
FIELD AND DATA REPORT

DOWNTOWN PORTLAND SEDIMENT CHARACTERIZATION PHASE II

WILLAMETTE RIVER
PORTLAND, OREGON

Prepared for
OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

June 2010

Prepared by



55 SW Yamhill Street, Suite 400 Portland, OR 97204
P: 503.239.8799 F: 503.239.8940
info@gsiwatersolutions.com www.gsiwatersolutions.com



This Page Intentionally Left Blank

FIELD AND DATA REPORT

DOWNTOWN PORTLAND SEDIMENT CHARACTERIZATION PHASE II

WILLAMETTE RIVER PORTLAND, OREGON

Prepared by

GSI WATER SOLUTIONS, INC.
PORTLAND, OREGON

HART CROWSER, INC.
BEAVERTON, OREGON



June 18, 2010

Kevin Parrett, PhD
Senior Environmental Scientist



June 18, 2010

Richard D. Ernst, RG
Principal Geologist

This Page Intentionally Left Blank

TABLE OF CONTENTS

LIST OF FIGURES.....	ii
LIST OF TABLES	iii
LIST OF APPENDICES (DVD Only).....	iv
LIST OF ACRONYMS	v
1.0 INTRODUCTION	1
1.1 Background.....	1
1.2 Results of DPSC Phase I	3
1.3 Purpose and Objectives	3
1.4 Document Organization.....	5
2.0 PROJECT ORGANIZATION.....	7
2.1 Team Organization And Responsibilities.....	7
2.2 Health and Safety.....	7
2.3 Project Schedule	7
3.0 ANALYSIS OF ARCHIVED DPSC PHASE I SEDIMENT SAMPLES	8
4.0 PHASE II SAMPLE COLLECTION	9
4.1 Sampling Vessel	9
4.2 Station Positioning and Vertical Control	9
4.3 Field Documentation	10
4.4 Sample Identification.....	10
4.5 Equipment Decontamination Procedures	11
4.6 Sediment Sample Collection	11
4.6.1 Grab Samples	11
4.6.2 Core Samples.....	13
4.6.3 Modified Sample Names	14
4.7 Bioassay Sample Collection.....	14
4.8 Investigation-Derived Waste.....	15
4.9 Sample Handling, Transport, and Custody.....	15
4.10 Field Quality Control Samples.....	15
5.0 LABORATORY ANALYSIS AND QUALITY ASSURANCE AND QUALITY CONTROL	16
5.1 Physical and Chemical Analyses	16
5.2 Bioassay Analyses	16
5.3 Laboratory QA/QC Procedures.....	17
5.4 Data Review, Verification, and Validation Procedures	18
5.5 Data Quality and Usability	18
6.0 DATA MANAGEMENT	20
6.1 Database	20
6.2 Data Reduction and Handling	21
7.0 PHYSICAL AND CHEMICAL RESULTS.....	24
8.0 BIOASSAY RESULTS	26
9.0 REFERENCES.....	27

LIST OF FIGURES

Figure 1-1	Vicinity Map
Figure 4-1a through 4-1k	Sediment Sampling Locations
Figure 7-1a thru 7-11	Select Analyte Concentrations in Surface Sediment Scatter Plots
Figure 7-2a thru 7-21	Select Analyte Concentrations in Subsurface Sediment Scatter Plots
Figure 7-3a thru 7-31	Select Analyte Concentrations in Surface Sediment Maps
Figure 7-4a thru 7-41	Select Analyte Concentrations in Subsurface Sediment Maps

LIST OF TABLES

Table 3-1	Archived Phase I Sediment Sampling Station Locations
Table 3-2	Archived Phase I Grab Sample Summary
Table 3-3	Archived Phase I Core Sample Summary
Table 4-1	Sediment Sampling Station Locations
Table 4-2	Sediment Stations Modified from Target Locations
Table 4-3	Modified Sample IDs
Table 4-4	Grab Sample Summary
Table 4-5	Core Sample Summary
Table 5-1	Laboratory Methods for Sediment Samples
Table 5-2	Data Validation Qualifiers and Definitions
Table 5-3	Summary of Field and QC Samples
Table 7-1	Analytical Results of Archived DPSC Phase I Surface Sediment
Table 7-2	Analytical Results of DPSC Phase I Subsurface Sediment
Table 7-3	Analytical Results of DPSC Phase II Surface Sediment
Table 7-4	Analytical Results of DPSC Phase II Subsurface Sediment
Table 7-5	Analytical Results of Rinsate Blanks
Table 7-6	Analytical Results of Investigation Derived Waste
Table 8-1	Bioassay Results of Surface Sediment Samples

LIST OF APPENDICES (DVD Only)

- Appendix A Archived Phase I Grab Collection Details and Photographs
- Appendix B Archived Phase I Core Collection and Processing Details and Photographic Mosaics
- Appendix C Grab Collection Details and Photographs
- Appendix D Grab Sample Description Logs
- Appendix E Core Collection and Processing Details and Photographic Mosaics
- Appendix F Core Processing Logs
- Appendix G Field Notebooks
- Appendix H SSS Videos – Diver Assisted Grabs (*provided on separate DVD*)
- Appendix I Cultural Resources Monitoring Report
- Appendix J CAS Laboratory Reports
- Appendix K NAS Laboratory Reports
- Appendix L Data Validation Report
- Appendix M Analytical Results and Data Reduction of Split and Reanalyzed Samples
- Appendix N Data Files

LIST OF ACRONYMS

ARI	Analytical Resources Incorporated
CAS	Columbia Analytical Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
City	City of Portland, Bureau of Environmental Services
CLP	Contract Laboratory Program
cm	centimeter
COC	contaminant of concern
cPAH	carcinogenic PAH
DEQ	Oregon Department of Environmental Quality
DPSC	Downtown Portland Sediment Characterization
ECSI	Environmental Cleanup Site Information
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
FS	feasibility study
GPS	global positioning system
GSI	GSI Water Solutions, Inc.
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPAH	high molecular weight PAH
HRGC/MS/MS	High-resolution gas chromatography/mass spectrometry/mass spectrometry
HSP	Health and Safety Plan
IDW	investigation-derived waste
LCS	laboratory control sample
LPAH	low molecular weight PAH
LWG	Lower Willamette Group
m ²	square meter
MS	matrix spike
MSD	matrix spike duplicate
MSS	Marine Sampling Systems
NAS	Northwest Aquatic Services
PAH	polycyclic aromatic hydrocarbon

PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PEF	potency equivalency factor
PGE	Portland General Electric
PGM	Portland Gas Manufacturing
PP&R	Portland Parks and Recreation
QA/QC	quality assurance/quality control
RDL	reporting detection limit
RI	remedial investigation
RM	River Mile
RM11E	River Mile 11 East
SAP	sampling and analysis plan
SCRA	site characterization and risk assessment
SSS	Subsea Sampling Solutions
SVOC	semivolatile organic compound
SWCA	SWCA Environmental Consultants
TEF	toxicity equivalency factors
TEQ	toxic equivalents
TOC	total organic carbon
TPH	total petroleum hydrocarbon
VPH	volatile petroleum hydrocarbons

1.0 INTRODUCTION

This Field and Data Report provides the results of the second phase of the Downtown Portland Sediment Characterization (DPSC Phase II). The DPSC was initiated in 2008 (DPSC Phase I) to assess the presence of environmental contaminants within the downtown Portland reach of the Willamette River, tentatively defined as extending from River Mile (RM) 12 to 16 (Figure 1-1). The Oregon Department of Environmental Quality (DEQ) performed a preliminary screening level evaluation of the Phase I data and identified nine Focus Areas for further investigation. Follow-up analyses of archived Phase I sediment samples were completed in response to the evaluation and in order to inform the development of sampling and analytical procedures for the DPSC Phase II. The analytical results for these archived samples also are included in this report.

The approach and procedures for the DPSC Phase I are detailed in the Sampling and Analysis Plan (SAP) prepared by GSI Water Solutions, Inc. (GSI, 2008). GSI and Hart Crowser, Inc. (Hart Crowser), prepared a SAP Addendum for the Phase II efforts that builds upon the approach and methodologies followed in the Phase I characterization (GSI and Hart Crowser, 2010). Deviations from the SAP and SAP Addendum are described in this report.

The DPSC is separate and distinct from the ongoing remedial investigation and feasibility study (RI/FS) of the Lower Willamette River (Portland Harbor) Superfund Site. However, the DPSC employed sampling and analytical procedures used by the Lower Willamette Group (LWG), as approved by the U.S. Environmental Protection Agency (EPA), in characterizing the Portland Harbor Superfund Site.

This report is intended to describe field activities and present analytical results. The evaluation of the DPSC Phase II data is limited to graphical representations and mapping of select analytes. A detailed interpretation and discussion of these data are beyond the scope of this report.

Funding for the DPSC Phase II was provided by DEQ, the City of Portland (City), and TriMet.

1.1 BACKGROUND

The downtown reach of the Willamette River has been used and modified for more than 150 years. Various industrial activities have occurred on the banks of the river, including ship building and ship breaking, heavy manufacturing, pesticide formulating, manufactured gas production, power generation and distribution, lumber processing, and commodities importing and exporting. The river banks have been significantly modified

and used for automotive, rail, and marine transportation, particularly in the lower half of the downtown reach. Waterfront and upland facilities and roadways may have contributed contaminants to the Willamette River via direct discharges (e.g., stormwater and non-stormwater flows), groundwater discharges, overwater activities, overland runoff, or bank erosion.

Before the DPSC, limited sediment investigations had taken place in the downtown reach. Most data are confined to three sites that have been remediated or currently are undergoing remediation with DEQ oversight: Portland General Electric (PGE) Station L, Ross Island, and Zidell. The LWG also collected samples within the downtown reach as part of the Portland Harbor Superfund Site RI/FS (Integral, et al., 2007 and 2009). These samples generally were collected near RM 12, 15, and 16 and represent a relatively small data set. All existing data were presented in the DPSC Phase I SAP (GSI, 2008) and the LWG data were highlighted in the DPSC Phase I Field and Data Report (GSI, 2009a). The LWG *Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral et al., 2007) also provides a list of historical sediment investigations conducted between RM 12 and RM 16.

In 2009, Northwest Natural conducted an investigation of sediments in the vicinity of the former Portland Gas Manufacturing (PGM) Site. This facility, located at approximately RM 12.2 on the west bank of the Willamette River, was used between 1860 and 1913 for manufacturing gas from coal, carbureted water (water enriched with oil), and, briefly, oil. Sediment samples from 12 core stations were collected between August 17 and August 19, 2009. Additionally, one sediment core was collected and processed at the request of the City of Portland to support the DPSC Phase II. Sampling and analytical procedures of this investigation are described in the Field Sampling Plan (Anchor QEA, 2009a) and Sediment Investigation Report (Anchor QEA, 2009b) prepared for NW Natural by Anchor QEA.

Two of the Focus Areas identified in DEQ's preliminary screening level evaluation (RM 13.1E and 13.5E) are being investigated by PGE (URS, 2010). Results of these investigations are expected to be submitted to DEQ in June 2010.

Extensive sampling and characterization of downriver sediments have occurred as part of the Portland Harbor Superfund Site RI/FS (Integral et al., 2009). The segment along the east bank of the Willamette River between RM 11 and RM12.1 was investigated further by the City in 2009 and 2010. Results of the in-river sediment investigation were provided to DEQ in August 2009 (GSI, 2009b). Results of the river bank and in-river sediment trap investigations will be provided to DEQ in June 2010.

1.2 RESULTS OF DPSC PHASE I

The DPSC Phase I was conducted as a collaborative effort by DEQ, the City, ZRZ Realty Company, PGE, PacifiCorp, and TriMet. Between May and June 2008, GSI collected 81 grab samples and 36 core samples. These sediment samples were analyzed for an extensive suite of potential contaminants of concern (COC) including polychlorinated biphenyls (PCB) as Aroclors, butyltins, dioxins/furans, metals, pesticides, polycyclic aromatic hydrocarbons (PAH), semivolatile organic compounds (SVOC), and total petroleum hydrocarbons (TPH). Results of this Phase I characterization were presented in a Field and Data Report (GSI, 2009a).

Following submission of the Field and Data Report, DEQ performed a preliminary screening level evaluation of the data and identified nine Focus Areas based on conservative risk-based screening levels (DEQ, 2009). DEQ recommended additional investigation and source identification efforts of these Focus Areas. An SAP Addendum was prepared to address DEQ's recommendations for additional investigation through: (1) analysis of archived DPSC Phase I sediment samples and (2) the collection and analysis of additional grab samples and core samples (GSI and Hart Crowser, 2010).

1.3 PURPOSE AND OBJECTIVES

The purpose of the DPSC Phase II is to gain a better understanding of the nature and extent of potential COCs within the nine Focus Areas identified in DEQ's preliminary screening evaluation (DEQ, 2009) and the TriMet Supplemental Sampling area. A brief summary of each Focus Area and Phase II objectives are provided in this section.

Focus Area RM 12.1E – Key potential risk-drivers in this area are PCBs, dioxins/furans, pesticides, and metals. Grab samples and core samples were collected in the immediate vicinity of stormwater outfalls OF40 and WR-309 to help delineate the nature and extent of potential COCs and aid in source identification. Chemical analysis of several archived Phase I samples was used to confirm the presence of pesticides using high-resolution gas chromatography/mass spectrometry/mass spectrometry (HRGC/MS/MS) and evaluate the distribution of PCBs and pesticides in surface and near-surface sediment. Samples were not analyzed for dioxins/furans.

Focus Area RM 12.4W – Key potential risk-drivers in this area are metals and PAHs. A grab sample was collected for bioassay analysis to evaluate benthic toxicity. Chemical analysis of a sediment core (DPSC-C041) collected in August 2009 during the NW Natural sediment investigation of the former Portland Gas Manufacturing Site was used to evaluate the distribution of potential COCs in surface and near-surface sediment. This core was provided to the City and archived at Columbia Analytical Services. Chemical

analysis of this core and several archived Phase I samples was used to evaluate the distribution of PAHs and metals in near-surface sediment.

Focus Area RM 12.5E – Key potential risk-drivers in this area are PCBs, dioxins/furans, metals, pentachlorophenol (PCP), and pesticides. Grab samples and core samples were collected in the immediate vicinity of stormwater outfalls WR-313 and WR-315 to help delineate the nature and extent of potential COCs and aid source identification. Chemical analysis of several archived Phase I samples was used to confirm the presence of pesticides using more sophisticated analytical methodology (HRGC/MS/MS) and evaluate the distribution of dioxins/furans and metals in surface and near-surface sediment.

Focus Area RM 12.9W – Key potential risk-drivers in this area are PCBs, butyltins, dioxins/furans, metals, PAHs, and pesticides. Grab samples were collected along the harbor wall to evaluate benthic toxicity and the distribution of potential COCs. Grab samples and core samples were collected in the immediate vicinity of stormwater outfall OF08A to help delineate the nature and extent of potential COCs and aid in source identification.

Focus Area RM 13.1E – Key potential risk-drivers in this area are PCBs, dioxins/furans, and pesticides. This area was evaluated by PGE under an Administrative Order with DEQ. PGE's work was described in a separate SAP with field work conducted in March 2010 (URS, 2010). Chemical analysis of several archived Phase I samples was used to confirm the presence of pesticides using more sophisticated analytical methodology (i.e., HRGC/MS/MS) and evaluate the distribution of PCBs and pesticides in surface and near-surface sediment.

Focus Area RM 13.3E – Key potential risk-drivers in this area are PCBs, dioxins/furans, pesticides, and PAHs. A grab sample was collected for bioassay analysis to evaluate benthic toxicity. An additional grab sample was collected in the immediate vicinity of stormwater outfall WR-448 to help delineate the nature and extent of potential COCs and aid in source identification. Chemical analysis of several archived Phase I samples was used to evaluate the distribution of PCBs, dioxins/furans, PAHs, and pesticides in surface and near-surface sediment.

Focus Area RM 13.5E – Key potential risk-drivers in this area are PCBs, dioxins/furans, metals, and pesticides. This area was evaluated by PGE under an Administrative Order with DEQ. PGE's work was described in a separate SAP with field work conducted in March 2010 (URS, 2010). Chemical analysis of an archived Phase I sample was used to evaluate the distribution of PCBs, dioxins/furans, metals, and pesticides in near-surface sediment.

Focus Area RM 14.1W – Key potential risk-drivers in this area are PCBs, dioxins/furans, pesticides, and metals. Grab samples and core samples were collected to determine an outer boundary of affected sediments and to better delineate the nature and extent of potential COCs in subsurface sediment in the southern portion of this area. Chemical analysis of several archived Phase I samples was used to confirm the presence of pesticides using more sophisticated analytical methodology (i.e., HRGC/MS/MS) and evaluate the distribution of PCBs, dioxins/furans, and pesticides in surface and near-surface sediment. Samples were not analyzed for dioxins/furans.

Focus Area RM 15.1E – Key potential risk-drivers in this area are PCBs, dioxins/furans, pesticides, and metals. Grab samples were collected to determine an outer boundary of impacted sediments and to better delineate the nature and extent of potential COCs in surface sediment downstream of previously collected samples.

TriMet Supplemental Sampling – The objective for this area is to provide sediment quality data to support TriMet’s permitting of the Portland-Milwaukie Willamette Bridge crossing at approximately RM 13.6. Grab samples and core samples were collected near planned bridge piers and analyzed for a broad suite of chemical and physical constituents specified in the *Sediment Evaluation Framework for the Pacific Northwest* (USACE, 2009): PCB, butyltins, metals, PAH, pesticides, TPH, grain-size, sulfides, and ammonia.

The SAP Addendum describes procedures for riverbank reconnaissance. However, a formal reconnaissance was not performed because the City had recently researched building records and inspected the riverbank in the vicinity of the Focus Areas to identify and survey active and in-active outfalls. The maps presented in this Field and Data Report incorporate this information.

1.4 DOCUMENT ORGANIZATION

This report presents the field and laboratory procedures and findings of the DPSC Phase II. Additional details of the investigative approach and sampling procedures are provided in the SAP and SAP Addendum. This report is organized into the following sections:

- Section 1 provides an introduction.
- Section 2 outlines the project organization.
- Section 3 summarizes the DPSC Phase I follow-up sample analyses.
- Section 4 describes the field sampling, sample handling, and documentation procedures.
- Section 5 summarizes the laboratory analysis program, including laboratory quality assurance/quality control (QA/QC) protocols and data validation procedures.

- Section 6 describes data management procedures.
- Section 7 summarizes physical and chemical analytical results.
- Section 8 presents the bioassay analytical results.
- Section 9 lists cited references.
- Supporting documentation is provided in the appendices.

2.0 PROJECT ORGANIZATION

This section summarizes the organizational structure, responsibilities, and resources employed to support the DPSC Phase II, including field activities, laboratory services, data validation, and data management and reporting. Additional details are provided in the SAP Addendum.

2.1 TEAM ORGANIZATION AND RESPONSIBILITIES

The DPSC Phase II was implemented by GSI and Hart Crowser under a contract with the DEQ. Additional support was provided by the following subcontractors:

- **Columbia Analytical Services, Inc. (CAS)** – Courier and physical-chemical analytical services
- **GeoEngineers, Inc. (GeoEngineers)** – Database management and reporting support
- **Northwest Aquatic Services (NAS)** – Biological analytical services
- **Subsea Sampling Solutions (SSS)** – Operation of sampling vessel and equipment
- **SWCA Environmental Consultants, Inc. (SWCA)** – Cultural resource monitoring

2.2 HEALTH AND SAFETY

Field activities associated with the DPSC Phase II were completed in compliance with Hazardous Waste Operations and Emergency Response (HAZWOPER) regulations under Chapter 29 Code of Federal Regulations 1910.120.

2.3 PROJECT SCHEDULE

During the summer and fall of 2009, follow-up analyses were performed on selected archived DPSC Phase I samples as specified in the SAP Addendum and Section 3 of this report. One sediment core (DPSC-C041) was collected in August 2009 by Anchor QEA, LLC, during the NW Natural sediment investigation of the former PGM Site. Samples (core intervals A and B) were provided to the City for use in the DPSC Phase II. Sediment sampling for DPSC Phase II was conducted in February and March 2010. Laboratory analyses, including the reanalysis of selected samples, and data validation were completed by the end of May 2010.

3.0 ANALYSIS OF ARCHIVED DPSC PHASE I SEDIMENT SAMPLES

During the summer and fall of 2009, follow-up analyses were performed on selected archived DPSC Phase I sediment samples based on recommendations from DEQ's preliminary screening level evaluation. The station coordinates of the archived DPSC Phase I sediment samples selected for analysis are provided in Table 3-1. Seven grab samples and 15 sampling intervals from 10 core stations were analyzed for potential COCs as summarized in Table 3-1 and Table 3-2, respectively.

Appendix A contains copies of the relevant DPSC Phase I grab sample photographs. Table A-1 summarizes the grab collection details. Similarly, the core photograph mosaics were updated for the 10 archived Phase I cores analyzed during Phase II. These updated core mosaics are presented in Appendix B. Table B-1 summarizes the core processing and analytical details by core section.

The analytical methodology used for the archived Phase I samples was consistent with the Phase I SAP with one exception: HRGC/MS/MS following analytical Method E1699M was used on several samples to confirm elevated pesticide concentrations. This method is not prone to false positive detections or over-reporting concentrations of organochlorine pesticides as a result of interference from non-target chemical compounds, such as PCBs.

As specified in the SAP Addendum, formal data validation of the archived Phase I sample results was performed along with the Phase II data. The archived Phase I and new Phase II results are reported together in Section 7 of this report.

4.0 PHASE II SAMPLE COLLECTION

The SAP and SAP Addendum specify the procedures and methods used for sample collection, record keeping, sample handling, storage, shipping, and field quality control. Deviations from the SAP field procedures are described in this section.

4.1 SAMPLING VESSEL

With the exception of core sample DPSC-C041, which was collected by Anchor QEA, LLC, in August 2009, DPSC Phase II power-grab samples and vibracore samples were collected using a vessel operated by SSS.

4.2 STATION POSITIONING AND VERTICAL CONTROL

Station positioning was accomplished using the global positioning system (GPS) on-board the SSS vessel. Target coordinates and actual station coordinates are provided in Table 4-1. SSS used a GeoExplorer (Series 2008) GPS unit, manufactured by Trimble, to collect sample station coordinate data. Field conditions that may have affected GPS data accuracy include on-water movement of the GPS unit during satellite signal acquisition and tall vertical structures (e.g., waterfront wall and bridges) in the vicinity of nearby sample stations. Based on GPS unit specifications and field conditions, Phase II coordinate data appear to be accurate to within 2 meters.

Vertical positioning was established using a lead line and/or fathometer during sample collection at each station. Depth measurements were recorded to the nearest tenth of a foot. Precision of vertical measurements depends on environmental factors, including waves and wind, as well as tidal fluctuations of the river.

Sample stations collected using a diver instead of remotely operated hardware were not sounded by lead line for safety reasons. Depth readings on the diver's watch were used instead. Depths typically were confirmed by the reading from the electronic fathometer depth measurement provided by the vessel operator.

Water depths were not reported as elevations (feet above/below the Columbia River Datum) as described in the SAP. This calculation can be made if further interpretation of the DPSC sample results were needed in the future.

4.3 FIELD DOCUMENTATION

Field activities were documented through grab sample description logs, core collection and processing logs, and grab and core photographs, which provide important information on sediment properties. This documentation is provided in Appendices C through F, as identified below.

- Appendix C Grab Collection Details and Photographs
- Appendix D Grab Sample Description Logs
- Appendix E Core Collection and Processing Details and Photographic Mosaics
- Appendix F Core Processing Logs

Field activities and observations also were documented in a bound field logbook. This logbook was used to describe information such as personnel, date, time, station designation, sampler(s), types of samples collected, and any observed modifications to the SAP. A scanned image of the field notebook is available in Appendix G.

Video images were collected by SSS during the diver-assisted grab sampling on March 24 and March 25, 2010. The video clips that SSS collected are included (on a separate DVD) as Appendix H.

A professional archeologist, provided by SWCA, inspected all surface and subsurface sediment samples, as specified in the SAP Addendum and in accordance with the U.S. Army Corps of Engineers approval of the Preconstruction Notification for Nationwide Permit #6 (Survey Activities). Documentation of cultural resource monitoring is provided in Appendix I.

4.4 SAMPLE IDENTIFICATION

All samples were assigned unique identifiers and codes, as described in the SAP. The sample identification scheme was designed to distinguish among the individual grab samples, core samples, and field QC samples. Grab sample locations are preceded by the letter “G” to distinguish them from core sample locations, which are preceded by the letter “C.”

The Phase I DPSC approach for field replicates, as described in the DPSC (Phase I) Field and Data Report, was to designate all field duplicates as “500” series samples. Because duplicates were collected for samples with identification (ID) numbers greater than 100 (e.g., DPSC-G112), then the modified Phase II approach for these samples was to add a “5” in front of the sample ID of the field duplicate (e.g., DPSC-G5112).

Discrepancies in the designated nomenclature were corrected as discussed in Section 4.6.3 of this report.

4.5 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment decontamination was performed to avoid cross-contamination between samples. Equipment that came in direct contact with sample material was decontaminated before use at each station and between field duplicate samples using the standard phosphate-free detergent, 10 percent nitric acid, alcohol, and deionized water rinse procedure specified in the SAP. Methanol, specified in the SAP, was substituted with ethanol as a rinse solvent to minimize health and safety concerns for field staff.

The sediment grab equipment was washed using phosphate-free detergent and rinsed with site water between stations. Vibracore outer aluminum sleeves were rinsed with site water, and the inner poly liners were decontaminated, and the ends capped, by SSS before being loaded on the vessel. The stainless-steel core catchers also were decontaminated and wrapped in foil before on-water operations.

4.6 SEDIMENT SAMPLE COLLECTION

Sediment samples were collected in general accordance with the procedures described in the SAP and SAP Addendum. These procedures generally followed those developed by the LWG and approved by the EPA for the Portland Harbor Superfund Site. Modifications to the procedures outlined in the SAP and SAP Addendum are described in this section.

Figures 4-1a through 4-1k show locations where samples were collected successfully and Table 4-1 shows the coordinates of those successful sampling locations. For the composited grab samples, an approximate centroid between the retained grab attempts was selected as a representative location. Table 4-2 identifies sample stations for which the locations or analytical program deviated from the SAP. This includes unsuccessful samples, samples with insufficient material for analysis, or samples with follow-up analysis. Table 4-3 identifies samples that were renamed to correct inaccuracies or inconsistencies, as discussed in Section 4.6.3.

4.6.1 Grab Samples

Grab samples were collected successfully from 27 locations, as shown in Figure 4-1a through 4-1k and listed in Table 4-1. One field replicate (DPSC-G102-2) was collected,

as discussed in Section 4.6.3. Grab samples were not collected at stations DPSC-G087, DPSC-G090, DPSC-G105, and DPSC-G111 for reasons specified in Table 4-2.

Three methods were employed to collect grab samples: power-grab, divers, dry-land sampling. All but five samples were collected with a Van Veen-type, pneumatic power-grab sampling device operated by SSS. The power-grab sampler had a maximum penetration capability of 22 centimeters (cm). Four grab samples were collected by divers using a stainless-steel spoon to transfer sediment from the river bottom to a cellulose acetate butyrate tube. Because of low river levels, one sample (DPSC-G097) was collected in the dry using a stainless-steel spoon to transfer sediment (bank soil) to a stainless-steel bowl.

Multiple attempts were required at many locations to obtain an acceptable grab sample (i.e., adequate penetration depth and sufficient fine-grained material for chemical analysis). Rocks and debris (e.g., riprap armoring) on the river bottom precluded the SSS power-grab sampler from attaining the desired penetrations at most sampling locations. Several samples had recovery depths as shallow as 2 cm, although the average recovery depth was 11 cm on retained DPSC Phase II grab samples. To attain sufficient sample volume on the poor recovery sample stations, two or three attempts were retained and the sediments composited, as noted on Table 4-1. Four additional composite samples (DPSC-G091 through DPSC-G094) that were unsuccessful using the SSS power-grab sampler were subsequently collected by SSS divers. The divers collected exposed sediment from an approximately 5-foot radius. Photographs of the grab samples are provided in Appendix C. Grab sample locations, penetration depths, and other relevant collection details are included in Table C-1 of Appendix C.

If a grab sample were deemed acceptable, a representative aliquot of sediment was collected and processed in accordance with the SAP. Significant modifications to the analytical program are presented in Table 4-2 and described here. One grab sample (DPSC-G099) was not analyzed because of the absence of sufficient fine-grained material upon inspection at the contract laboratory. This sample was archived at the laboratory and the “A-Section” of the collocated core (DPSC-C099-A) was analyzed in lieu of the grab sample. Another predominately coarse-grained grab sample (DPSC-G115) was sieved and the resulting 90 grams of fine-grained sediment was analyzed for PCBs, pesticides, metals, dioxin/furans, and total organic carbon (TOC). Insufficient volume was available for analysis of PAHs and TPH. Similarly, insufficient sediment was available for dioxin/furan analysis on DPSC-G096. Table 4-4 lists the grab samples submitted to the laboratory for analyses and archiving.

The following physical characteristics of the sediment were described and recorded on grab sample description forms: sediment texture, sediment color, odors, grab penetration

depth (nearest cm), degree of sediment washing or surface disturbance, and any obvious features or characteristics such as wood or shell fragments or aquatic organisms. Grab sample description logs are provided in Appendix D.

4.6.2 Core Samples

Core samples were collected from nine stations as shown in Figure 4-1a through 4-1k and listed in Table 4-1.

Multiple attempts were required at many locations to obtain an acceptable core sample. Rocks and debris on the river bottom precluded the SSS vibracore sampler from attaining the target penetrations at most sampling locations. One sample had a recovery depth as shallow as 1.3 feet (40 cm); although, the average recovery depth was 4.8 feet (146 cm) on retained DPSC Phase II core samples. Given the difficulties encountered, the field staff retained two attempts of three core stations (DPSC-C090, -C095, and -C112) and the most representative of these cores (as determined by the core processing staff) was submitted to the laboratory for analysis and archival. Photographs of discrete core sections were digitally assimilated into a single photographic mosaic for each core station (see Appendix E). Core collection and processing details are included in Table E-1 and an analytical summary by core section is provided in Table E-2 of Appendix E.

Core logging and processing occurred at the SWCA facility located at 935 SE 12th Avenue in Portland, Oregon. Each core tube was cut open, photographed, logged¹, and sampled as described in the Phase I SAP; however, the Phase II core sectioning methodology differed from the Phase I SAP in that each subsurface core was sectioned into predetermined sampling intervals, rather than sectioned on the basis of variances in lithology. The predetermined sampling intervals for a target 13-foot penetration were: “A” (zero to 1 foot), “B” (1 to 3 feet), “C” (3 to 5 feet), “D” (5 to 7 feet), “E” (7 to 10 feet), and “F” (10 to 13 feet).

Representative material from each section was homogenized, placed into sample containers, and submitted to the laboratory for analysis or archiving as specified in the SAP and SAP Addendum. With a few exceptions, sediment from the “B” depth interval (1 to 3 feet) was selected for chemical testing. The two TriMet cores had sediment from the deepest interval submitted for chemical analysis. Both intervals of core sample DPSC-C041, collected by Anchor QEA, LLC in August 2009, were submitted for chemical analysis. Sediment from the remaining depth intervals was archived at CAS for possible additional chemical analysis in the future. Follow-up analysis from three of the

¹ Eric Collins, RG, oversaw logging of all sediment cores, with the exception of core sample DPSC-C041 collected by Anchor QEA during the PGM sediment investigation.

“A” core intervals was requested following discussion with the Project Manager as described in Table 4-2.

Table 4-5 lists the core samples submitted to the laboratory for analyses and for archiving. The core processing logs are presented in Appendix F.

4.6.3 Modified Sample Names

Several samples were incorrectly labeled as indicated in Table 4-3. These sample labeling errors were corrected in the database. Sample DPSC-C041 was inadvertently labeled with the “RM11E” prefix by Anchor QEA, LLC and thus was changed to “DPSC” to reflect its inclusion in this study. The other two name changes are a result of a misunderstanding between the coordinates of station DPSC-C100/-G100 and DPSC-C102/-G102. This misunderstanding led to the collection of a field replicate sample (DPSC-G102-2). Additionally, TriMet core DPSC-C100 was collected in place of the originally intended core DPSC-C102.

4.7 BIOASSAY SAMPLE COLLECTION

Five stations were identified for biological toxicity (bioassay) testing. In contrast to samples analyzed only for chemical contaminants, which have a minimum target penetration depth of 20 cm, riverbed material from these stations was collected only from the upper 10 cm because of confounding factors in deeper sediment (e.g., ammonia is more likely to be present in deeper sediments and can be toxic to test organisms, resulting in test failure, which may not be caused by chemical contamination). Where both chemical and biological analyses were conducted, sample material from the upper 10 cm was homogenized and distributed to the appropriate bioassay and chemical analytical containers.

At grab stations designated for bioassay sampling, a total of 3 liters of sediment was collected for submittal to NAS for bioassay testing with one exception. Insufficient sediment volume was attainable for sample DPSC-G096 and thus the minimum sample volume of 2 liters was submitted to NAS. To attain adequate volume on grab samples DPSC-G088 and DPSC-G096, more than one retained grab sample was composited for chemical and biological analyses. To assess for potential confounding factors, sample containers for ammonia and total sulfides were collected as described in the SAP Addendum.

4.8 INVESTIGATION-DERIVED WASTE

Liquid and solid waste from DPSC activities was managed as specified in the SAP. Excess water or sediment remaining after sampling and processing on the vessel was returned to the Willamette River near the collection site. Investigation Derived Waste (IDW) was generated during core processing activities at the onshore facility and placed in a 55-gallon drum. IDW was managed, characterized, and disposed of in accordance with the SAP and applicable regulations. A total of one drum of sediment was accumulated during core processing activities. Samples were collected from this drum and analyzed for characteristics of hazardous waste. Results of these analyses are presented in Section 7 of this report. Based on the analytical results, the drum was determined to be non-hazardous waste and was disposed of at the Hillsboro Landfill, a DEQ-licensed Subtitle D solid waste landfill, by WasteXpress of Portland, Oregon, under subcontract to Hart Crowser.

Limited volumes of decontamination solutions containing phosphate-free detergent, nitric acid, and ethanol were generated during the sampling event on the vessel and at the onshore core processing facility. These liquids were managed in sealed 5-gallon plastic buckets and were disposed of in the sanitary sewer at the processing facility as approved by the City's Batch Discharge Permit.

All disposable materials used in sample collection and processing, such as paper towels, aluminum foil, and gloves, were placed in heavyweight garbage bags before disposal as solid waste.

4.9 SAMPLE HANDLING, TRANSPORT, AND CUSTODY

Samples collected during the DPSC sampling event were tracked from the time of sample collection through laboratory and data analysis using standard chain-of-custody and sample shipping/transfer procedures. These procedures are detailed in the SAP. Copies of the chain-of-custody forms are provided with the laboratory reports in Appendices J and K.

4.10 FIELD QUALITY CONTROL SAMPLES

QC samples were collected during field sampling to ensure that data quality objectives were met. Field QC samples collected during the DPSC are specified in the SAP. These samples included field duplicate (split) samples and rinsate samples, both of which were collected at approximately 5 percent of the sediment sampling stations. A temperature blank was included in each cooler that transmitted samples to the laboratory.

5.0 LABORATORY ANALYSIS AND QUALITY ASSURANCE AND QUALITY CONTROL

This section summarizes the physical and chemical analyses, and the bioassay analyses performed on sediment samples collected during the DPSC Phase II. Laboratory QC and data validation protocols also are described. These protocols were followed to ensure that data quality and representation are in accordance with method requirements and that data usability is appropriately assessed for the project objectives.

5.1 PHYSICAL AND CHEMICAL ANALYSES

CAS of Kelso, Washington, performed the physical and chemical analyses on archived DPSC Phase I and DPSC Phase II samples, except for dioxin/furan analyses, which were completed by CAS's laboratory in Houston, Texas.

With a few exceptions, DPSC Phase II samples were analyzed for a focused set of target parameters referred to as the "Partial Analyte Group." The Partial Analyte Group consists of:

- PCB Aroclors
- Conventionals (TOC and total solids; TriMet samples include grain size)
- Metals (aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, silver, selenium, and zinc)
- PAHs (non-alkylated)
- Pesticides
- TPH (with silica gel treatment)

A subset of samples also was analyzed for butyltins and/or dioxins/furans as specified in the SAP Addendum. Where bioassays were performed or TriMet samples were collected, sediment samples were also analyzed for ammonia and total sulfides. The analytical methods for sediment testing are presented in Table 5-1. Laboratory reports provided by CAS are presented in Appendix J.

5.2 BIOASSAY ANALYSES

As described in Section 4.7, a subset of the grab samples was selected for bioassay testing as described in the SAP Addendum. Five grab samples were analyzed using the following tests:

- 10-day *Chironomus dilutus* (previously *C. tentans*) survival and growth test by ASTM Method E-1706 and EPA/600/R99/064, Method 100.2

- 28-day *Hyalella azteca* survival and growth test by ASTM Method E-1706 and EPA/600/R-99/064 Method 100.4 (modification to 28 days)

Other analytical requirements include: (1) eight replicates were performed for each test; (2) interstitial ammonia was measured both at the beginning and end of the test in at least one replicate and the negative control (i.e., clean freshwater sediment from Beaver Creek near Newport, Oregon); (3) a negative control was run for each test and will be obtained from a freshwater environment; and (4) a positive control (reference toxicant) was run for the methods. NAS provided tabulated results of the above tests in electronic and hard copy formats for validation, review, and interpretation. Laboratory reports provided by NAS are presented in Appendix K.

The bioassay results were not subject to formal data review and data validation and were not incorporated into the project database. Bioassay results are discussed in Section 8 of this report.

5.3 LABORATORY QA/QC PROCEDURES

Laboratory QA/QC was maintained through the use of standard EPA methods and other accepted methods and standard analytical procedures for the DPSC analytes. The analytical methods and QC measurements and criteria used are based on current Contract Laboratory Program (CLP) and SW-846 requirements, and EPA guidance. The method-specific and other analytical and laboratory QC procedures and protocols followed are detailed in the SAP. These procedures incorporated analysis of the following laboratory QA/QC components:

- Internal QC samples
- Method blanks
- Laboratory duplicates
- Surrogate spikes
- Laboratory control samples
- Matrix spike (MS) and matrix spike duplicate (MSD) samples
- Standard Reference Material samples

Analytical QC measurements were performed primarily on sample matrices from the DPSC project.

5.4 DATA REVIEW, VERIFICATION, AND VALIDATION PROCEDURES

Field and laboratory data collected for the DPSC were subjected to a formal verification and validation process in accordance with EPA guidance documents as described in the SAP.

Hart Crowser performed the data validation to determine the usability of the data toward meeting project objectives. A thorough data validation review was performed on 100 percent of the data, and approximately 5 percent of the data were subject to additional validation. Additional validation reviews were performed on chromatograms from the analysis of pesticides and PCBs.

For the data validation, laboratory data deliverables reviewed included case narratives; chain of custody documentation; laboratory summary result forms; instrument tuning and calibrations; results for applicable instrument blanks, method blanks, and equipment rinsate blanks; internal standard recoveries; method-specific QC measurements; surrogate, laboratory control samples (LCS/LCSD), and MS/MSD recoveries; laboratory and field duplicate relative percent differences; and sample chromatograms and quantification reports.

Performance-based control limits established by the laboratory and control limits provided in the method protocols were used to evaluate data quality and determine the need for data qualification. Data qualifiers were assigned during data validation to the electronic data deliverables (EDD) when applicable QA/QC limits were not met and the qualification was warranted following guidance specified by EPA (1999, 2002, and 2004), QC requirements specified in the SAP, and method-specific QC requirements, as applicable. Data validation qualifiers and definitions are presented in Table 5-2.

Final, qualified laboratory results were transmitted in EDDs to GeoEngineers for data management, further evaluation, and reporting as described in Section 6 of this report. A data validation report was prepared to document the validation process and that report is provided in Appendix L.

5.5 DATA QUALITY AND USABILITY

Data generated in the field and at the laboratories were verified and validated according to the criteria and procedures described in the SAP. Data quality and usability were evaluated on the basis of the results of the data validation and the data quality objectives established for this investigation. Performance criteria included analytical goals for precision, accuracy, representativeness, and comparability of the data, which were assessed during data validation, as described above, in Appendix L, and in the SAP.

Completeness was calculated by comparing the total number of acceptable data (non-rejected data) to the total number of data points generated. Overall, completeness for the DPSC sediment data is more than 99 percent.

Selected data not meeting applicable data quality criteria were qualified as estimated, undetected, or rejected during data validation. Data qualified as estimated (J or UJ) have a generally acceptable degree of uncertainty and represent data of generally good quality, reasonable confidence, and are usable for their intended purposes, with the knowledge that these data may be less precise or less accurate than unqualified data. Data qualified as undetected are usable for all intended purposes. All data that were rejected (R) are not usable for any purpose and should not be used.

In many samples, both PCBs and organochlorine pesticides were reported as detected. In this situation, interferences from the inability of the instrument to differentiate selected PCB congeners from certain organochlorine pesticides may occur. As such, it is possible that some target compounds may be reported as a false positive or the concentration that was quantified may exhibit a positive bias because of the co-elution (or interference) with one, or more, organochlorine pesticide and/or PCB congener. The contract laboratory is aware of this co-elution issue and was careful to identify and report as accurately as possible the concentrations of each organochlorine pesticide and PCB mixture identified as present in the affected samples.

The number of DPSC Phase II surface and subsurface samples, archived Phase I surface and subsurface samples, and field QC samples submitted for each parameter group is summarized in Table 5-3. More detailed discussion regarding the qualification of the data can be found in the data validation report in Appendix L.

6.0 DATA MANAGEMENT

Data generated as part of the DPSC were documented and managed as described in previous sections and in accordance with the SAP. These data consisted of field data sheets, photographs, field notebooks, and electronic data files. To the extent practicable, all measurements and other quantitative and qualitative data were incorporated into an EQuIS database (EarthSoft, Inc.).

6.1 DATABASE

Sediment samples were sent to CAS for chemical analyses. After analyses were completed, the laboratory provided electronic EDDs following the EQuIS four-file format (sample, test, batch, and results). The EDDs were organized by sample delivery groups and in a comma-delimited text file format. The EDDs were sent from the laboratory to GSI and Hart Crowser. The unvalidated files were forwarded to GeoEngineers for storage while Hart Crowser proceeded with data validation according to the SAP. Copies of the EDDs were made and the contents were modified to reflect adjustments identified during the data validation process. The primary modification was the addition of a validator qualifier field, where the final qualifier for the result was placed. This ensured the original laboratory qualifiers also remained intact. The modified EDDs were sent to GeoEngineers where they were checked for proper EQuIS structure and content. Additional information needed to complete the database (such as sampling locations, composite information, and field replicate and split information) was compiled by GSI and forwarded to GeoEngineers for inclusion into the DPSC database.

Before uploading the EDDs, GeoEngineers developed an EQuIS Version 3 database based on the valid values or reference values of the LWG EQuIS database. During the process of loading the EDDs, EQuIS was used to check the EDDs for: correct reference codes (such as for analytes, test methods, and sample matrices); proper relationships for results, tests, batches, and samples (to ensure all results matched with a test, tests with samples, and sample/test pairs with batches); and that all derived samples (such as replicates, splits, and MS) had corresponding parent samples.

Additionally, EQuIS was used to check information such as date and time formats, and text field lengths to ensure consistency throughout the database. EQuIS was used to prevent any EDD with code or format errors from successfully uploading until the errors were corrected. Original copies of the EDDs that were uploaded successfully were saved for purposes of documenting and tracking the data.

The DPSC project database contains all of the data reported by the analytical laboratories. These data include field splits, laboratory duplicates, laboratory dilutions,

results for the same analyte from multiple analytical methods (e.g., SW8270 and SW8270-SIM), and laboratory QA samples such as MS, surrogates, and method blanks.

As mentioned in Section 5.2 of this report, the bioassay results were not incorporated into the project database, but are presented separately in Section 8.

6.2 DATA REDUCTION AND HANDLING

Two documents were used as guidelines for data reduction and handling:

- *Portland Harbor RI/FS Technical Memorandum: Guidelines for Data Averaging and Treatment of Non-detected Values for the Round 1 Database* (Integral et al., 2004).
- *Draft Portland Harbor RI/FS Remedial Investigation Report, Appendix A3, SCRA Database and Data Management* (Integral et al., 2009).

The guidelines describe the rules used for averaging data and retaining or modifying qualifiers, and were used to reduce the DPSC data to a single value per sample analyte. The resulting data were checked and verified for 100 percent of the resulting DPSC EQUIS database.

Samples subject to averaging included laboratory QC duplicates for metals, field QC splits, and samples reanalyzed at the direction of the Project Manager to assess potentially anomalous results. Original sample results are contained in the DPSC EQUIS database. Laboratory QC duplicate results and their parent sample results were averaged before inclusion in the tables in Section 6 of this report. Analytical results for individual field QC split and reanalyzed samples are presented in Appendix M along with their averaged values. Only the averaged values are used in the statistical analyses, scatter plots, analyte concentration maps, and Excel data files, as discussed in Section 7 of this report.

The LWG averaging rules address three general combinations of detected and non-detected results:

- If two or more individual analytes within an analyte group were detected, only the detected results were averaged (the non-detected results are ignored).
- If only an individual analyte within an analyte group was detected, the detected value was reported as the average (the non-detected results are ignored).
- If none of the individual analytes within an analyte group was detected, the highest reporting detection limit (RDL) was reported as the average.

When averaging multiple results, the data validation qualifiers were propagated according to the LWG guidelines. If all of the results in the calculated average include the same qualifier (Table 5-2), then the qualifier was applied to the calculated average. If one or more of the results are qualified as estimated (J-flagged), then the calculated average was similarly qualified (J). A “T” qualifier was added to all results that were mathematically derived, including averaged and summed results.

The LWG guidelines also specify summation rules for select analytical groups:

- Total PCBs Aroclors were calculated as the sum of individual Aroclors.
- Total butyltins were calculated as the sum of the following compounds: butyltin ion, dibutyltin ion, tributyltin ion, and tetrabutyltin.
- Total PCDD/Fs were calculated as the sum of dioxin and furan homologs: tetrachlorodibenzo-p-dioxins, pentachlorodibenzo-p-dioxins, hexachlorodibenzo-p-dioxins, heptachlorodibenzo-p-dioxins, octachlorodibenzo-p-dioxin, tetrachlorodibenzofurans, pentachlorodibenzofurans, hexachlorodibenzofurans, heptachlorodibenzofurans, and octachlorodibenzofuran.
- Dioxin and furan TCDD toxic equivalents (TEQ) were calculated using the 2005 World Health Organization consensus toxicity equivalency factors (TEF) relative 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD or TCDD) values for mammals. TEQs were calculated as the sum of each detected congener concentration multiplied by the corresponding TEF value (non-detect values are set to zero for TEQ calculations)². When all of the congeners were not detected in a given sample, the individual congener detection limits are multiplied by their respective TEF and the maximum individual value for the total, along with a U qualifier, is used as the TEQ for that sample.
- Total low molecular weight PAHs (LPAH) were calculated using the concentrations for 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene. Total high molecular weight PAHs (HPAH) were calculated using the concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(a)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-cd)pyrene, and pyrene. Total PAHs were calculated by summing the LPAH and HPAH values.
- Benzo(a)pyrene TEQ (Total BaPEq) values were calculated as the sum of each detected cPAH by their respective potency equivalency factor (PEF; non-detect values are set to zero for TEQ calculations). When all of the cPAHs were not detected in a given sample, the individual cPAH detection limits are multiplied by

² This procedure was described inaccurately in the Phase I Field and Data Report. However, the calculations were performed correctly.

their respective PEF and the maximum individual value for the total, along with a U qualifier, is used as the Total BaPEq for that sample.

- Total DDx values were calculated with the concentrations of the six DDx compounds: 2,4'-DDD; 4,4'-DDD; 2,4'-DDE; 4,4' DDE; 2,4'-DDT; and 4,4'-DDT. Total DDD values were calculated with 2,4'-DDD and 4,4'-DDD; total DDE values were calculated with 2,4'-DDE and 4,4'-DDE; and total DDT was calculated by summing 2,4'-DDT and 4,4'-DDT.
- Total chlordanes were calculated as the sum of the following compounds: cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor. Technical grade chlordane also was reported by the laboratory, but is not included in the Section 6 tables in this report.
- Total endosulfans were calculated as the sum of alpha-endosulfan, beta-endosulfan, and endosulfan sulfate.
- TPH was calculated as the sum of diesel-range hydrocarbons and residual-range hydrocarbons.

In general, the calculated totals are the sum of all detected concentrations. If all of the analytes were not detected, then the highest RDL was selected for the calculated total, and a “U” qualifier was carried through to indicate that all results were reported as undetected. All calculated totals are flagged with a “T” indicating they are mathematically derived values.

The LWG guidelines address the retention of significant figures and these guidelines generally were followed in generating and maintaining the DPSC EQUIS database. The number of significant figures provided by the analytical laboratory was maintained in the DPSC EQUIS database. In addition, significant figures were maintained during calculations, such as averaging splits and summing totals. However, the final results of these calculations were not rounded to the smallest number of significant figures for the values included in the calculations. That is, the final results from the averaging and totaling calculations may contain too many significant figures. The inclusion of additional significant figures should not affect the interpretation of the DPSC analytical data.

7.0 PHYSICAL AND CHEMICAL RESULTS

This section presents the physical and chemical analytical results for archived DPSC Phase I samples and DPSC Phase II samples. For the purposes of this study, and for consistency with the LWG data reporting protocols, samples are referred to as either “surface” or “subsurface” samples, rather than as grab samples and core samples. Surface samples are defined as riverbed sediment collected within the uppermost foot (30.5 cm). These include all of the grab samples and the “A” section of cores where the maximum penetration of the “A” section is no greater than 30.5 cm. This is the case for all of the DPSC Phase II cores and most of the archived DPSC Phase I core samples. Two exceptions are the “A” sections of cores DPSC-C035 and DPSC-C036 (PP&R area). The penetration depth on these two “A” section samples, described in the Phase I Field and Data Report, is greater than 30.5 cm and thus these core intervals are grouped with subsurface sediment.

Analytical results of the surface and subsurface samples have been tabulated for the archived DPSC Phase I samples and the DPSC Phase II samples as follows.

- Table 7-1 and Table 7-2 present analytical results of the archived DPSC Phase I surface and subsurface samples, respectively, following reduction of the field QC splits and laboratory QC duplicate/triplicate samples.
- Table 7-3 and Table 7-4 present analytical results of the DPSC Phase II surface and subsurface samples, respectively, following reduction of the field QC splits and laboratory QC duplicate/triplicate samples.
- Table 7-5 and Table 7-6 provide analytical results of the field QC rinsate blank samples and IDW samples, respectively.

A series of figures was prepared to help visualize the distribution of analyte concentrations within the downtown reach for the archived DPSC Phase I (including PP&R), DPSC Phase II, and LWG samples. Figures 7-1a through 7-11 and Figures 7-2a through 7-2l are scatter plots of analyte concentrations in surface and subsurface samples, respectively, versus RM. Figures 7-3a through 7-3l are maps presenting the spatial distribution of select analyte concentration data (total PCB Aroclors, total butyltins, dioxin/furan TCDD TEQ concentrations, arsenic, lead, mercury, total PAHs, benzo(a)pyrene equivalent [B(a)P-Eq], naphthalene, total DDX, total chlordanes, and dieldrin) in surface samples. Figures 7-4a through 7-4l show the highest concentration of analyzed subsurface core intervals.

As discussed in Section 6 of this report, analytical results of parent samples, field QC split samples, laboratory QC duplicate/triplicate samples, and averaged samples are

provided in Appendix M. Appendix N contains the Excel data files for all datasets included in this study. These datasets include the DPSC Phase II, archived DPSC Phase I, original DPSC Phase I (including PP&R), and LWG samples between RM 11.6 and 16.0. Results have been reduced to provide average values for field splits and laboratory QC duplicates/triplicates.

8.0 BIOASSAY RESULTS

This section presents the biological testing results for samples collected during DPSC Phase II. Five surface sediment samples (upper 10 cm) were submitted in two separate groups (one group with three samples and the other group with two samples) to NAS for biological testing using 10-Day Midge (*Chironomus dilutus*) and 28-Day Amphipod (*Hyalella azteca*) bioassays. NAS performed separate biological testing on each sample group with eight replicates conducted on each sample and the negative control. Bioassay results for each test report survival (as percent mortality) and growth (as average dry weight/surviving organism).

Table 8-1 presents the survival and growth results for each test. Appendix K includes copies of NAS's reports. Each report provides the results and backup documentation of each test, including test protocols, raw data (e.g., organism counts, water quality measurements, interstitial ammonia concentrations), statistical calculations, and positive control results.

9.0 REFERENCES

- Anchor QEA, 2009a. Field Sampling Plan for Sediment Investigation. Portland Gas Manufacturing Site. Prepared for NW Natural. Anchor QEA, LLC. February 2009.
- Anchor QEA, 2009b. Sediment Investigation Report. Portland Gas Manufacturing Site. Prepared for NW Natural. Anchor QEA, LLC. December 2009.
- ASTM, 2000. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM Standard Method No. D 2488-00. *In*: ASTM Book of Standards, Volume 04.08. American Society for Testing and Materials, West Conshohocken, PA. 2000
- DEQ, 2009. Downtown Portland - Willamette River Sediment Evaluation - Preliminary Identification of Locations of Interest. Oregon Department of Environmental Quality. October 13, 2009.
- EPA, 1999. USEPA Contract Laboratory Program, national functional guidelines for organic data review. EPA/540/R-99/008. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. October 1999.
- EPA, 2002. Guidance on Environmental Data Verification and Data Validation. EPA QA/G-8. EPA/240/R-02/004. U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC. November 2002.
- EPA, 2004. USEPA Contract Laboratory Program national functional guidelines for inorganic data review. Final. OSWER 9240.1-45. EPA 540-R-04-004. October 2004. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation (OSRTI), Washington, DC.
- EPA, 2005. USEPA National Functional Guidelines for Chlorinated Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review. OSWER 9240.1-51. EPA 540-R-05-001. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation (OSRTI), Washington, DC. September 2005.
- GSI, 2008. Sampling and Analysis Plan, Downtown Portland Sediment Characterization. Prepared for the City of Portland and Oregon Department of Environmental Quality. GSI Water Solutions, Inc. May 2008.
- GSI, 2009a. Field and Data Report, Downtown Portland Sediment Characterization, Willamette River, Oregon. Prepared for the Oregon Department of Environmental Quality. GSI Water Solutions, Inc. January 2009.
- GSI, 2009b. Draft Surface and Subsurface Sediment Field and Data Report, River Mile 11 East, Focused Sediment Characterization. Prepared for the City of Portland. GSI Water Solutions, Inc. August 2009.

GSI and Hart Crowser, 2010. Sampling and Analysis Plan Addendum. Downtown Portland Sediment Characterization Phase II, Willamette River, Oregon. Prepared for the Oregon Department of Environmental Quality. GSI Water Solutions, Inc. February 2010.

Integral, Woodward, and Kennedy/Jenks, 2004. Portland Harbor RI/FS Technical Memorandum: Guidelines for Data Averaging and Treatment of Non-detected Values for the Round 1 Database. Prepared for the Lower Willamette Group. Prepared by Integral Consulting Inc., Woodward Environmental LLC, Kennedy/Jenks Consultants. June 10, 2004.

Integral, Woodward, Kennedy/Jenks, and Anchor, 2007. Portland Harbor RI/FS Round 2 Comprehensive Site Characterization Summary and Data Gaps Analysis Report. Prepared for the Lower Willamette Group. Prepared by Integral Consulting Inc., Woodward Environmental LLC, Kennedy/Jenks Consultants, Anchor Environmental LLC. February 21, 2007.

Integral, Woodward, Kennedy/Jenks, and Anchor, 2009. Draft Portland Harbor RI/FS Remedial Investigation Report. Prepared for the Lower Willamette Group. Prepared by Integral Consulting Inc., Woodward Environmental LLC, Kennedy/Jenks Consultants, Anchor QEA, LLC. October 27, 2009.

URS, 2010. Sampling and Analysis Plan, Portland General Electric Willamette River Sediment Remedial Investigation, River Miles 13.1 and 13.5. Prepared for Portland General Electric Company. URS Corporation. February 5, 2010.

USACE, 2009. Sediment Evaluation Framework for the Pacific Northwest. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Washington Department of Ecology, Washington Department of Natural Resources, Oregon Department of Environmental Quality, Idaho Department of Environmental Quality, National Marine Fisheries Services, U.S. Fish and Wildlife Services. May 2009.