA, Helen Hillman from NOAA, and Jeremy Buck from USFWS. The intended mark and recapture pilot program for subyearling

Formatted

chinook salmon was halted after signs of heat stress were observed in fish held in buckets prior to marking.

During the Round 1 collection of all remaining species from July 22 through November 10, 2002, six fishing techniques were used. These included beach seining, boat electrofishing, backpack electrofishing, trot line, angling, and crayfish traps. At the beginning of the Round 1 field program, fishing techniques, sample handling, and fish processing were observed in the field by David Terpenning of EPA and Eric Blischke from DEQ. Subsequent visits were made by Joseph Goulet (EPA) and Helen Hillman (NOAA), who, along with LWG consultant field managers and field crew, helped clarify issues such as station definitions and appropriate fishing methods.

The LWG field teams collected fish in the ISA, both day and night, over 79 days. A total of 1,870 fish were collected, including 863 sculpin, 419 crayfish, 128 largescale sucker, 90 smallmouth bass, 78 carp, 92 subyearling chinook salmon, 64 brown bullhead, 35 northern pikeminnow, 48 black crappie, 30 peamouth, 18 yellow bullhead, 3 lamprey ammocoetes, and 2 walleye. Forty-two individuals participated in the fish tissue collection effort. Striplin Environmental Associates staff coordinated the effort, which was carried out by personnel from Ellis Ecological Services, Fishman Environmental Services, Windward Environmental, Kennedy/Jenks Consultants, and Anchor Environmental. All people directly involved with the fishing effort were authorized to collect fish under the scientific taking permit granted by the Oregon Department of Fish and Wildlife to Ellis Ecological Services. With the exception of juvenile lamprey, the 2002 fish sampling program was successful in collecting all target species at all target locations in the ISA to satisfy the Round 1 data needs of the human health and ecological risk assessments.

Fish samples were processed at the field laboratory by a field laboratory staff led by Fishman Environmental personnel. Fish specimen sample handling and processing procedures followed those detailed in EPA-approved project SOPs and QAPP. Following final agreement with EPA on fish sample compositing schemes, frozen samples were shipped to Axys Analytical Services Ltd. (Sidney, B.C., Canada) for tissue homogenization.

Formatted

1.0 INTRODUCTION

This document describes field operations carried out during Round 1A and Round 1 (2002) of the Portland Harbor RI/FS from June 24 to December 20, 2002. Except where noted in the sections that follow, all field activities, including navigational positioning, data management, sample collection, and sample handling and processing, followed guidelines specified in the Round 1 Work Plan (SEA et al. 2002), Round 1A and 1 field sampling plans (SEA et al. 2002a,b), and Fish Tissue Sampling Standard Operating Procedure (SOP) (SEA et al. 2002c).

The 2002 Round 1A and Round 1 Portland Harbor RI efforts described here include collection of the following samples:

- Sediments at sculpin, crayfish and benthic infauna stations (co-located sediments)
- Composited beach sediments
- Benthic infauna
- Clams for tissue chemistry analyses
- Crayfish for tissue chemistry analyses
- Fish for tissue chemistry analyses
- Juvenile salmonids for the mark/recapture pilot Study

The results of additional 2002 investigation efforts described in the Round 1A FSP are provided as individual reports under separate cover. These activities included the following:

- Aquatic plant and amphibian/reptile reconnaissance (Windward 2003a)
- Hard-bottom benthos sampling using multiplates (Windward 2003b)
- Lamprey harvest reconnaissance survey (Kennedy/Jenks 2003)
- Nearshore deposition/erosion monitoring using sediment stakes (Anchor in prep.)
- Summer 2002 river-wide bathymetry survey (DEA 2003).

In addition, the following three activities were performed:

- Juvenile lamprey reconnaissance (SEA and Windward 2003)
- Soft-bottom benthos tissue reconnaissance (SEA and Windward 2003)
- Seep reconnaissance survey (GSI 2002).

Figures 1-1a-b show the general locations of all stations where sediment, tissue (fish, crayfish, and clams) and benthic infauna were collected in 2002 and include a station-by-station summary of the collected media, species, and planned laboratory analyses. Table 1-1 is an index of all field notebooks associated with

Formatted

this nearly 5-month sampling program. Originals and copies of all field notes are stored in the LWG Project Library at Striplin Environmental Associates'(SEA) Olympia, WA office.

Formatted

2.0 CHRONOLOGY OF FIELD OPERATIONS

Table 2-1 summarizes the chronology of the 2002 field operations described in this report. The collection of subyearling chinook salmon in the ISA took place from June 24-27, 2002 during Round 1A sampling. The Juvenile Salmonid Mark/Recapture Pilot Study occurred on July 8 and 9, 2002. The collection of all other fish species and crayfish was performed during Round 1 sampling from July 22 to November 10, 2002. Beach sediment sampling occurred from October 9-14, 2002 and co-located surface sediments were collected from October 16-25, 2002 with an additional sampling day on November 12, 2002. Benthic infauna were sampled from October 22-25, 2002 and clams were collected from October 29 to November 5, 2002, with and additional day on November 12, 2002.

Formatted

3.0 SEDIMENT SAMPLING

Surface (0-15 cm) sediments for chemical analyses were collected at nearshore sculpin and/or crayfish tissue sampling locations and benthic infauna stations located adjacent to and in the main channel stations to support the ecological risk assessment (ERA). Composite surface beach sediment samples were collected for chemical analyses to support the human health risk assessment (HHRA). All sample logs are provided in Appendix A.

3.1 CO-LOCATED SURFACE SEDIMENTS

Co-located sediments were collected from 27 stations in the ISA from October 16 to November 12, 2002 (Figures 3-1a-b, Tables 3-1 and 3-2). Field operations were conducted using a 29-foot aluminum-hulled research boat provided and operated by John Vlastelicia (Scapoose, OR), or the *R/V Nancy Anne* provided and operated by Marine Sampling Systems (Burley, WA).

3.1.1 Navigation and Station Coordinates

SEA subcontractor, David Evans & Associates, provided computer-integrated navigation aboard John Vlastelicia's boat using a Trimble 4000SE Differential Global Positioning System (DGPS). Differential corrections were obtained real-time via radio broadcasts from the Continuously Operating Reference Station (CORS) site at Appleton, WA. Positions were recorded in Coastal Oceanographics Hypack Max for real-time stationing and monitoring of sampling operations. Hypack allows the raw coordinates (WGS84 geodetic) to be displayed in project coordinates (U.S. State Plane, North American Datum 1983, Oregon North Zone).

Marine Sampling Systems provided its own computer-integrated navigation system for operations aboard the *R/V Nancy Anne*. Horizontal positions were acquired using a Trimble AG132 DGPS. Real-time differential corrections were obtained from the CORS site at Appleton, WA. Positions were logged in Mapsite Navigational Software. In addition, at the start and conclusion of each survey day aboard the *R/V Nancy Anne*, the vessel was piloted to a known, fixed location and the vessel position recorded. This served as a daily check on navigation system accuracy.

Geographic information system (GIS) coordinates with observed depths for each grab sample can be found in Table B-1 (Appendix B).

3.1.2 Collection Methods

All sample collection was conducted in accordance with procedures described in the Round 1 FSP (SEA 2002b).

Formatted

Co-located surface sediments were collected from a total of 27 stations. A summary of sample types collected from each station is presented in Table 3-2. All surface sediments were collected using either a 0.1-m^2 single van Veen grab sampler provided by SEA or a 0.3-m^2 hydraulic power grab sampler provided by Marine Sampling Systems. The target surface sediment-sampling interval was from 0-15 cm below the sediment-water interface. In fine-grained sediments, a 0- to 15-cm sediment sample was routinely obtained. In sandy areas, some samples less than 15 cm in depth were obtained using the van Veen and accepted per the Puget Sound Estuary Program guidelines (PSEP 1986) cited in the Round 1 FSP (SEA 2002b). In all cases, the penetration depth of all samples retained was recorded on sample collection log sheets.

Upon retrieval of the grab sampler, a SEA staff geologist described the contents of the grab and recorded the description onto a sample log sheet. The following parameters of each grab were described:

- **Time.** The time (local) when the grab sampler reached the river bottom was recorded.
- **Penetration Depth.** The maximum penetration from the center of the grab sampler into the sediment was measured.
- **Texture/Grain Size.** The average grain size, including any noticeable changes in particle size with depth was described. Any sedimentary layering within was also noted.
- **Sediment Color.** The color of the sediment was noted, including any variations in color with depth.
- **Notable Odors.** Any odor emanating from the sediment was described. The relative strength of the odor was also noted.
- **Debris.** Any debris, including organic debris such as wood, contained within the sediment was described.
- **Sample Quality.** Any other notable features of the grab contents were described.

Copies of all sample log sheets are provided in Appendix A. Original sample log sheets are on file in the LWG Project Library at SEA's office in Olympia, WA.

Only sediment that did not come into contact with the walls or top screens of the grab sampler was collected for chemical analyses. A minimum of three casts of the grab sampler was taken at each station to generate a composite. Sample compositing proceeded as described in the Round 1A FSP (SEA 2002d). A representative volume of sediment from each grab was scooped into a stainless-steel bowl using a stainless-steel spoon. Once sediment was collected from the final grab, the sediment was stirred to form a homogenate that was consistent in both texture and color. The sediment was then scooped into individual sample

Formatted

jars (see below). Sediment samples for volatile organics analysis were collected immediately upon retrieval from an undisturbed, randomly chosen grab.

3.1.3 Sample Handling and Processing

As described above, homogenized sediment at an individual station was transferred to glass sample jars provided by the analytical laboratories. Care was taken to transfer the sediment from the mixing bowl to the jars as quickly as possible following homogenization to minimize the potential for contamination from an outside source. Sample jars were capped, labeled, bagged individually, and stored in a cooler on ice until the end of the sampling day. At the end of each field day, samples were transported by the field crew to the LWG field lab at the ATOFINA Chemicals. facility in Portland, OR. There, samples that could be frozen were transferred to a chest freezer. Those samples that could not be frozen (grain size, volatile organics) were held on ice for up to 4 days until they could be transported to SEA's office in Olympia, WA.

Frozen sample jars were immediately transferred into a chest freezer upon arrival at the SEA office in Olympia. Grain-size and volatile organic sample jars were transferred into refrigerators. Sample jars were wrapped in bubble-wrap and placed with ice in coolers for shipment to the analytical laboratories. All chain-of-custody requirements outlined in the FSP (SEA 2002b) were followed.

3.2 BEACH SEDIMENTS

Sediments from 20 beaches were collected along the ISA from October 10-14, 2002 (Figures 3.1a-b, Table 3-2). FES provided a 20-foot vessel for transport to the target beaches and navigation/station positioning on the beaches.

3.2.1 Navigation and Station Coordinates

Representatives from FES recorded station coordinates for beach sediment collection using a Corvallis MicroTechnology (CMT) hand-held unit, model MC-GPS. Once data gathering in the field was completed, the GPS technician differentially corrected the GPS points and converted them to GIS points. The GPS points could then be overlaid on aerial photographs or project maps. GPS data typically yield 95% precisions ranging from 0.277 to 0.469 meters (0.91 to 1.54 feet).

3.2.2 Collection Methods

Beach sediments were collected from a total of 20 stations. A summary of types of samples collected from each station is presented in Table 3-2. Beach sediments consisted of sediments from 0-15 cm below the ground surface. All sediments were collected using stainless-steel hand corers.

Formatted

To collect beach sediment, field personnel were transported to a given beach by boat. A FES technician recorded the GPS coordinates at a pre-determined starting location on the beach. Each beach was sub-divided into three transects parallel to the shoreline, as described in the FSP (SEA 2002b). The river water-line was set as the bottom of the beach (transect 1). The vegetation of the upland edge of the sand was set as the top of the beach (transect 3), and one-half the distance between these transects was set as the mid-beach (transect 2). Each beach was sampled using the stainless-steel hand-corers at a minimum of three locations, depending on the total length of the beach. FES technicians measured off a pre-determined distance from the starting location where the first beach coordinates were recorded. A pre-determined randomly-selected transect (1, 2, or 3) was then sampled at each pre-determined measured distance from the starting point. Sediment retained in the hand-corer was transferred into a foil-covered stainless steel bowl. Subsequent sampling of the beach proceeded in this manner until the preset number of randomly chosen locations (both along and up or down the beach) was sampled to form a composite.

3.2.3 Sample Handling and Processing

Homogenized sediment from each beach composite was transferred into glass jars (provided by the analytical laboratories) immediately after mixing. Labeled sample jars were then placed inside resealable plastic bags and placed in a cooler with ice. At the end of each field day, samples were transported by the field crew to the LWG field lab at ATOFINA. There, samples that could be frozen were transferred to a chest freezer. Those samples that could not be frozen (grain size) were held on ice, up to four days, until they could be transported to SEA's office in Olympia.

Frozen sample jars were immediately transferred into a chest freezer upon arrival at the SEA office in Olympia. Grain-size sample jars were transferred into refrigerators. Sample jars were wrapped in bubble-wrap and placed with ice in coolers for shipment to the analytical laboratories. All chain-of-custody requirements were followed as outlined in the FSP (SEA 2002b).

3.3 OTHER SURFACE SEDIMENTS

Sediment was collected from 10 additional nearshore and in-channel stations in the ISA from October 28-29, 2002 (Figures 3-1a-b, Table 3-2). All field operations were conducted onboard the *R/V Nancy Anne*. These 10 stations were placed at both nearshore and channel locations that supplemented the distribution of the 27 co-located stations.

3.3.1 Navigation and Station Coordinates

Horizontal positions were acquired onboard the *R/V Nancy Anne* using a Trimble AG132 DGPS as described above in Section 3.1.1.

Formatted

3.3.2 Collection Methods

All sample collection was conducted according to guidelines outlined in the FSP (SEA 2002b). A summary of types of samples collected from each station is included in Table 3-2. Sediments were collected and handled, as described above (Sections 3.1.2 and 3.1.3), using a van Veen grab. A hydraulic power grab was used once because of the presence of wood debris, which precluded the closing of the van Veen grab.

Formatted

4.0 BENTHIC INFAUNA/CLAM SAMPLING

4.1 SOFT-BOTTOM BENTHIC INFAUNA

Soft-bottom benthic infauna samples were collected from 22 stations in the ISA (12 co-located stations, 10 nearshore/channel stations) over a non-consecutive period from October 22-29, 2002 (Tables 3-1 and 3-2, Figures 3-1a-b). All benthic infauna sampling was conducted onboard the *R/V Nancy Anne.*

4.1.1 Navigation and Station Coordinates

Horizontal positions were acquired onboard the *R/V Nancy Anne* as described in Section 3.1.1. GIS coordinates with observed depths for each grab sample can be found in Table B-1 (Appendix B).

4.1.2 Collection Methods

A summary of the types of samples collected from each station is presented in Table 3-2. Benthic infauna collections were paired with either co-located sediment stations or with the 10 additional nearshore and channel sediment stations. Upon arrival at each benthos/sediment station, the first cast of the 0.1-m^2 single van Veen grab sampler was designated as a benthos grab. A benthic ecologist onboard would first make a determination concerning the suitability of the grab for processing. If the contents of the grab were deemed acceptable, the entire contents of the grab were emptied into a 0.5-mm sieve box. The contents of the grab were then gently washed through the sieve box using site water. The material retained from each screen was rinsed into separate, labeled polyethylene bags. To preserve the infaunal samples in the field, a solution of 88.3 % ethyl alcohol was added to each sample bag after removing most of the overlying water from the sample.

Three additional grabs were then collected from each location to form a composite sample for sediment chemical analyses as described in Section 3.1.2.

4.1.3 Sample Handling and Processing

At the end of each field day, the benthic infauna samples and co-located sediment samples were transported by the field crew to the LWG field lab at ATOFINA. There, infauna samples were stored in coolers until they could be transported to the SEA office in Olympia. Sediment samples were handled and stored as described in Section 3.1.3.

Benthic infaunal samples were shipped to Howard Jones of Marine Taxonomic Services, Ltd. in Corvallis, OR in a single batch for sorting by major taxonomic groups. Samples were then sent to EcoAnalysts, Inc. in Moscow, ID for species identification or determination to the lowest practical taxonomic level. All chain-of-custody requirements outlined in the FSP (SEA 2002b) were followed.

Formatted

4.2 CLAMS

During a reconnaissance of the site in September 2002 (SEA and Windward 2003), the non-native bivalve species, *Corbicula fluminea*, was determined to be the largest, most widespread, and abundant soft-bottom organism for tissue chemical analyses in the ISA.

4.2.1 Clam Reconnaissance

Additional clam reconnaissance information was gathered during the co-located sediment and benthic infauna station sampling conducted from October 10-23, 2002. During this period, the presence of *C. fluminea* specimens was noted to estimate which stations might have relatively high abundances of clams. Based on these observations, five locations were estimated to have relatively high clam densities (Table 3-3, Figures 3-1a-b). Also during this sampling, clams representing a range of sizes were collected and measured along their two major axes, dissected, and their soft tissue weighed. By measuring and weighing clams across the range of observed sizes, a correlation was made between the length of the clams and their wet-tissue weight. This relationship was used to estimate total clam tissue biomass collected during the follow-on clam collections.

4.2.2 Clam Collection

Between October 24 and November 12, 2002, clam tissue collection was attempted at the five target locations listed in Table 3-3. At each station, replicate drops of a 0.1-m^2 single van Veen grab sampler were repeated in an effort to collect the required estimated total combined weight of *C. fluminea* for tissue analyses (150 g/station) (An additional ~110 g of *C. fluminea* [total 260 g] were collected at station 06R002 for laboratory QC analyses). Following retrieval of each grab, the contents of the grab were emptied onto a sampling table or tray and searched for *C. fluminea*. Only organisms with a maximum shell-width greater than 1.5 cm were retained for processing and analyses as smaller clams were determined to have negligible tissue biomass. The bottom of the sampling tray aboard the *R/V Nancy Anne* was modified with a 1-cm steel mesh screen. Sediment from the grab that was emptied onto the tray was washed using site water, and clam specimens retained by the screen were thoroughly washed to remove as much sediment from the outer shell as possible. Clams were measured along their longest axis, and counted.

At the end of each sampling effort at a given station, *C. fluminea* specimens were wrapped together in aluminum foil and placed in a plastic bag. The name of the station and the date were recorded on the outside of each plastic bag, and the bags were placed in a cooler with ice onboard the sampling vessel until they could be transported to the ATOFINA lab at the end of each sampling day.

Table 3-3 summarizes the effort required to collect *C. fluminea* tissue at the five target stations. Spatial variability was high as indicated by the numerous grab

Formatted

deployments (from 54 to 219 grabs) at each station requiring up to four sampling days per station. Clam collection at station 07R003 proved most difficult. Grab sampling at this station first took place on October 29, 2002, yielding 12 clams (approx. 18 g) after 91 grabs and 2.5 hours. Subsequently, attempts were made to collect *C. fluminea* on the beach and shallow sand spit adjacent to 07R003 (both beach raking and grab sampling efforts were made). Station 07R030 was later defined as a new location adjacent to station 07R003 due to the expanded search area (Figure 3-1b); minimal clam biomass (14.5 g) was obtained in this location.

4.2.2 Sample Handling and Processing

At the end of each field day, clams were transported by the field crew to the LWG field lab at ATOFINA. There, samples were frozen in a chest freezer until they could be transported to the SEA office in Olympia. Upon arrival at the SEA office, frozen samples were immediately transferred from coolers into a chest freezer.

Formatted

5.0 FISH AND CRAYFISH SAMPLING

Collection of fish and crayfish tissue from the ISA followed guidelines outlined in the Fish Tissue Sampling SOP (SEA et al. 2002c). Eleven fish species and one crayfish species were identified for tissue analyses for the ecological and human health risk assessments. The target species for the ERA were:

- Northern pikeminnow (*Ptychocheilus oregonensis*)
- Smallmouth bass (*Micropterus dolomieui*)
- Sculpin (*Cottus sp.*)
- Subyearling chinook salmon (*Oncorhynchus tshawytscha*)
- Peamouth (*Mylocheilus caurinus*)
- Largescale sucker (*Catostomus macrocheilus*)
- Lamprey ammocoetes
- Crayfish.

Of these species, only lamprey ammocoetes could not be found in sufficient numbers for tissue analyses.[1]

The target species for the HHRA were:

- Carp (*Cyprinus carpio carpio)*
- Black crappie (*Pomoxis nigromaculatus)*
- Bullhead (*Ameiurus nebulosus*)
- Smallmouth bass (*Micropterus dolomieui*)
- Crayfish.

In addition, walleye and largescale sucker were collected as alternative species for brown bullhead and carp, respectively. These alternate species were not used for tissue analyses because adequate numbers of bullhead and carp were caught.

Beach seining and dip netting were the only sampling techniques used during Round 1A for the collection of subyearling chinook salmon. Six sampling techniques were used during Round 1 to collect fish: beach seining, boat electrofishing, backpack electrofishing, trot line, angling, and crayfish traps. The sampling techniques, amount of effort, and number of fish caught per station are summarized in Table 5-1; the actual locations fished using the various methods are shown in Figures 5-1a through 5-1e.

[1] A concerted effort was made to locate lamprey ammocoetes in the ISA by LWG and tribal biologists over four days in September and October 2002 without success. Methods tested and observations made during this effort are reported in SEA and Windward (2003).

Formatted

A total of 1,870 fish were collected in 79 days. Tables C-1 and C-2 (Appendix C) provide an information record of each fish caught during the Round 1A and Round 1 sampling effort. The fish included 863 sculpin (Figures 5-2a, b, and c), 419 crayfish (Figures 5-3a, b, and c), 128 largescale sucker (Figures 5-4a and b), 90 smallmouth bass (Figures 5-5a and b), 78 carp (Figures 5-6a and b), 92 subyearling chinook salmon (Figures 5-7a and b), 64 brown bullhead (Figures 5-8a and b), 35 northern pikeminnow (Figures 5-9a and b), 48 black crappie (Figures 5-10a, and b), 30 peamouth (Figures 5-11a, and b), 18 yellow bullhead (Figures 5-8a and b), 3 lamprey ammocoetes (Figures 5-12a, and b), and 2 walleye (Figure 5-12a).

Fishing efforts required a substantial amount of resources and personnel. SEA staff coordinated the overall effort, which was carried out primarily by personnel from Ellis Environmental Services (EES), with assistance from FES, Windward Environmental (Windward), Kennedy/Jenks Consultants (Kennedy/Jenks), and Anchor Environmental. Table 5-2 lists the names of the 42 individuals who participated in the fish tissue collection effort.

All people directly involved with the fishing effort were authorized to collect fish under the scientific taking permit granted to ESS by the Oregon Department of Fish and Wildlife.

5.1 NAVIGATION AND STATION COORDINATES

Trimble GeoExplorer 3 Global Positioning System (GPS) units were used to record coordinate data, the time and date of each sampling effort, and the numbers of fish collected, retained, or released. A data dictionary and menu-driven data collection system were developed by EES and programmed into the GPS units to facilitate consistent data collection techniques and to minimize data entry errors. Handwritten field notebooks were also used to duplicate data collected using the GPS units and make note of any other field observations. The coordinate data were downloaded periodically from the GPS units at EES, differentially corrected (using Portland State University base station data), and projected from geographic coordinates to the state plane coordinate system. Handwritten field notebooks also were collected periodically from the field crew to accompany the GPS data. These data were reviewed immediately after periodic downloads to communicate and correct any data entry errors with the field crew.

Prior to September 19, 2002 all positional data were obtained using point coordinates. This included boat electrofishing, backpack electrofishing, beach seining, trot lines, and angling efforts. Sampling points, representing a particular sampling effort, were derived by averaging coordinates collected each second by the GPS unit. The area sampled during each effort was dependent upon the sampling objectives for the species being collected and the sampling gear used.

Formatted

The field crew used hardcopy maps describing the general location of each sampling location or area to determine where to focus sampling efforts.

To address U.S. Environmental Protection Agency (EPA) concerns regarding the area sampled while electrofishing, methods used to record positional data were modified on September 20, 2002 to include the collection of line data. Once the GPS units were reprogrammed and field crew retrained, boat and backpack electrofishing efforts were represented by line data consisting of "vertices", or points of inflection, collected every 5 seconds and "nodes" collected at the beginning and end of each sampling run. Data processing methods were not significantly altered. Electrofishing runs were then limited to 500 seconds to reduce the spatial area covered.

Once all of the data had been differentially corrected, projected, and compiled at EES, quality assurance checks were made using digital aerial photography for positional data and the handwritten field notebooks for numeric and categorical data. The resulting spatial database was stored using GIS. Spatial data and associated attributes were also exported and compiled in spreadsheets for reporting purposes. All GPS coordinates were e-mailed to SEA office in Olympia and incorporated into the Fish Tissue Data Master Table (Appendix C, Table C-1).

On October 7, 2002, the fishing effort was doubled in order to increase the fish catch per day. Operations increased from two boats and five people in the field to five boats and 14 people a day. A sufficient amount of GPS units necessary for every team to directly record their positional data was unavailable. The three existing GPS units were assigned to the fishing teams that required constant navigation records, such as the boat electrofishers. Teams without GPS units were assigned to collect fish at fixed and marked nearshore stations, such as crayfish and sculpin stations, which already had GPS coordinates on record. Field notebook entries from non-GPS teams were transferred to the Fish Tissue Data Master Table (Appendix C, Table C-1), and the coordinates necessary for each specific event were copied from a previous GPS record for each respective station. Each fish assigned previously recorded coordinates received a "NA" qualifier under GPS date and time columns in Table C-2 (Appendix C).

FES provided an additional GPS unit, which was used during beach seining and trot line settings. The FES GPS unit was a Corvallis Micro Technology MC-GPS unit. This GPS data typically yield 95% precisions ranging from 0.277 to 0.469 meters (0.91 to 1.54 feet). FES used C/A code so their accuracy was 1-3 meters.

5.2 TARGET STATION MODIFICATIONS

Three stations proved to be poor habitat for the collection of sculpin, and alternative stations with better sculpin habitat were selected as close to the

Formatted

original station as possible. On July 26, 2002, station 03R034 was added as an alternative to station 03R003. On August 27, 2002, station 05R020 became the alternative to station 05R002. On November 7, 2002, station 07R006 was added as an alternative to station 07R001 (Figure 1-1, Figures 5-2a-b, and Tables C-1 and C-2 [Appendix C]). All new stations were approved by EPA.

On October 7, 2002, an additional sculpin and crayfish station, station 02R015 located downstream from the Multnomah Channel, was added at the request of EPA (Figure 1-1, Figure 5-2a, and Tables C-1 and C-2 [Appendix C]).

5.3 EQUIPMENT DECONTAMINATION

All field equipment used to collect and process fish was decontaminated according to the Fish Tissue Sampling SOP. No deviations were made from that protocol. Equipment described under fishing methods in Section 5.4 below was always decontaminated prior to sampling a new station. All dip nets, buckets, measuring boards, handheld scales, and coolers used to retrieve and store fish were also decontaminated at each new station. The beach seine was simply washed in site water during deployment and retrieval. Due to its large size and volume, the beach seine could not be practically decontaminated using the same protocol as other sampling equipment. However, all fish caught by beach seine were placed for a few minutes in a decontaminated bucket containing site water and therefore rinsed before being handled and processed.

5.4 FISHING METHODS

5.4.1 Beach Seine

A 100-foot-long pole-seine was used for beach seining. It required an 18-foot boat with a 30-HP outboard engine and three people to deploy and retrieve the net. After the net was placed surrounding the fish, technicians on the beach hauled in the "wings" of the net. As the net approached the beach, fish were driven into the net and hauled up on shore. All fish were handled with powder-free nitrile gloves, dip nets, and buckets. A total fish count was taken, and only target species were sorted into a bucket. The remaining fish were returned to the water. The bucket with fish was then handed over to the fish-processing team. If fish were to be held for more than 30 minutes before being transferred to the processing team, they were placed in resealable plastic bags and stored in a cooler with wet ice. Each bag was marked with the date, time, station number, fishing technique code, event number, and initials of the sampler.

5.4.2 Trot Line

Trot lines were built with 50- to 80-lb braided Dacron line with nylon monofilament leaders. Each trot line was 100 to 150 feet long with 25-30 # 4 and

Formatted

6 hooks. Hooks were baited with earthworms purchased from D & G Bait Co[2]. Trot lines were attached to a piling above the water line, slowly stretched out with the help of a boat and anchored at the other end with a lead weight. They were occasionally attached between two pilings or spread out at the bottom with both ends attached to lead weights, which in turn were attached by a line to floats at the surface. Trot lines were left on site overnight and retrieved the following day. Technicians wearing powder-free nitrile gloves slowly retrieved the line unhooking the fish and placing them inside a plastic bucket. Often times, it was difficult to remove a hook without damaging a fish sample. It was necessary to cut the nylon leader as far away from the mouth making it easy to identify a fish in need of hook removal during sample processing at the laboratory. All fish containing hooks were noted in the field notebook. The bucket with fish was then handed over to the fish-processing team. If fish were to be held for more than 30 minutes before being transferred to the processing team, fish were placed in resealable plastic bags and stored in a cooler with wet ice. Each bag was marked with date, time, station number, fishing technique code, event number, and initials of the sampler.

5.4.3 Angling

Angling was conducted using a standard rod and reel with monofilament line (6-12 lb test). A variety of lures was used depending on the target species. Black crappie were caught using lead-weighted hooks with an attached rubber crappie jig. White-rubber tailed crappie jigs were the most successful and therefore were used almost exclusively. Smallmouth bass were caught with a variety of lures, depending on the desired sampling depth. Lead-weighted hooks with attached green-rubber tube jigs were used to fish the bottom, while plastic crank baits resembling small fish or crayfish were used to fish the shallower surface waters (0-3 m). Electric trolling motors were used to more accurately access specific smallmouth angling locations and enable the complete coverage of selected areas. Angling for black crappie was done primarily between dusk and 3:00 AM. Angling teams sampled predominantly near pier/dock structures where existing facility lights illuminated the water surface. Coleman™ gas lanterns were used to provide light around pier/dock structures without existing facility lights. Crappie jigs were placed on weighted hooks and lowered between pilings or adjacent to floating dock structures to an average depth of 10 m. Angling for smallmouth bass was conducted primarily at dawn and dusk. Smallmouth bass were sampled at the surface and near the bottom. Crank baits were used to sample surface waters at depths ranging from 0-4 m, while rubber tube jigs were used to sample the river bottom at an average depth of 10 m. Once caught, fish were handled using powder-free nitrile gloves, unhooked, and immediately placed into individual resealable bags. Each bag was marked with the date, time, station number, fishing technique code, event number, and initials of the sampler.

[2] D & G Bait Co, 15981 SE 122nd Ave, Clackamas, OR 97015, (503) 557-2248.

Formatted

Bagged fish were then placed in coolers with wet ice for transport to the LWG laboratory for processing.

5.4.4 Crayfish Traps

Standard minnow traps were used for capturing crayfish. Bait consisted of commercially available canned cat food, frozen smelt, and frozen shad. Numerous small holes were punched in the cat food cans to allow diffusion of the food scent into the water while preventing crayfish from ingesting the can contents. Frozen smelt or shad were cut into small pieces and placed into perforated plastic canisters with screw-on plastic lids. Canisters were attached to the inside of the traps using plastic zip ties. Crayfish traps were deployed within 100 feet of the shoreline at marked sculpin stations. Sculpin stations were marked in 100-foot widths along the shoreline. Depth of deployment varied according to station bathymetry. Traps were retrieved and carefully rinsed before being placed inside the boat. Technicians wearing powder-free nitrile gloves retrieved crayfish from traps and placed them inside resealable plastic bags. Plastic bags containing crayfish were then stored inside coolers with wet ice until ready for processing. Each bag was marked with the date, time, station number, fishing technique code, event number, and initials of the sampler.

5.4.5 Boat Electrofishing

Boat electrofishing was conducted from a 20-foot jet sled equipped with a Smith Root Model 5.0 GPP electrofisher. Typically, 3-4 amps of output current were applied, and the pulse rate varied between 30-80 % of 60-120 volts direct current. Pulse rate and width were adjusted periodically depending on conductivity, fish species, and behavior. Conductivity, dissolved oxygen and water temperature conditions were independently collected using an YSI Model 85 multi-parameter water quality probe each sampling day. The electrofisher typically attracted fish from 10-15 feet away. Electrofishing was conducted for periods of at least 500 seconds, at which point the location and effort were recorded. The boat electrofishing team consisted of a pilot and two people wearing chest waders and electrical safety gloves holding long dip nets at the bow of the boat and secured by a safety rail. Stunned fish were collected with the dip nets and placed inside large open coolers containing site water.

Handling of fish was done using powder-free nitrile gloves. Fish were counted and placed on a decontaminated measuring board. Any target fish that met the size range requirement was then transferred to a plastic tote with an interlocking lid to prevent the fish from jumping out. The tote was then transferred over to the processing team. If fish were to be held for more than approximately 30 minutes before being transferred to the processing team, fish were placed in resealable plastic bags and stored in a cooler with wet ice. Each bag was marked with the date, time, station number, fishing technique code, event number, number of electrofishing seconds, and initials of the sampler.

Formatted

5.4.6 Backpack Electrofishing

Backpack electrofishing was done with a gas-generator-powered Smith-Root Model 15-D Backpack Electrofisher. Settings were generally in the standard pulse range of I-4 (60 Hz at 4 ms) to K-6 (80 Hz at 8 ms), and varied in voltage power from 100 volts to 400 volts as per effectiveness. Settings in the Programmable Output Waveform range were used in some instances. Electrofishing was also done with a Smith-Root Model 12 with a 24-volt battery. The output voltage range varied from 300-400 volts, depending on fish behavior and water conditions. The pulse range varied between I-4 (60 Hz at 4 ms) and K-6 (80 Hz at 8 ms). Effort was recorded in seconds at electroshocking stations to determine catch per effort.

The backpack electrofishing team consisted of two technicians wearing chest waders and insulated electrical safety gloves. One technician carried the backpack unit holding the anode wand in one hand and cathode “tail” dragging behind in the water. The other technician held a dip net and a plastic bucket. Once a fish was stunned, it was scooped by a dip net carried by the second technician and placed inside the plastic bucket. The bucket with fish was then handed over to the fish-processing team. If fish were to be held for more than approximately 30 minutes before being transferred to the processing team, fish were placed in resealable plastic bags and stored in a cooler with wet ice. Each bag was marked with the date, time, station number, fishing technique code, event number, number of electrofishing seconds, and initials of the sampler.

5.5 FIELD SAMPLE HANDLING AND PROCESSING

Fish samples were handled with powder-free nitrile gloves. All equipment was decontaminated prior to processing samples at each new station and between different species (Section 5.3). Fish were first measured for total length and, if appropriate, fork length by placing them flat on a measuring board. The total length of a fish was measured from the front of the jaw, which is most anterior to the end of the longest caudal ray when the rays are squeezed together, but excluding the caudal filaments, to the end of the tail. Fork length was measured from the tip of the snout to the posterior end of the middle caudal rays (FishBase 2002). The total length of crayfish specimens was measured from the rostrum, the flat "horn" between the crayfish's eyes to the telson, to the last center segment of the tail (Pennak 1989). After length measurements, fish were weighed using a handheld scale suited for the weight of the fish (Pesola® 60 g x 0.5 g, Pesola® 1000 g x 10 g, and Chatillon™ 6 kg x 50 g). Once weighed, the fish sample was placed on aluminum foil (dull side towards fish), wrapped and placed inside a resealable plastic bag. A label was written on Rite-in-the-Rain™ paper, placed inside another resealable plastic bag, and, in turn, placed inside the bag containing the fish sample. This was to ensure that no chemicals present in the treated label paper would contact the fish sample. The processed fish sample was then placed inside a cooler containing wet ice. At the end of each day, the cooler was brought

Formatted

back to the LWG laboratory. All fish were then removed from the cooler, counted, and stored in the 4°C refrigerator. The refrigerator was then locked, and a total fish number was entered in the LWG laboratory storage logbook and signed. Beginning on October 3, 2002, it was found to be more efficient to process the fish in the laboratory than in the field immediately after fish capture. All fish caught in the field were placed in resealable plastic bags, marked with the date, time, station number, fishing technique code, event number, number of electrofishing seconds, initials of the sampler and placed in a cooler with ice. At the end of the field work, the fish samples were then processed by the field crew at the LWG laboratory at ATOFINA following the same procedures as described above.

5.5.1 Data Management

Four different groups of notebooks were generated from a total of 38 notebooks during Round1A and Round1 fish tissue collection (Table 1-1). The first group, FES Lab Books (11 books), included information about fish tissue processed at the LWG laboratory at ATOFINA. The second group, SEA Field Books (11 books), included information about fish tissue collection and processing. The third group, EES Field Books (8 books), included information about fish tissue collection and water quality. The fourth group was the Auxiliary Field Books (8 books), which included information about fish tissue collection and lamprey surveys.

Once fish were processed in the field and stored at the LWG refrigerator for further tissue processing by the laboratory team, the field notebooks were scanned and e-mailed daily to SEA. The data were received at SEA office in Olympia, and the Fish Tissue Data Master Table (Appendix C, Table C-1) was updated manually into an Excel spreadsheet. In addition to the field fish processing data, the locations where the fish were caught were recorded with a GPS unit by the EES crew in the field and post-processed at their office and delivered electronically either as a Text File or as an ArcView™ Shape file to SEA via e-mail. This information was then transferred into the Fish Tissue Data Catch Coordinates table (Appendix C, Table C-2). This table contains the X and Y locations for fishing events and locations for specific fish catch. The coordinates were then matched to specific fish based on date, time, station, key day, sampler, method, recorded catch, and effort, and copied into the Fish Tissue Data Master Table. After new field data were added, the table was checked for duplicate sample codes to identify any mislabeled samples. If duplicates were identified, the field collectors and the lab were notified and the appropriate actions were taken to correct the problem.

As described in Section 5.1, on October 7, 2002, field efforts were doubled and the number of GPS instruments was insufficient for every team to directly record their positional data. It was also unnecessary because many stations, such as all of the co-located crayfish/sculpin stations, were established as fixed points with

Formatted

GPS coordinates previously recorded and also marked with fluorescent orange spots at both ends of the delineated 100-ft shoreline. The three existing GPS units were assigned to the fishing teams that required constant navigation records, such as the boat electrofishers. All other teams were assigned to collect fish at fixed stations, which already had GPS coordinates on record. Field notebook entries from non-GPS teams were transferred to the Fish Tissue Data Master Table (Appendix C, Table C-1), and the coordinates necessary for each specific event were copied from a previous GPS record for each respective station. Each fish assigned previously recorded coordinates received a "NA" qualifier under GPS date and time columns in Table C-2 (Appendix C).

Some trot line and angling efforts lacking field GPS coordinates were located visually on a map based on field notes by the sampler, and a coordinate was assigned to a specific location using ArcMap™. Boat electrofishing and backpack electrofishing were collected as lines. Crayfish and trot line events were collected as points. After September 20 2002, GPS files were being delivered as line and point shape files (instead of text files). The coordinates for the line files were converted to a centroid using an ArcView™ extension. The coordinate from the centroid was then substituted into the catch coordinate for boat electrofishing and backpack electrofishing events.

5.6 ANALYSES OF FIELD FISH SAMPLING TECHNIQUES

It is important to report some factors that may have improved fish sampling techniques with the goal of better preparing future fish sampling events.

Crayfish were noted to be of larger size in deeper water (30-40 feet) than closer to shore. They preferred sandier than muddier substrates and were collected most successfully with traps that had long bodies (approximately 30 inches) and long entry cones. The best bait used was frozen smelt.

In certain areas, it was difficult and potentially hazardous to obtain sculpin by electrofishing because the terrain was too steep and the water too deep. As the water deepened, it became more difficult to visually detect a sculpin and scoop it out of the water with a net, even if it had been stunned by the electrodes from either a boat or a backpack. It was equally difficult to retrieve any sculpin that may have fallen into the large gaps between stones of a riprap area. Trot lines proved efficient in catching sculpin at locations sharing the physical characteristics mentioned above. Any delay in retrieving overnight trot lines would increase the chances for crayfish to partially consume sculpin bodies caught on lines set close to the bottom. Sculpin were infrequently caught with crayfish traps.

Black crappie were collected most successfully by trot lines and/or jigging with a white plastic lure at depths of 30 - 40 feet in quiescent bodies of water such as

Formatted

Swan Island Lagoon. Most black crappies were caught at night between 5:00 and 10:30 PM. Electrofishing proved inefficient since black crappies tend to live in waters deeper than the electric field of a boat electrofisher can reach (i.e. approximately 10 feet).

Carp and smallmouth bass were more difficult to catch at lower water temperatures.

5.7 LABORATORY SAMPLE HANDLING AND PROCESSING

5.7.1 Laboratory Location

The LWG laboratory for fish processing was located in a separate, locked set of rooms inside the gated and guarded decommissioned ATOFINA plant at 6400 NW Front Ave, Portland, OR. The laboratory was thoroughly cleaned by a professional team before any installations occurred. The laboratory room ceilings and some wall openings were sealed with plastic sheeting, and all air vents were fitted with micro-filters. A positive pressure system was created with plastic drapes separating the inner laboratory rooms from the outer workroom. Additionally, an “air-lock” entrance room was built to prevent direct transport of airborne particles from the outside into the laboratory. This room was also used to store all field equipment. The laboratory was outfitted with a water de-ionizing unit, venting hood, two sinks, and all laboratory safety equipment listed in the SOP.

5.7.2 Monitoring of Personnel in Laboratory

Upon entering the LWG laboratory, all personnel were required to sign in with their name, date, time and purpose on the sign-in sheet located at a table by the front door. The numbered sheets were kept in a binder for a record of all entrances, and the originals are stored in the LWG Project Library at the SEA office in Olympia, WA.

5.7.3 Laboratory Opening Procedures

Upon entering the laboratory, several tasks were performed each day:

A. Freezers and refrigerators were unlocked, and the temperature was monitored for all units. Temperature readings were noted in the bound refrigeration logbook with date and time. Any unit with a temperature reading out of compliance (+4°C ± 2°C for refrigerators or -20°C ± 4°C for freezers) was adjusted and the adjustment noted in the logbook.

B. The digital balance was calibrated.

C. The numbers of fish in the refrigeration units (Units R1 & R2) were compared to the number of fish logged in by the field crew in the chain-of-custody logbook after field processing. Any

Formatted

discrepancies were immediately noted and the field manager contacted.

D. Printed scanned field notes by field crew were reviewed prior to laboratory processing.

E. All working surfaces were covered with aluminum foil, shiny side down, as per SOP.

5.7.4 Fish Processing Procedures

Decontamination of laboratory equipment and laboratory fish handling followed the instructions of the Fish Tissue Sampling SOP. All surfaces were covered with clean aluminum foil with the dull side up prior to contact with fish samples.

A. Whole-body HHRA Fish

1. Fish were weighed on the calibrated digital balance.
   a. Any hooks noted in the fish, due to being caught on a trotline, were removed prior to weighing in the processing laboratory. Hook removal was noted in the condition section of the laboratory notebook entry
   b. Any fish that exceeded the capacity of the digital balance (3000 g) were weighed on a seed scale (Morris Scale Model 20, 20 lbs x 1 oz, temperature compensated) and the weights converted to metric. The accuracy of the seed scale was tested and found to be ±7 g at 2000 g NSTS (0.35 % error).
   c. Beginning on October 3, 2002, it was found to be more efficient to process the fish in the laboratory than in the field immediately after fish capture (Section 5.5). Therefore, unless hook removal was necessary for fish caught on a trotline, fish were not re-weighed by the laboratory crew.
   d. The weight was noted in the laboratory processing notebook and the sample processing form.
2. The fish was examined for observable anomalies, using the Fish Health Examination Sheet (SEA et al. 2002c) as a guide, and the condition was noted in the laboratory notebook (Field Laboratory Notebooks, Table 1-1). Entries were descriptive (e.g. “2 mm red spot on distal end of caudal fin ray 2”).
3. Whole-body fish were then re-wrapped in clean aluminum foil, shiny side away from the fish, and put into an appropriately sized bag with the bagged sample label that was written by the field crew. The bag with fish and label was sealed according to the Fish Tissue Sampling SOP.

B) Whole-body ERA Fish:

Whole-body ERA fish were not unwrapped and inspected unless caught on a trotline, at which point they were unwrapped, inspected for the presence of a hook and re-weighed if the hook was removed. Removal of the hook and the new weight were noted in the laboratory notebook under the condition

Formatted

entry and on the sample processing form, and the fish was re-wrapped in clean aluminum foil similar to the whole-body HHRA fish.

C) Fillet HHRA Fish:

1. Fish were weighed on the calibrated digital balance according to instructions in the Fish Tissue Sampling SOP.
   a. Any hooks present in the fish, due to being caught on a trotline, were noted but not removed, due to the subsequent filleting process.
   b. Any fish that exceeded the capacity of the digital balance (3000 g) were weighed on a seed scale (Morris Scale Model 20, 20 lbs x 1 oz, temperature compensated) and the weights converted to metric. The accuracy of the seed scale was tested and found to be ±7 g at 2000 g NSTS (0.35 % error).
   c. Beginning October 3, 2002, all fish caught were weighed by the field crew in the laboratory. Therefore, unless hook removal was necessary for fish caught on a trotline, fish were not re-weighed by the laboratory crew.
   d. The weight was noted in the laboratory processing notebook and the sample processing form.
2. Fish length was measured on a measuring board covered in aluminum foil.
   a. Total length was measured from the tip of the snout to the end of the caudal fin, when compressed dorsal-ventrally. The length was determined by marking the end of the tail with a sharp object and folding the aluminum foil at that point to read the ruler.
   b. Fork length was measured from the tip of the snout to the fork of the caudal fin, with the fin extended. The length was determined by marking the end of the tail with a sharp object and folding the aluminum foil at that point to read the ruler. For fish with a highly preyed upon or eroded caudal fin, the fork length measurement represented a best estimate of length.
3. As described in the Fish Tissue Sampling SOP, the fish were scaled prior to filleting. For fish without scales (i.e., yellow and brown bullhead), the skin was removed from the entire fish prior to filleting, in accordance with the SOP and EPA (2000) guidance. Prior to September 5, 2002, scaleless fish were processed so that only one side of the scaleless fish was skinned and this skinned side was filleted for the skin off without belly flap (labeled as FS) tissue sample. Because the entire fish was not skinned prior to September 5, 2002, the fillet samples processed prior to September 5, 2002 (5 samples in total), had the skin left on with the belly flap included (labeled as FL). After September 5, 2003, scaleless fish were processed consistent with the SOP and EPA guidance such that the entire fish was skinned prior to filleting. The FL samples processed after September 5, 2002, were skinless, but included the belly flap, while the FS samples were skinless without the belly flap.

Formatted

4. Fish were filleted according to instructions found in the Fish Tissue Sampling SOP.
5. Weights of each fillet was measured on clean aluminum foil on the digital balance and was recorded in the laboratory processing notebook and the sample processing form.
6. A new sample label was made for each fillet. Starting near the end of September, the original label was placed in a folder. Prior to that, the original label was included in the bag with one of the new fillet labels. It was thought that including both the original and fillet-specific labels in one label bag with one fillet may create undue confusion and delay at the homogenization and analysis laboratory, hence the change in label practice.
7. Each fillet was wrapped in clean aluminum foil, shiny side away from the tissue, and packaged as for the whole-body HHRA and ERA fish.

5.7.5 Sample Storing Procedures

In order to keep track of each fish caught and having the capability of quickly retrieving samples for compositing or for a possible corrective action, it was necessary to keep a detail record of each fish as described below.

- Each fish sample, after being sealed as per the Fish Tissue Sampling SOP, (was color-coded with colored duct tape according to the color scheme in Table 5-3.
- Each sample was placed in a freezer unit, and the location (freezer unit number and shelf), date, time of storage and processor were noted in the storage notebook (Figure 5-13). The data were then transferred to a spreadsheet (Table C-3, Appendix C).
- The sample storage log was entered into the laboratory computer at the end of the day, and any samples moved or shipped were updated on the electronic version.

5.7.6 Corrective Actions

Any discrepancies or problems were noted on a corrective action form, as well as the proposed and actual actions taken (forms are stored in the LWG Project Library at SEA). The information was given to the field manager who approved the action. The form was then signed by the laboratory personnel and the field manager. Problems included dropped fish (subsequently discarded); piercing the gut cavity during filleting (procedures in the Fish Tissue Sampling SOP followed); temperature non-compliance (samples were retained, but a note was made referring to the fact that FES notified the people responsible for fish compositing, so that they could consider the non-compliance issues, which may not affect tests for some of the fish); inability to remove trotline hooks from samples (subsequently discarded); unsuitability of sample due to extreme

Formatted

predation (subsequently discarded); errors in reported measurements that were checked and corrected; and delay in processing/extended hold times; any freezer unit with a temperature reading out of compliance (+4°C ± 2°C for refrigerators or -20°C ± 4°C for freezers); and any discrepancies on numbers of fish in the refrigeration units (Units R1 & R2) when compared to the number of fish logged in by the field crew in the chain-of-custody logbook after field processing. Most of the corrective action forms were forwarded to Windward and Kennedy/Jenks for consideration in compositing schemes. Original and copies of all corrective action forms are stored in the LWG Project Library at SEA office in Olympia, WA.

Occasionally, a sample was mislabeled in the field or in the laboratory, and the data on the sample label needed to be updated (Table C-4, Appendix C). This may have occurred when the most up-to-date information on sample numbering was not available in the field, GPS coordinates determined that the sample was caught in a different area than assumed, or incorrect data/error on the part of the field or laboratory crew. Errors and necessary corrections were confirmed with the field manager and/or database manager to facilitate correction on all pieces of data pertaining to the sample (i.e., laboratory notebook, laboratory processing form, field notebook, data master table, label, and sample storage log). After confirmation, the sample was located, custody seal removed, and sample label removed. All errors were crossed out with a single line, and the change was then dated and initialed. The sample label was then returned to the sample bag, which was re-sealed according to the Fish Tissue Compositing and Shipping SOP (SEA et al. 2002d) and returned to the freezer. A record of the correction was kept on the re-labeling check sheet starting on September 24, 2002 (Figure 5-14). Prior to this date, records of requests for corrections were kept in a notebook, and the appropriate changes were made to the laboratory notebook, laboratory processing form and sample storage log. The laboratory crew then notified SEA of the changes.

5.7.7 Data Management

Field data was logged in and transmitted to SEA on a daily basis as follows.

- At the end of each day, data from the sample processing forms were entered into the most recent Fish Tissue Data Master Table (weight, fork length, total length, FS weight and FL weight). The updated master table was e-mailed from the laboratory account to database managers at SEA.
- All pages in the laboratory notebook were scanned into the laboratory computer and e-mailed to Windward, SEA, Kennedy/Jenks and FES for review and off-site storage.
- The storage log was entered and updated.

Formatted

- Any corrective action forms were scanned and e-mailed to Windward and Kennedy/Jenks.

5.7.8 Laboratory Closing Procedures

Before leaving the laboratory each work day, several tasks were performed:

- Verified that all freezer and refrigerator units were monitored
- Verified that all freezers were re-locked
- Decontaminated all used utensils and cutting boards
- Cleaned all work surfaces
- Scanned and stored laboratory notebook pages, e-mailed data to SEA, Windward, Kennedy/Jenks and FES, and updated the sample storage log
- Signed out on sign-in sheet located near door
- Turned off all lights and locked the main door.

5.7.9 Shipping

All sample handling and equipment preparation followed the Fish Tissue Compositing and Shipping SOP (SEA et al. 2002d). These procedures included the following:

- Composite information was received from Windward or Kennedy/Jenks and added into the data master table by SEA.
- Staff and supplies were coordinated, including dry ice arrangements.
- The sample storage log was referenced by the laboratory crew to aid in finding fish samples.
- Fish from the appropriate species were pulled from the freezers and sorted into “composite”, “archive”, and “non-use” clean bins. Samples that were not being used were returned to the freezer. Individual tissue samples were grouped together into the appropriate composite and then double-checked by one person calling out the fish ID and the other person checking off the fish sample ID on the composite list.
- Composited samples were then bundled together into one appropriately sized bag, and a new label reflecting the composite code was created. The label was placed into a zippered plastic bag and included in the bag with the composited fish samples. The bag of composites was sealed and returned to the freezer until ready to be placed into a cooler prepared with dry ice for shipping.

Formatted

- Coolers were prepared for shipping and packed; two hazardous material placards with dry ice information were attached, in addition to the placards noted in the Fish Tissue Compositing and Shipping SOP.
- Prior to November 20, 2002, coolers were taken to the FedEx office at Swan Island and shipped to the Axys laboratory in Sydney, BC. Starting on November 20, 2002, coolers were placed into the care of SEA chemistry QA manager who drove the coolers to the border, meeting with an agent from the homogenizing laboratory, to ensure and expedite delivery.
- Copies of all shipping forms were made and stored at FES and SEA.
- The sample storage log was updated to reflect the transfer of samples from the laboratory and the movement of samples for archiving.
- The laboratory was cleaned and locked after completing shipping preparation.

Formatted

6.0 JUVENILE SALMONID MARK/RECAPTURE PILOT STUDY

The study of residence time of subyearling chinook salmon was originally scheduled to begin in May 2002 and continue through the peak period of downstream migration (i.e., late May through June). However, between the submission of the Section 10 fishing permit and research startup, the proposed research was required to be reviewed and approved by the EPA. EPA decided that instead of emphasizing residence time of subyearling chinook in the 2002 season, emphasis should be placed on the collection of fish for tissue analysis. The scope of the residence time study was reduced to a pilot study to evaluate the efficacy of using fluorescent elastomer tags for marking subyearlings and developing an estimate of recovery efficiency. These changes in priorities were discussed with NOAA Fisheries in May 2002.

Due to the time required for the EPA review and approval, startup of the pilot study was delayed until mid-July. By that time, water temperature in the ISA had increased to levels that were stressful to juvenile salmonids. Juvenile salmonids were captured by beach seine on July 8 and 9, 2002. Field personnel found that the stress of handling at the ambient water temperatures was too high to allow meaningful results for a tag-recovery-efficiency estimate. Therefore, sampling for these purposes was discontinued, and no information was developed in 2002 on the residence time of subyearling chinook.

Formatted

7.0 REFERENCES

Anchor Environmental. (In Preparation). Sediment Stake Erosion/Accretion Analysis. Anchor Environmental L.L.C., Portland, OR.

ArcMap™. ESRI-Seattle. Suite 500, 100 S. King Street, Seattle, WA 98104.

ArcView™ 8.2. ESRI-Seattle. Suite 500, 100 S. King Street, Seattle, WA 98104.

DEA. 2003. Lower Willamette River Multibeam Bathymetric Survey Report, Summer 2002. Prepared for Striplin Environmental Associates, Inc. David Evans and Associates, Inc., Portland, OR.

EPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1 - Fish Sampling and Analysis. 3rd ed. EPA 823-B-00-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

FishBase. 2002. A Global Information System on Fishes. http://www.fishbase.org/search.html (Accessed on 12/13/02).

GSI. 2002 (draft). Technical Memorandum: Results of Seep Reconnaissance Survey River Mile 2 – 10.5 Lower Willamette River. Prepared for Lower Willamette Group, Portland OR. Groundwater Solutions, Inc., Portland, OR. (December 11, 2002).

Kennedy/Jenks. 2003 (draft). Lamprey Harvest Reconnaissance Survey for 2002 Technical Memorandum. Prepared for Lower Willamette Group, Portland OR. Kennedy/Jenks Consultants, Portland, OR. (February 21, 2003).

Pennak, R. W. 1989. *Fresh-water invertebrates of the United States: Protozoa to Mollusca.* [3rd Ed.]. John Wiley & Sons, Inc., New York, 628 pp.

PSEP. 1986. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Final Report. TC-3991-04. Prepared for EPA, Region 10 and Puget Sound Estuary Program, Seattle, WA. Tetra Tech and HRA, Inc., Bellevue, WA.

SEA. 2002a. Fish Tissue Homogenization and Shipping SOP Round 1 Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc., Olympia, WA. (August 28, 2002).

SEA. 2002b. Portland Harbor RI/FS Round 1 Quality Assurance Project Plan Final Report. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA. (November 22, 2002).

SEA and Windward Environmental. 2003. Technical Memorandum: Lamprey Ammocoete and Benthic Infaunal Biomass, Reconnaissance Surveys of the Lower Willamette River, September 16-17, 2002 and October 8-9, 2002. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA.

Formatted

(February 14, 2003). *in* SEA, Windward Environmental, Anchor Environmental, Kennedy/Jenks , and Groundwater Solutions. In preparation. Portland Harbor RI/FS Programmatic Work Plan. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA, Appendix C, Attachment 2.

SEA, Windward Environmental, Anchor Environmental, Kennedy/Jenks , and Groundwater Solutions. 2002 (draft). Round 1 Work Plan Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA. (June 7, 2002).

SEA, Windward Environmental, Anchor Environmental, and Kennedy/Jenks. 2002a. Field Sampling Plan Round 1A Portland Harbor RI/FS, Draft. Prepared for Lower Willamette Group, Portland OR. Striplin Environmental Associates, Inc, Olympia, WA. (April 22, 2002).

SEA, Windward Environmental, Anchor Environmental, and Kennedy/Jenks. 2002b (draft). Round 1 Field Sampling Plan, Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA. (June 14, 2002).

SEA, Windward Environmental, and Kennedy/Jenks. 2002c. Fish Tissue Sampling SOP Round 1A Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA.

SEA, Windward Environmental, and Kennedy/Jenks. 2002d. Fish Tissue Compositing and Shipping SOP Round 1A Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA.

Windward. 2003a (draft). Aquatic Plant and Amphibian/Reptile Reconnaissance Survey. Prepared for Lower Willamette Group, Portland, OR. Windward Environmental, L.L.C., Seattle, WA. (March 7, 2003). *in* SEA, Windward Environmental, Anchor Environmental, Kennedy/Jenks , and Groundwater Water Solutions. In preparation. Portland Harbor RI/FS Programmatic Work Plan. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA, Appendix C, Attachment 1.

Windward. 2003b (draft). Benthic Macroinvertebrate Community Sampling. Prepared for Lower Willamette Group, Portland, OR. Windward Environmental, L.L.C., Seattle, WA. (March 6, 2003). *in* SEA, Windward Environmental, Anchor Environmental, Kennedy/Jenks , and Groundwater Water Solutions. In preparation. Portland Harbor RI/FS Programmatic Work Plan. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc, Olympia, WA, Appendix C, Attachment 4.

Formatted

APPENDIX A: GRAB SAMPLE LOG SHEETS

Formatted

APPENDIX B: SEDIMENT AND BENTHIC INFAUNA STATION SAMPLING COORDINATES

Table B-1. Sediment And Benthic Infauna Station Sampling Coordinates.

Formatted

APPENDIX C: TABULATED FISH TISSUE DATA

Table C-1. Fish Tissue Data Master Table.
Table C-2. Fish Catch Coordinates.
Table C-3. Storage Log Of Fish Samples In LWG Laboratory Freezers.
Table C-4. Record Of Change On Fish Labels.