Data Report

Lower Duwamish Waterway, East Waterway, and West Waterway Subsurface Sediment Characterization

Seattle, Washington

May 17, 2013

Prepared for:

US Army Corps of Engineers
Seattle District
2735 E. Marginal Way S.
Seattle, WA 98124

US Army Corps of Engineers®
Seattle District

Prepared by:

HDR Engineering, Inc.
606 Columbia Street NW,
Suite 200
Olympia, WA 98501

Science and Engineering for the Environment, LLC
4401 Latona Ave NE
Seattle, WA 98105

Ken Taylor Associates, Inc.
500 Fifth Avenue, Suite 4100
Seattle, Washington 98104

LIST OF ACRONYMS AND ABBREVIATIONS

ARI	Analytical Resources, Inc.
BMS	Below Mud Surface
BT	bioaccumulation trigger
CAD	confined aquatic disposal
CLP	US EPA Contract Laboratory Program
CoC	chain of custody
COC	chemical of concern
COR	Contracting Officer's Representative
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CAS	Columbia Analytical Services
CTL	Contract Team Technical Lead
CVAA	Cold Vapor Atomic Absorption
DDT	dichlorodiphenyltrichloroethane
DI	Deionized Water
DQI	Data Quality Indicators
DGPS	Differential Global Positioning System
DMMO	Dredged Material Management Office
DoD	U.S. Department of Defense
DMMP	Dredged Material Management Program
DVR	Data Validation Report
Ecology	Washington State Department of Ecology
EC50	Effective Concentration 50%
EDD	electronic data deliverable
EDL	estimated detection limit
EIMS	Environmental Information Management System
EMPCs	estimated maximum potential concentrations
EPA	U.S. Environmental Protection Agency
EW	East Waterway
FIM	Field Investigation Manager
GC/MS	gas chromatography/mass spectrophotometry
GPS	Global Positioning System
HDR	HDR Engineering, Inc.
HPAH	high molecular weight polycyclic aromatic hydrocarbon
HRGC	high resolution gas chromatography
HRMS	high resolution mass spectrometer
ID	Identification
IDW	Investigation-Derived Waste
KTA	Ken Taylor and Associates, Inc.
LC50	Lethal Concentration 50%
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LOD	Limits of Detection
LOQ	Limits of Quantification
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LCS	laboratory control sample

MDL	method detection limit
ML	maximum level
MLLW	Mean Lower Low Water
MS/MSD	matrix spike/matrix spike duplicate
NAD 83	North American Datum of 1983
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NWAS	Northwestern Aquatic Sciences
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PEDs	polyethylene passive samplers
POC	Point of Contact
PRG	Preliminary Remediation Goals
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RAL	Remedial Action Level
RL	Reporting Limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SEE	Science and Engineering for the Environment, LLC
SIM	selective ion monitoring
SL	screening level
SMARM	Sediment Management Annual Review Meetings
SMS	Sediment Management Standards
SOP	standard operating procedure
SRM	Standard Reference Material
SVOCs	semi-volatile organic compounds
TBT	tributyl tin
TEF	toxic equivalency factor
TEQ	toxicity equivalent quotient
TOC	total organic carbon
TS	total solids
TVS	total volatile solids
USACE	U.S. Army Corps of Engineers
WDNR	Washington Department of Natural Resources
WW	West Waterway
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
mg/kg OC	milligram per kilogram organic carbon
pg/kg	picograms per kilogram

Table of Contents

1.0 Introduction 1

1.1 Background 1
1.2 Project Objectives 2
1.3 Target Sampling Locations and Chemicals of Concern (COCs) 3
1.3.1 East Waterway 3
1.3.2 West Waterway 3
1.3.3 Lower Duwamish Waterway 3
1.3.4 CAD Site 4
1.4 Sampling and Analysis Chronology 4

2.0 Field Methods 5

2.1 Field Collection Methods 5
2.1.1 Field Collection Vessel, Processing, and Personnel 5
2.1.2 Navigation and Depth Measurements 5
2.1.3 Vibracore Sediment Collection 6
2.1.4 Sediment Grab Samples 7
2.1.5 Sampling Locations 7
2.2 Subsurface Sediment Processing 9
2.2.1 Core Subsampling Intervals and Sample Nomenclature 9
2.2.2 Analytical and Biological Samples 10
2.3 Carr Inlet Reference Sediment Collection 12
2.4 Samples for PCB Methods 1668 and 680 12

3.0 Analytical Results 13

3.1 Summary of Data Validation Findings 13
3.2 Comparison to DMMP Guidelines and SMS 14
3.2.1 East and West Waterway 15
3.2.2 LDW North 16
3.2.3 LDW Central 17
3.2.4 LDW South 19
3.3 Analytical Results Compared to the LDW Superfund Site PRGs and RALs 20
3.4 CAD Results 21
3.4.1 Physical Observations of CAD Cores 21
3.4.2 Analytical Results 22
3.5 Results of Congener and Homolog Analyses for Select LDW Stations 22
3.5.1 Data Review and Validation 23
3.5.2 Results 24

4.0 Results of Biological Tests 25

4.1 Selection of Bioassay Stations 25
4.2 Results of Individual Bioassays 25
4.2.1 Amphipod Results 26
4.2.2 Larval Results 26
4.2.3 *Neanthes* Results 26
4.3 Biological Testing Summary 26

5.0 References 27

Tables

1-1. DMMP Screening Level (SL), Bioaccumulation Trigger (BT) and Maximum Level (ML) Marine Guideline Chemistry Values (updated June 2011), and Washington State Sediment Management Standards
1-2. Lower Duwamish Superfund Site Proposal Remedial Action Levels and Preliminary Remediation Goals

2-1. Navigation and Tide Check Stations
2-2. Station Collection Summary
2-3. Target Sampling Locations and Intervals
2-4. Subsampling Elevations for Stations in the Lower Duwamish, East and West Waterways
2-5. Analytical and Biological Sample Summary
2-6. Analytical Results for Selected Bioassay Stations in the Lower Duwamish Waterway

3-1. East and West Waterway: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards
3-2. LDW North: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards
3-3. LDW Central: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards
3-4. LDW South: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards
3-5. Summary of Dioxin TEQs to DMMP
3-6. Comparison of Results to the Lower Duwamish Superfund Site Proposal Remedial Action Levels and Preliminary Remediation Goals
3-7. Summary of CAD Analytical Results
3-8. Total PCBs from Aroclor, Congener, and Homolog Analyses
3-9. Total PCB Concentrations from Aroclor, Congener, and Homolog Analyses

4-1. Bioassay QA/QC Performance Standards and Interpretive Criteria for Non-Dispersive Disposal Sites
4-2. Summary of Bioassay Results Relative to the DMMP Non-Dispersive Site Guidelines
4-3. Comparative Bioassay Results Relative to the DMMP Non-Dispersive Site Interpretive Guidelines

Figures

1-1. Vicinity Map

2-1. East and West Waterways - Target and Final Coring Locations
2-2. LDW North - Target and Final Coring Locations
2-3. LDW Middle – Target and Final Coring Locations
2-4. LDW South – Target and Final Coring Locations
2-5. Carr Inlet Reference Station Locations

2-6. CAD Cores 01 – 03 Photo Montage
2-7. CAD Cores 01 – 03 Sampling Intervals

3-1. East and West Waterways – Detected COC Exceedances
3-2. LDW North – Detected COC Exceedances
3-3. LDW Central – Detected COC Exceedances
3-4. LDW South – Detected COC Exceedances
3-5. Comparison of Total PCB Concentrations as Sum of Congeners, Homologs, and Aroclors
3-6. Regression of Total PCBs as Sum of Congeners (U=1/2 RL), Homologs (April and March Data) against Sum of Aroclors
3-7. Regression of Total PCBs as Sum of Congeners (U=1/2 RL) against Homologs (April Data)

Appendices

A. Final Sampling and Analysis Plan
B. Sediment Collection Daily Reports
C. Field and Lab Notebooks
  C-1. Field Notebook
  C-2. Lab Notebook
  C-3. Chain-of-Custody Forms
D. Sediment Drive Logs
E. Sediment Core Logs
F. Core Photographs
G. Results of Chemical Analysis
  G-1. Lower Duwamish, West Waterway, and East Water Way Analytical Results Compared to DMMP and SMS Guideline Values
  G-2. Calculation of Dioxin/Furan TEQs
  G-3. Calculation of Carcinogenic PAH TEQs
  G-4. CAD Analytical Results Compared to SMS Guideline Values
H. Analytical Laboratory Reports
  H-1. Analytical Resources, Inc. Data Reports
  H-2. ALS/CAS Data Reports
  H-3. MIT Black Carbon Data Report
I. Validated Electronic Data Deliverables
J. Analytical Data Validation Reports
K. Bioassay Reports
  K-1. Northwestern Aquatic Sciences Data Reports
  K-2. Bioassay Data Validation Checklists
  K-3. Bioassay Electronic Data Deliverables and Statistical Analyses

1.0 Introduction

This Data Report (Report) for the Lower Duwamish Waterway, East Waterway, and West Waterway Subsurface Sediment Characterization Project describes the results of sediment sampling, chemical and biological analyses, and other evaluations needed to provide a reconnaissance-level characterization of sediments within and adjacent to the federally-authorized navigation channels of the Duwamish River in Seattle, Washington. Specifically, surface and subsurface sediment samples were collected in the Lower Duwamish Waterway (LDW), the East Waterway, and the West Waterway (Figure 1-1). This sediment characterization effort was conducted by a team led by HDR Engineering, Inc. (HDR), Science and Engineering for the Environment (SEE), and Ken Taylor and Associates (KTA) for the U.S. Army Corps of Engineers (USACE), Seattle District. USACE and the other Dredge Materials Management Program (DMMP) Agencies [US Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology) and the Washington State Department of Natural Resources (DNR)] approved the Sampling and Analysis Plan (SAP).

The characterization of sediments was conducted in accordance with the approved SAP. The SAP (Appendix A) describes the overall sampling strategy, sediment collection methods, chemical testing methods, biological testing methods, and data reporting requirements for dredged material characterization. In addition to the results of the sampling and analyses, this Report discusses where and why deviations from the SAP occurred, quality assurance and quality control measures undertaken, reviews and validation of the data, and the collected field and laboratory data.

1.1 Background

As authorized by Congress in the Rivers and Harbors Acts of 1925 and 1930, the USACE conducts maintenance dredging of the Seattle Harbor Federal Navigation Project in the Duwamish River. The Duwamish River originates at the confluence of the Green and Black Rivers near Tukwila, Washington, then flows northwest for approximately 12 miles where it splits into two channels, which flow northward and discharge into Elliott Bay (Figure 1-1).

Three separate authorized channels exist within the Duwamish River: the West Waterway, the East Waterway, and the LDW (Figure 1-1). The West Waterway federal channel begins at the mouth of the river at Elliott Bay, and runs along the west side of Harbor Island for approximately 6,100 feet (ft) (1.16 miles). The authorized depth of the West Waterway is -34 ft Mean Lower Low Water (MLLW). The East Waterway also begins at the confluence with Elliott Bay, running on the east side of Harbor Island for approximately 7,200 ft (1.4 miles). The authorized depth of the East Channel varies from -39 to -51 ft MLLW. The LDW federal navigation channel begins at the southern terminus of the West Waterway Channel, beginning at River Station 00+00 and continuing to the head of the channel at Turning Basin 3 at Station 275+56. The authorized depth of the channel in the LDW varies from -15 to -30 ft MLLW. The portion of the LDW included in this characterization study extends from Station 0+00 to 240+00, which encompasses the LDW Superfund site from River Mile 0 to 4.0.

All three federal navigation channels are within designated National Priority List, or Superfund, sites. The East and West Waterways are included in the Harbor Island Superfund site, while the

designated LDW Superfund site extends from the southern tip of Harbor Island, and extends to just south of Turning Basin 3. All three waterways have on-going investigation and cleanup activities, with oversight by EPA and Ecology.

Shoaling of sediments that exceed the authorized channel depth was observed in bathymetric profiles obtained in April 2012. This reconaissance study provides information on whether the sediments, if dredged in the navigation program, are likely to be suitable for disposal at an unconfined, open-water disposal site managed by the DMMP. The data were collected in a manner consistent with regional regulatory analytical protocols and serve to fill data gaps in the subsurface sediments, inform future testing design for USACE (relevant to future dredging decisions), and may be used by EPA and Ecology to inform their respective cleanup programs.

A confined aquatic disposal (CAD) site was created in the West Waterway in 1984 to contain sediments contaminated with polychlorinated biphenyls (PCBs) and metals. The USACE placed dredged sediments in an existing depression in the West Waterway, and capped the CAD site with clean sand dredged from Turning Basin 3. Environmental monitoring of the CAD site occurred in 1989 and in 1995. Those monitoring events showed that the CAD site had effectively contained the contaminants; monitoring has not occurred since 1995. The USACE elected to conduct CAD monitoring with this sediment characterization program.

1.2 Project Objectives

The programmatic objective for this program was to inform planning for potential future dredging maintenance within the authorized federal navigation channels of the Duwamish River. Specific objectives of this work included:

- Provide preliminary information to support sample design for future testing to support navigation program planning by determining whether sediments in the LDW may be suitable for open water disposal
- Provide current status on the level of sediment contamination in the federal navigation channel to further inform the ongoing EPA Superfund site activities
- Evaluate the long-term performance of the CAD site in the West Waterway that was created by USACE in 1984 for disposal of PCB-contaminated sediment
- Provide information to better inform the relationships between bulk-sediment PCBs, as measured by PCB Aroclors, PCB homologs, and individual PCB congeners.

Option 2 of the Project Work Statement included additional work to provide information to support the LDW Superfund site remedial decision-making process by performing passive porewater and sediment analysis, using diver-installed polyethylene passive samplers (PEDs). The Work Plan for these activities is referenced in the SAP but was provided separately to USACE and EPA. The reporting for Option 2 will also be provided separately and is not referred to again in this report.

1.3 Target Sampling Locations and Chemicals of Concern (COCs)

Target sampling locations were identified in the SAP based upon the project objectives and the potential to encounter the chemicals of concerns (COCs) based upon a review of previous sediment characterization studies and relevant information from the draft *Lower Duwamish Waterway Feasibility Study* (Lower Duwamish Waterway Group [LDWG] 2010). For this program, COCs are defined by three sets of guidelines or criteria: (1) the DMMP's chemical guideline values (Table 1-1); (2) the Washington State Sediment Management Standards (SMS) (Table 1-1); and (3) the Lower Duwamish Superfund site Proposed Remedial Action Levels (RAL) and Preliminary Remediation Goals (PRG) (Table 1-2).

1.3.1 East Waterway

A single sampling location was designated in the East Waterway (Figure 1-1). The station is not located specifically within the federal channel but is just outside the channel on the approach to the U.S. Coast Guard, Pier 36 Slip. The slip is a United States port facility that contains moorage for Coast Guard vessels. Shoaling on the north approach to the slip is interfering with vessel movement at low tide. Sediments from Slip 36 were last characterized in 1999 (USACE et al 2002). In the 1999 characterization, COCs that exceeded DMMP guidelines included copper, lead, silver, fluoranthene, pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, total dichloro-diphenyl-trichloroethane (DDT) and total PCBs. Biological testing was performed concurrently with chemical analyses and failed for four of the eight stations tested. All four failures were for larval bioassay and failed under the DMMP single-hit rule.

1.3.2 West Waterway

Four sampling locations were designated within the West Waterway; they are within the federal channel between West Waterway Stations 0+00 and 35+00. Two stations are located on the west side of the channel. Both locations are proximal to the former Pacific Sound Resources site. Two stations are located on the east side of the waterway; one in front of the Todd Shipyard and the other off of the former Lockheed Shipyard. Principal COCs identified included arsenic, copper, lead, mercury, zinc, organo-tins (tri-, di-, and monobutyltin), PCBs, polycyclic aromatic hydrocarbons (PAHs), and dioxins/furans.

1.3.3 Lower Duwamish Waterway

The LDW study area for this program was between river stations 0+00 to 240+00 (LDW Superfund River Miles 0.0 to 4.0). The USACE DMMP dredge suitability determinations dating back to 1997 and annual dredging reports dating back to 1989 were reviewed for any dredging characterization studies for this stretch of the river. This section of the federal channel was last characterized for navigation purposes in 1999, and data are only available for the portion from approximately Station 118+00 to 130+00 (SEA 2000). These samples were collected as part of a larger characterization program that extended from Slip 2 (118+00) to the 16th Avenue South Bridge (Station 200+00). In the 1999 evaluation, sample locations designated as S1 – S12 (Slip 2 to the First Avenue South Bridge) were within that year's dredge footprint. Screening Level (SL) exceedances were reported for PCBs and tributyltin (TBT). On a dry-weight basis, PCBs exceeded the SL at 12 sampled stations. SL exceedances for TBT in porewater were noted for

two stations. Two stations (S2 and S3) failed the bioassay disposal guidelines; both the sediment larval test and the *Neanthes* growth failed the two-hit guidelines. Additional two-hit exceedances were noted for the larval test (S12) and the *Neanthes* growth endpoint (S1, S4, S7, S8 and S11), but those were not corroborated by a second test and thus passed the open water disposal guidelines.

The current characterization study segment corresponds approximately to River Mile 0.0 to 4.0 in the LDWG Feasibility Study. The principal chemicals of potential concern identified in the LDWG Feasibility Study in that section of the Duwamish include arsenic, PCBs, PAHs, and bis-2-ethylhexylphthalate, dioxins, and carcinogenic PAHs (cPAHs).

Sites that are either under an Agreed Order with Ecology, or may be an Ecology source control area in this segment of the waterway may be found at Ecology's Toxic Cleanup Program web site for the LDW. These sites may be sources of COCs to the federal navigation channel.

1.3.4 CAD Site

Sampling at the CAD site was designed to duplicate sampling that was performed in 1995 by SAIC (SAIC 1996). COCs that were placed into the CAD site included copper, lead, zinc, and PCBs. The 1995 monitoring event only measured for the metal COCs and PCBs. In that survey, copper, lead, and zinc measured within the sand cap cover were at concentrations elevated above the 1989 survey but below the DMMP SL. PCBs in the sand cover were generally unchanged from the 1989 survey and were at levels below the SL, for all but one measure. At the station labeled "VDS" (labeled as CAD001 in this current study) the measures at +45 cm above the cap surface had Aroclor 1242 and 1254 reported at concentrations of 280 and 470 µg/kg, respectively. While elevated over the 1989 measure, this 1995 measure was less than the SL, and the concentrations closer to the cap/sediment interface (+15 cm) were reported at 31 and 36 µg/kg respectively for the two Aroclors. In the sole surface sediment sample collected on the cap cover, several PAHs exceeded the SL. These included anthracene, total low molecular weight PAHs (LPAHs), benzofluoranthenes, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, and total high molecular weight PAHs (HPAHs). As these were not identified as COCs in the CAD site sediments, the 1995 report concluded that the PAHs were likely from offsite sources (SAIC 1996).

1.4 Sampling and Analysis Chronology

The schedule for sampling and analyses closely followed that identified in the SAP. Field sampling commenced on October 8, 2012, immediately following final approval of the SAP by the DMMP agencies, and was completed by October 19, with demobilization on October 20.

Table 1-1. DMMP Screening Level (SL), Bioaccumulation Trigger (BT) and Maximum Level (ML) Marine Guideline Chemistry Values (updated June 2011), and Washington State Sediment Management Standards

Chemical	CAS Number	DMMP Guidelines			Sediment Management Standards	
		SL	BT	ML	SQS	CSL
Metals		*mg/kg dry weight*			*mg/kg dry weight*	
Antimony	7440-36-0	150	—	200	—	—
Arsenic	7440-38-2	57	507.1	700	57	93
Cadmium	7440-43-9	5.1	11.3	14	5.1	6.7
Chromium	7440-47-3	260	260	---	260	270
Copper	7440-50-8	390	1,027	1,300	390	390
Lead	7439-92-1	450	975	1,200	450	530
Mercury	7439-97-6	0.41	1.5	2.3	0.41	0.59
Selenium	7782-49-2	---	3	---	---	---
Silver	7440-22-4	6.1	6.1	8.4	6.1	6.1
Zinc	7440-66-6	410	2,783	3,800	410	960
Organometallic Compounds (µg/L)						
Monobutyltin	78763-54-9	—	—	—	—	—
Dibutyltin	1002-53-5	—	—	—	—	—
Tributyltin (interstitial)	56573-85-4	0.15	—	—	—	—
Tetrabutyltin	1461-25-2	—	—	—	—	—
Organobutyltins (mg/kg dw)		73	73	—	—	—
Organics						
PAHs		*µg/kg dry weight*			*mg/kg OC*	
Total LPAH	---	5,200	—	29,000	370	780
Naphthalene	91-20-3	2,100	—	2,400	99	170
Acenaphthylene	208-96-8	560	—	1,300	66	66
Acenaphthene	83-32-9	500	—	2,000	16	57
Fluorene	86-73-7	540	—	3,600	23	79
Phenanthrene	85-01-8	1,500	—	21,000	100	480
Anthracene	120-12-7	960	—	13,000	220	1200
2-Methylnaphthalene[(1)]	91-57-6	670	—	1,900	38	64
Total HPAH	—	12,000	—	69,000	960	5300
Fluoranthene	206-44-0	1,700	4,600	30,000	160	1,200
Pyrene	129-00-0	2,600	11,980	16,000	1,000	1,400
Benz(a)anthracene	56-55-3	1,300	—	5,100	110	270
Chrysene	218-01-9	1,400	—	21,000	110	460
Benzofluoranthenes (b, j ,k)	205-99-2 205-82-3 207-08-9	3,200	—	9,900	230	450
Benzo(a)pyrene	50-32-8	1,600	—	3,600	99	210
Indeno(1,2,3-c,d)pyrene	193-39-5	600	—	4,400	34	88
Dibenz(a,h)anthracene	53-70-3	230	—	1,900	12	33
Benzo(g,h,i)perylene	191-24-2	670	—	3,200	31	78
Chlorinated Hydrocarbons		*µg/kg dry weight*			*mg/kg OC*	
1,4-Dichlorobenzene	106-46-7	110	—	120	3.1	9
1,2-Dichlorobenzene	95-50-1	35	—	110	2.3	2.3
1,2,4-Trichlorobenzene	120-82-1	31	—	64	0.81	1.8
Hexachlorobenzene (HCB)	118-74-1	22	168	230	0.38	2.3
Hexachlorobutadiene	87-68-3	11	—	270	3.9	6.2
Phthalates		*µg/kg dry weight*			*mg/kg OC*	
Dimethyl phthalate	131-11-3	71	—	1,400	53	53
Diethyl phthalate	84-66-2	200	—	1,200	61	110
Di-n-butyl phthalate	84-74-2	1,400	—	5,100	220	1,700
Butyl benzyl phthalate	85-68-7	63	—	970	4.9	64
Bis(2-ethylhexyl) phthalate	117-81-7	1,300	—	8,300	47	78
Di-n-octyl phthalate	117-84-0	6,200	—	6,200	58	4,500
Phenols		*µg/kg dry weight*			*µg/kg dry weight*	
Phenol	108-95-2	420	—	1,200	420	1,200
2-Methylphenol	95-48-7	63	—	77	63	63
4-Methylphenol	106-44-5	670	—	3,600	670	670
2,4-Dimethylphenol	105-67-9	29	—	210	29	29
Pentachlorophenol	87-86-5	400	504	690	360	690
Miscellaneous Extractables		*µg/kg dry weight*			*µg/kg dry weight*	
Benzyl alcohol	100-51-6	57	—	870	57	73
Benzoic acid	65-85-0	650	—	760	650	650
		µg/kg dry weight			*mg/kg OC*	
Dibenzofuran	132-64-9	540	—	1,700	15	58
N-Nitrosodiphenylamine	86-30-6	28	—	130	11	11
Pesticides & PCBs		*µg/kg dry weight*			*mg/kg OC*	
4,4'-DDD	72-54-8	16	—	—	—	—
4,4'-DDE	72-55-9	9	—	—	—	—
4,4'-DDT	50-29-3	12	—	—	—	—
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT		—	50	69	—	—
Aldrin	309-00-2	9.5	—	—	—	—
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane)	5103-71-9 5103-74-2 5103-73-1 39765-80-5 27304-13-8	2.8	37	—	—	—
Dieldrin	60-57-1	1.9	—	—	—	—
Heptachlor	76-44-8	1.5	—	—	—	—
Total PCBs	---	130	38 [(2)]	3,100	12	65

Notes:

1. 2-Methylnaphthalene is not included in the summation for total LPAH.

3. This value is normalized to total organic carbon, and is expressed in mg/kg organic carbon.

CAS = Chemical Abstract Service Registry Number

mg/kg=milligram per kilogram

µg/kg=microgram per kilogram

mg/kg OC = milligram per kilogram organic carbon

CSL = Cleanup Screening Level

SQS = Sediment Quality Standards

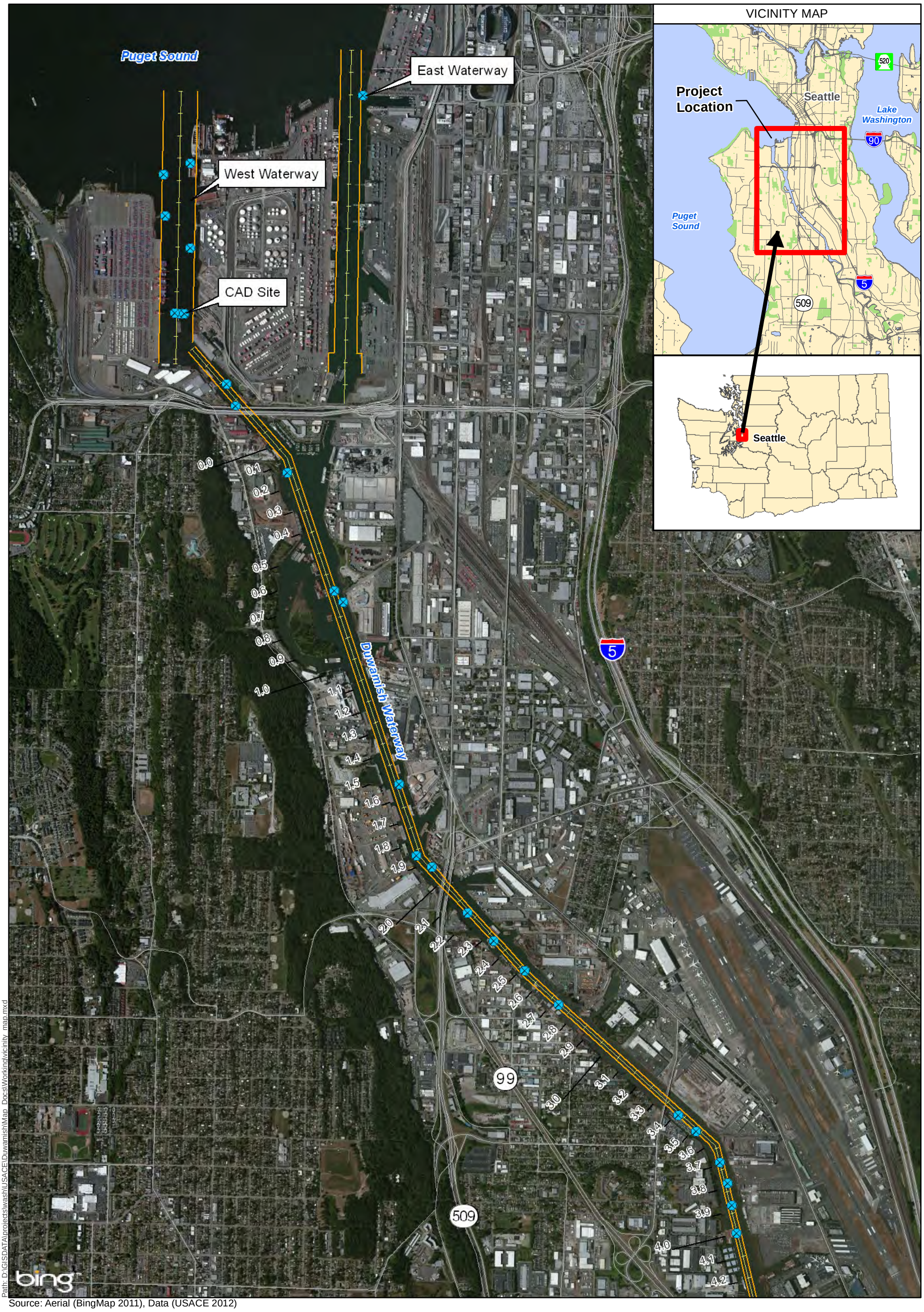
Table 1-2. Lower Duwamish Superfund Site Proposed Remedial Action Levels and Preliminary Remediation Goals

Proposed Remedial Action Levels and Preliminary Remediation Goals	Total PCBs (µg/kg)	cPAHs (µg TEQ/kg- dw)	Dioxins/ Furans (ng TEQ/kg dw)	Arsenic (mg/kg dw)	Sediment Management Standards
Sediment Remedial Action Level [1]	240 (Equivalent to SQS at 2% OC)	1,000	25	57	SQS chemical or toxicity
Lowest Sediment Preliminary Remediation Goal [2]	2 [3]	380	2 [3]	7 [3]	SQS chemical or toxicity

1. Sediment Remedial Action Levels are triggers that require a cleanup action to be taken. The following are subtidal RALs for risk driver chemicals. All but Washington State Sediment Quality Standards (SQS) are applied site-wide; SQS are applied on a point-by-point basis. EPA is in the process of clarifying that the PCB SQS (which is the RAL) is OC-normalized.

2. Sediment Preliminary Remediation Goals (PRGs) are long-term goals in the program, and in many cases are at or below limits of analytical resolution, specifically for background-set chemicals that drive human health risk. To the extent that these are resoluble by the DMMO program methods for analysis, they are used for comparison to contaminant concentrations at stations within the Superfund site.

3. Values based on non-urban background values



Path: D:\GISDATA\projects\wash\USACE\Duwamish\Map_Docs\Working\vicinity_map.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

Legend

- Sampling Location
- Navigation Channel
- Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker

0 1,000 2,000 3,000 Feet

Figure 1-1
Vicinity Map

2.0 Field Methods

This section discusses the methods used to collect, log, and composite the sediment cores and samples from the East Waterway, West Waterway and LDW. In general, the methods followed those described in the SAP (Appendix A). Additions and deviations from the SAP are summarized in this section. Detailed supporting field information is provided in Appendices B through F.

2.1 Field Collection Methods

Details concerning the daily field collection activities are documented in the daily report logs (Appendix B), the field notebook (Appendix C-1), and in the sediment drive logs (Appendix D).

2.1.1 Field Collection Vessel, Processing, and Personnel

Sediment sampling was conducted from Marine Sampling Systems' research vessel the *R/V Nancy Ann.* Sediment sampling consisted of using a vibracore to collect subsurface sediments throughout the LDW, as well as a 0.1 m^2 Power Grab sampler to collect surface grab sample at CAD01 and the Carr Inlet reference sediments for biological testing.

Sampling and processing personnel included staff from HDR (Sandy Cody, Kim Hawkins, and Chad Wiseman); SEE, LLC (David Browning and Tim Thompson); and Marine Sampling Systems (Bill Jaworski and Dale Dickinson). The sampling crew was divided into a field collection team and a core processing team. As available, the field crew assisted in core logging and sample compositing at the processing facility. Daily assignments and crew activities are recorded in the daily report logs (Appendix B).

2.1.2 Navigation and Depth Measurements

A differential global positioning system (DGPS) was used to navigate to, occupy, and document all stations aboard the *R/V Nancy Ann* during each sampling event. A Trimble AG 132 DGPS, utilizing the U.S. Coast Guard differential signal from Whidbey Island and Vashon Island, Washington was interfaced to an on-board computer running software enabling real-time plan view navigation to the required sampling stations. All station coordinates were recorded in latitude and longitude as decimal minutes with a minimum precision of four decimal places and were based on the North American Datum of 1983 (NAD 83). Target and actual sampling locations are shown in Figures 2-1 through 2-4. Station coordinates may be found in Table 2-2.

At the start of the program, and subsequently each day of survey operations, a known horizontal and vertical control point was occupied to ensure the accuracy of the positioning, navigation, and elevation control systems. The Navigation Division of the Seattle District recommend several surveyed locations within the Duwamish, but the principal navigation check point used was that surveyed by the USACE in 2008, with a fixed marker on a pile at the south end of the BIA Dock in Slip 1 (Figure 2-2). That location provided both a daily check of the DGPS but also was a fixed tide elevation point that allowed for confirmation of the tidal gage readings. A secondary check, including a tide board, was located outboard of the north end of the South Park Marina (Figure 2-4). The results of the daily navigation checks are recorded in Table 2-1 and shown

relative to the horizontal control in Slip 1 on Figure 2-2. The navigation checks were within ±1.5 (range 0 – 1.3) meters of the surveyed control point, which was within the ±2 meters specification required in the SAP.

To ensure that sediments from the appropriate depth intervals were collected, the target stations were pre-surveyed and accurate depth measurements were taken principally using a fathometer calibrated with a lead line. The depth was corrected for tidal height, and if the target stations were in water that was too shallow or too deep, the sampling station was moved to a nearby area with the appropriate depth. Although recent bathymetry was available and all target stations identified in the SAP were sited based on that bathymetry, the dynamic estuarine environment conditions within the LDW area caused changes in river floor elevation through erosion or deposition since the last bathymetric survey. Stations sampled, depth-to-mudline, and tide-corrected surface elevations reported as elevation in feet to MLLW are recorded in Table 2-2.

To control for elevation, the corresponding water depths (depth to mudline) were recorded using an onboard Lowrance HDS-7 fathometer at each station. Adjustments to the recorded nominal depth relative to tidal elevation were determined principally with a Hazen tidal gage. The Hazen gage transducer was fixed adjacent to an in-water tide board at a known depth; the tidal elevation measured by the transducer was then transmitted via radio signal to a receiver on the boat. The receiver displayed the tide reading and made a hard copy of the tide, time, date, and the identification code of the transmitting unit. To confirm the accuracy of the tidal corrections, a tide board was installed for this project on the southwest corner of the Federal Building Dock at Slip 1 (Table 2-1, Figure 2-2). The twice-daily tide checks showed that the Hazen gage was within ± 0.1 ft of the tide gage measure. As a secondary check of the tide board, daily measurements were also made from the fixed navigation/elevation point at the BIA Dock.

For the East and West Waterways, and for the central and northern LDW, the Hazen tide gage was deployed at the southwest corner of federal dock at Slip 1. When sampling operations proceeded to the south reach of the LDW, the Hazen gage was relocated to the South Park Marina (Figure 2-4). All depth measurements were field corrected to MLLW. Collection depths, both as nominal depth and tide-corrected depth, for all stations are recorded in Table 2-2.

2.1.3 Vibracore Sediment Collection

Field notebooks and sediment drive logs were maintained for each core collected during the project. The field notebook is reproduced in Appendix C-1; the sediment drive logs are found in Appendix D. A high standard for percent recovery was set in the SAP: 80% recovery was the target for each core. A total of 118 drives were required to collect the required 59 cores (Tables 2-2 and 2-3). The average percent recovery across all accepted cores was 84%, with a range of 52.1% to 100% recovery. Samples that were accepted with less than 80% recovery were generally after three or more unsuccessful attempts.

All core samples were collected using a proprietary vibracore owned and operated by Marine Sampling Systems. The vibracore used a 4-inch-outer-diameter, 3.75-inch-inner-diameter precleaned aluminum tube and was driven into the sediment using a combination of vibratory fluidization of sediment and gravitational fall. Failure to obtain an acceptable core was most often due to either inadequate sediment recovery and/or refusal to the target sampling depth.

Collected cores were scribed with the station ID, the depth of the sample, and cut into approximately 4-ft segments for transport to the main laboratory, Analytical Resources, Inc. (ARI). All cores were kept on ice in the field and transferred to ARI at the end of each day where they were stored upright at 4ºC until processing.

2.1.4 Sediment Grab Samples

Surface sediment under the SMS is defined as the top 10 cm of material in the sediment column. For this program, surface sediment collection was conducted according to the SAP for grab samples collected at the CAD site and at the Carr Inlet reference locations. For the CAD site, two grab samples were collected and composited in the field and labeled as CAD01. Samples for total sulfides analysis were collected from discrete grabs. For each grab, the time, location, nominal water depth, tidal height, corrected water depth, as well as observations about the sediments (physical conditions, odors, color, biota, etc.) were recorded in the field collection notebook (Appendix C-1). Once all grabs were collected, they were mixed until uniform in physical consistency and color and then placed in appropriate labeled sample containers. For the Carr Inlet reference samples, the nominal grain size was estimated using the wet sieving method described in the SAP. All samples were kept cold in ice chests through transport to ARI. Reference sediment collection is discussed further in Section 2.3.

2.1.5 Sampling Locations

In most cases, the actual sampling location was within 50 ft of the targeted location. Exceptions occurred when the targeted location was not in the desired depth range for the characterization of the sediment strata of interest, or when refusal or poor sample retention required moving the station location. Actual sample locations on the Lower Duwamish relative to the target locations are shown in Figures 2-1 through 2-4; reference sample collection locations in Carr Inlet are shown on Figure 2-5. Specific details of the collections are given in Table 2-2; variances from the SAP in numbers of cores collected are shown in Table 2-3 and discussed further below.

East and West Waterway

Sampling locations on the East and West Waterway are shown in Figure 2-1. A deviation from the SAP occurred to accommodate a request to the USACE by the Port of Seattle to collect cores down to a depth of -55 ft MLLW at stations WW02 and WW03. The scope was modified with concurrence from the Dredged Material Management Office (DMMO) to collect only a single core within the West Waterway, instead of the specified two cores, as sufficient material would be available in the single core to conduct all the required analyses. Other pertinent collection details include:

- **WW02**: The planned sampling location for WW02 was on a relatively steep slope that caused the sampler to tip over during collection. In order to hit the target depth of -55 ft MLLW, it was necessary to use a 20-ft core tube. In that configuration, with approximately 5 ft of core to sit below the corer frame, it is difficult to hold upright – particularly on a slope. After several unsuccessful attempts to collect on the slope, the field crew decided to move the sampling station to a more level location. The field crew was able to find a flat shelf approximately 150 ft north of the planned location in 40 ft of water and successfully

collected a sample to a total drive depth of -61 ft MLLW. However, in discussion with the DMMO, it was decided that this initial core was collected too deep for the program's purposes since the surface elevation was below the authorized depth of the channel. While the first core was retained for the Port of Seattle, a second core was collected at a surface elevation of -31.4 ft MLLW. A successful total drive length of 20 ft was achieved (i.e., to -51.4 ft MLLW).

- **WW03**: The target sampling coordinates placed the sample immediately off the Todd Shipyard. Bathymetric measures made in the field showed that the sampling location was on narrow mound at -37.7 ft MLLW with steep slopes. Several unsuccessful attempts were made at the target location, including one that severely bowed the collection tube, which had to be cut out of the frame. In an attempt to identify an alternate sampling location, the field crew conducted a bathymetric survey of the area, and other than the mound, the immediate area around west dock at Todd Shipyard is above -45 ft MLLW. At the request of the DMMO, one additional attempt was made at the initial target location; a successful 20-ft core was collected to -57.7 ft MLLW, but again the core tube was severely bowed and had to be cut out of the frame. The inflection from the bowing was estimated at about 0.5 ft; depth of collection was not adjusted.

Confined Aquatic Disposal Site

Collection of the three cores and grab samples from the CAD site are shown on the inset box in Figure 2-1. A total drive length of 7 ft below mud surface (BMS) for each of the three locations adequately captured the contaminated material below the sand cover. CAD samples are discussed further in Section 3.5.

Lower Duwamish Waterway North

Target and actual sampling locations are shown in Figure 2-2. Stations that required modification to the sampling relative to the SAP are described below.

- **LDW01**: A total of three cores were required to be collected at this station. An error occurred in the SAP estimate of the volume of material that would be available from two cores with 2-ft intervals. A third core was added to ensure sufficient volume was available for all the required analyses.
- **LDW02**: Collection at this station presented several unique challenges. A complete description of the difficulties in collecting at LDW02 may be found in the Daily Reports for October 8, 9, and 11, 2012 in Appendix B. These challenges included poor DGPS signal under the Spokane Street Bridge, very steep slopes at the target location, and hard, incomplete drives through heavy gravel and rock. In consultation with the DMMO, the location was moved approximately 150 ft north to an area with a surface elevation at -25.1 ft MLLW, where two cores were successfully collected.
- **LDW04**: At the target location, three attempts were made to collect a core, but all were rejected due to insufficient penetration and sample recovery (< 50%). In consultation with the DMMO, the station was moved approximately 40 ft north. Three cores were collected at this location, with recoveries of 78.6%, 90.9%, and 71.4%, respectively, and averaging 80% across the three cores.

Lower Duwamish Waterway Central

Target and actual sampling locations are shown in Figure 2-3. Stations that required modification to the sampling relative to the SAP are described below.

- LDW09: The elevation at this station was shallower than expected, resulting in a top interval of 0 – 2 ft, instead of 0 – 1 ft as described in the SAP. Therefore, only four cores were required to collect sufficient sediment for all analyses.
- LDW11: It was necessary to relocate this station northward approximately 50 ft because a tug and barge were located directly over the sampling location.

Lower Duwamish Waterway South

Target and actual sampling locations are shown in Figure 2-4. In the southern section of the LDW, several core locations had to be moved due to the presence of subsurface obstructions that caused sample refusal and/or poor retention of material in the core tube. Generally, the station locations were within 50 ft of the target sampling locations. Additional modifications to the SAP are described below.

- LDW12: Only two cores were required to obtain necessary volume of material. While the expected elevation was -18 ft MLLW, the actual elevations in the two cores were -17.4 ft and -17.3 ft MLLW.
- LDW13: Three cores were collected to ensure sufficient material for all analyses.
- LDW17: Three cores were collected to ensure sufficient material for all analyses.
- LDW18: Four cores were collected to ensure sufficient material for all analyses.

2.2 Subsurface Sediment Processing

All sectioning, logging, subsampling, and compositing of the core samples occurred in a processing facility at ARI. Core segments were longitudinally cut by scoring each core segment lengthwise and then splitting the tube and exposing the sediment. All processing occurred indoors on a processing table. Each core was logged with the time, date, person logging, sediment type, and stratigraphic features. The presence or absence of any visible contamination was recorded in the core log (Appendix E). In addition, photographs of each core segment were taken. Each core photograph included a label denoting station, replicate, time and date, and a scale (tape measure) showing depth BMS. While only specific strata were targeted for analysis in the SAP, the entire sediment column, including sediments above and below these target strata, was logged and photo-documented (Appendix F). Sediment core logs entered into the electronic format (gINT®) have been submitted separately to USACE.

2.2.1 Core Subsampling Intervals and Sample Nomenclature

The subsampling rationale described in the SAP is principally to characterize sediments from the sediment/water interface to the authorized federal navigation channel depth, and the corresponding Z-layer (see SAP Table 4-1). For some stations, the sampling included specified

intervals (e.g., 0 – 1 ft) to provide data to help inform the LDW Superfund process. As the actual elevation varied from 0.5 ft to over 1 ft within a sampling cluster, the sampling interval for a specific core varied correspondingly. Composite sampling intervals are given in Table 2-4. The table reports the measured elevation reported in MLLW and then the subsequent sampled intervals for each composite. For example, LDW01 required three cores for compositing and the elevation varied between -26.6 to -28.9 ft MLLW. For the first interval (C1), the sediment-water-interface to the authorized navigation depth of -30 ft MLLW, cores LDW01-1 and LDW01-2 had sample intervals of approximately 3.4 ft (-26.6 to -30 ft MLLW), while LDW01-3 contributed a sample interval of only 1.1 ft (-28.9 to -30 ft MLLW).. A representative portion from each interval of the cores sampled was placed in a bowl, and kept cool and covered until all the intervals were subsampled from all the cores for compositing.

Sample identification and labeling was altered from what was described in the SAP to reflect the deepest sample interval from the composited cores. For example, at LDW01, the deepest sampling interval was from LDW01-2, which was from 0 to 3.4 ft BMS; the assigned composite sample ID was then LDW01 0 – 3.4C. This nomenclature rule was also followed where multiple sample intervals were required, with the addition of a "1, 2, 3, or 4 to the "C" to indicate the interval. For example, there are three sample intervals for LDW08; LDW08 0-4C1, LDW08 4-9.8C2, and LDW08 Z. The association between the sample ID and the individual core locations and sampling intervals may be found in Table 2-4.

2.2.2 Analytical and Biological Samples

Sediments for compositing or unique tests (i.e., sulfides) were collected from the exposed center portion of the core; the outermost 0.5 cm was discarded unless there were volume limits due to sampling constraints. For each sediment core, the subsamples taken along the entire length of each core section making up the composite were combined and mixed to visible uniformity in pre-cleaned stainless steel bowls. Subsamples from this homogenate were then transferred into the appropriate containers for the individual analyses.

Sediments were subsampled, composited, and labeled according to the procedures described in the SAP. With exceptions noted below, a minimum of 10.5 liters of sediment was collected for analyses and/or archive. In addition, wherever possible, up to 8 liters of additional composited sediment for each station above that required in the SAP were collected and placed in food-grade polyethylene bags and reserved as potential bioassay archive material. Table 2-5 presents the complete inventory of samples collected and submitted to all the analytical and biological laboratories. Chain-of-custody (CoC) records may be found in Appendix C-3.

East and West and Waterway

A full set of samples were collected for all analytical and potential biological analyses at WW01. Due to a miscommunication between the DMMO and the sampling team, sediments for biological analyses were not collected for the other three West Waterway samples. This occurred as a result of the collection of cores in the West Waterway for the Port of Seattle to -20 ft BMS at WW02 and WW03, the decision was made to collect only a single core, instead of the two specified in the SAP. The misunderstanding was that the processing team thought that the DMMO had agreed to forgo the opportunity for biological testing in the West Waterway in lieu

of getting the deeper cores. This would not have been an issue, had not the USACE wanted to conduct bioassays at WW02. While sufficient material had been collected, it was not entered into the CoC as sediments for biological samples, and was archived by ARI at -20ºC, thus rendering the samples unusable for bioassays. Sulfide samples were inadvertently not collected for WW04 C1 and C2.

Confined Aquatic Disposal Site

The cores and surface grab samples were collected at the CAD stations as prescribed in the SAP. The coring sites selected were near those in the 1984 post-placement survey, and those sampled in 1995 (SAIC 1996). Based on the 1996 report (see Figure 2 in that document) the sample locations were planned for areas that were anticipated to have a sand cover of greater than 3 ft over the contained contaminated sediments. Consistent with the previous monitoring, the sampling intervals were centered at -15, +15, +30, and +45 cm from the cap/CAD sediment interface. Following the SAIC sampling scheme of collecting the sample for analysis from a 10 cm section around the specified intervals, the actual sampling intervals were then -10 to -20 cm, +10 to +20 cm, +25 to +35 cm, and +40 to +50 cm above/below the cap/CAD interface.

At all three core sampling locations, the sand cover material was less than the expected 3 ft. Figure 2-6 presents a photo montage of each of the three CAD cores made during processing. The sand cover material is clearly distinct from the contaminated-sediments and the surface sediments deposited since the CAD was placed. For CAD01 through CAD03, the measured sand cap thickness was 1.7 ft (53.3 cm), 2.1 ft (64.9 cm), and 0.67 ft (20.4 cm), respectively. In CAD01, the interface of the placed contaminated sediment and the underlying native LDW sediment is evident at approximately 4.7 ft below the surface elevation.

The thinner than expected cap cover impacted the sampling scheme and subsequent interpretation. For CAD01, the upper most interval (+45 cm) was only 0.4 ft (1.2 cm) below the sand cover/surface sediment interface (Figure 2-7). For CAD02, all sand cover samples were collected solely within the cap itself, with approximately 1.33 ft (40.5 cm) of surface sediment overlying the sand cover. In the case of CAD03, the +15 cm was collected just under the sand cover/surface sediment interface (0.3 cm), while the +30 and +45 cm intervals were actually within the more recently deposited surface sediments i.e., above the CAD cap. In consultation with the DMMO, those upper two intervals of CAD03 were sampled and analyzed and are presented for discussion in Section 3.

Quality Assurance/Quality Control Samples

Matrix spike, matrix spike duplicates, and field replicate samples were specified in the SAP to provide measures of quality assurance and quality control for the chemical analyses. The required QA/QC samples are listed in Table 2-5. The MS/MSD sample was collected at LDW08 4-9.8C2. The field replicates were splits from the two samples collected at LDW07 and were submitted blind to the analytical laboratories as LDW57 0-3.5C1 and LDW57 4-8C3, and from LDW08 submitted as LDW58 0-4C1.

2.3 Carr Inlet Reference Sediment Collection

Carr Inlet reference stations were selected in consultation with the DMMO to provide two sediments that would be similar in grain size to the range of LDW samples selected for bioassays. The decision process for selection of the biological stations is discussed in more detail in Section 4. The target stations and relative measured analytes are given in Table 2-6.

Two target grain sizes were specified by the DMMO for the bioassay reference stations to be collected in Carr Inlet; approximately 40% and 70% fines (silts plus clays). Previous Carr Inlet reference stations that had been reported with those grain sizes were CR23 and CR24. The actual sampling locations are shown in Figure 2-5, with the coordinates given in Table 2-2. Reference sediments were obtained onboard Marine Sampling Systems' *R/V Peter R*, using the 0.1 m^2 Power Grab. The field grain size measures for the two locations were 37% and 61%, respectively. Samples were composited and placed in sample containers while in the field, held on ice and then subsequently shipped to Northwestern Aquatic Sciences (NWAS) on ice for overnight delivery.

2.4 Samples for PCB Methods 1668 and 680

Ten samples were chosen by the DMMP agencies to be analyzed for PCBs by methods 1668 and 680. The Puget Sound Standard Reference Material (SRM) was used as one of the ten samples to facilitate comparison of results with similar work that is ongoing by Ecology. Of the remaining nine samples, the primary goal was to choose samples with a wide range of total PCBs, from undetected to concentrations above the ML/CSL. The nine samples chosen had a total PCB Aroclor range from 16 to 3,110 µg/kg dry weight. Additional consideration was given to the ratio of the detected Aroclors found in the samples. Throughout the waterways, the only Aroclors detected were 1248, 1254, and 1260. The fractional contribution of Aroclor 1254 to the Total PCB concentration for the chosen samples ranged from 0.38 to 1.00 µg/kg.

Samples were sent from ARI where they had been archived to ALS/CAS in Kelso, Washington for analysis. ALS/CAS' Houston lab performed the 1668 analyses and ALS/CAS' Rochester Lab performed the 680 analyses. Upon receipt and initial review of the homolog data, surrogate recoveries were determined to be very low and the lab was asked to re-analyze the data. After this procedure was followed, data were resubmitted, but results did not change. A further discussion with laboratory Quality Assurance personnel determined that re-extraction of the samples was required, along with a sulfur cleanup. A more detailed discussion of the results of these analyses is provided in Section 3.5.

Table 2-1. Navigation and Tide Check Stations

Date	Time	Latitude	Longitude	Notes
Target Locations				
Slip 1		47 33.40076 N	122 20.40576 W	BIA Dock at the Head of Slip 1
USACE Dock Tide Staff		47 33.43150 N	122 20.56324 W	SW Corner of the USACE Docks at head of Slip 1
South Park Marine Tide Staff		47 31.72283 N	122 18.82426 W	North End of the South Park Marina
Slip 1 Navigation Checks				
10/8/2012	12:45:11	47 33.40116 N	122 20.40582 W	
10/8/2012	16:34:12	47 33.40056 N	122 20.40597 W	
10/9/2012	8:28:34	47 33.40030 N	122 20.40596 W	
10/9/2012	14:46:03	47 33.40053 N	122 20.40570 W	
10/10/2012	8:34:59	47 33.40011 N	122 20.40624 W	
10/10/2012	17:12:22	47 33.40066 N	122 20.40558 W	
10/11/2012	9:07:26	47 33.40053 N	122 20.40650 W	
10/11/2012	14:23:08	47 33.40052 N	122 20.40579 W	
10/15/2012	8:32:24	47 33.40020 N	122 20.40583 W	
10/15/2012	16:30:31	47 33.40057 N	122 20.40604 W	
10/16/2012	10:04:44	47 33.40044 N	122 20.40591 W	
10/16/2012	15:00:42	47 33.40057 N	122 20.40566 W	
10/18/2012	7:55:46	47 33.40063 N	122 20.40562 W	
10/18/2012	16:10:37	47 33.40082 N	122 20.40661 W	
10/19/2012	7:56:37	47 33.40052 N	122 20.40558 W	
10/19/2012	10:42:21	47 33.40049 N	122 20.40532 W	

Table 2-2. Station Collection Summary

Station	Drill Event	Latitude	Longitude	Mud Line (ft)	Tide Height (ft MLLW)	Tide Time	Surface Elevation (ft MLLW)	Core Penetration (ft)	End Depth (ft MLLW)	Acquisition (ft)	Percent Recovery	Date Collected	Comment
LDW													
LDW01-1	1	47 34.36814 N	122 21.31064 W	-33.3	6.6	10:22:00 AM	-26.7	7.0	33.7	7.0	100.0	10/16/2012 10:23	
LDW01-2	1	47 34.36939 N	122 21.31279 W	-32.5	5.9	10:48:00 AM	-26.6	5.2	31.8	7.0	134.6	10/16/2012 10:48	
LDW01-3	2	47 34.36781 N	122 21.31322 W	-33.8	5	11:49:00 AM	-28.8	7.0	35.8	6.5	92.9	10/16/2012 11:48	
LDW02-1	3	47 34.30164 N	122 21.27642 W	-27.4	2.3	8:05:00 AM	-25.1	14.0	39.1	7.3	52.1	10/8/2012 13:58	Accepted core after third attempt, and capturing in the target range
LDW02-2	1	47 34.30214 N	122 21.27659 W	-28.5	2.4	8:40:00 AM	-26.1	13.5	39.6	7.5	55.6	10/8/2012 14:28	
LDW03-1	1	47 34.04362 N	122 20.97179 W	-34.7	9.1	11:15:00 AM	-25.6	7.0	32.6	6.7	95.7	10/9/2012 15:52	Accepted after four tries
LDW03-2	1	47 34.04419 N	122 20.97043 W	-35.2	8.6	11:43:00 AM	-26.6	7.0	33.6	7.4	105.7	10/9/2012 16:24	
LDW04-1	4	47 33.61790 N	122 20.70702 W	-33.8	5.9	11:15:00 AM	-27.9	7.0	34.9	5.5	78.6	10/11/2012 11:13	Accepted after four tries
LDW04-2	1	47 33.61850 N	122 20.70766 W	-35.4	6.93	11:43:00 AM	-28.5	5.5	34.0	5.0	90.9	10/11/2012 11:43	
LDW04-3	1	47 33.61690 N	122 20.70688 W	-36.4	7.8	12:09:00 PM	-28.6	7.0	35.6	5.0	71.4	10/11/2012 12:09	
LDW05-1	1	47 33.57176 N	122 20.65271 W	-19.3	9.7	1:18:00 PM	-9.6	7.0	16.6	5.8	82.9	10/11/2012 13:18	
LDW05-2	1	47 33.57214 N	122 20.65365 W	-20.2	10.2	1:43:00 PM	-10.0	7.0	17.0	6.5	92.9	10/11/2012 13:41	
LDW05-3	1	47 33.57232 N	122 20.65312 W	-19.6	10.6	2:03:00 PM	-9.0	7.0	16.0	6.0	85.7	10/11/2012 14:02	
LDW06-1	1	47 32.90470 N	122 20.33028 W	-33.8	8.7	3:35:00 PM	-25.1	14.0	39.1	11.2	80.0	10/8/2012 15:34	
LDW06-2	1	47 32.90521 N	122 20.33099 W	-34.5	8.2	4:10:00 PM	-26.3	14.0	40.3	13.4	95.7	10/8/2012 16:09	
LDW07-1	1	47 32.63965 N	122 20.22842 W	-27.4	4.95	9:02:00 AM	-22.5	14.0	36.5	12.9	92.1	10/9/2012 9:02	
LDW07-2	1	47 32.64052 N	122 20.22916 W	-28.4	5.8	9:32:00 AM	-22.6	14.0	36.6	12.0	85.7	10/9/2012 9:32	
LDW07-3	1	47 32.64001 N	122 20.22843 W	-28.6	6.6	10:00:00 AM	-22.0	14.0	36.0	11.4	81.4	10/9/2012 10:00	
LDW08-1	1	47 32.59876 N	122 20.14237 W	-27.7	7.5	10:31:00 AM	-20.2	14.0	34.2	11.4	81.4	10/9/2012 10:31	
LDW08-2	1	47 32.59933 N	122 20.14312 W	-29.3	8.4	11:06:00 AM	-20.9	14.0	34.9	11.5	82.1	10/9/2012 11:05	
LDW09-1	1	47 32.43179 N	122 19.94658 W	-28.2	10.2	12:53:00 PM	-18.0	7.0	25.0	6.5	92.9	10/9/2012 12:52	
LDW09-2	1	47 32.43200 N	122 19.94646 W	-29.3	10.3	1:15:00 PM	-19.0	7.0	26.0	6.5	92.9	10/9/2012 13:14	
LDW09-3	1	47 32.43166 N	122 19.94690 W	-28.9	10.3	1:40:00 PM	-18.6	7.0	25.6	6.8	97.1	10/9/2012 13:39	
LDW09-4	1	47 32.43185 N	122 19.94716 W	-28.1	10.2	2:03:00 PM	-17.9	7.0	24.9	7.4	105.7	10/9/2012 14:03	
LDW10-1	1	47 32.33152 N	122 19.80020 W	-25.3	10.3	3:24:00 PM	-15.0	14.0	29.0	11.9	85.0	10/10/2012 15:23	
LDW10-2	1	47 32.33225 N	122 19.80018 W	-24.5	9.96	3:51:00 PM	-14.5	14	28.5	13.1	93.6	10/10/2012 15:51	
LDW10-3	1	47 32.33186 N	122 19.79948 W	-24.4	9.4	4:12:00 PM	-15.0	14	29.0	11.9	85.0	10/10/2012 16:22	
LDW11-1	1	47 32.22990 N	122 19.64351 W	-19.9	4.1	9:23:00 AM	-15.8	7	22.8	6.2	88.6	10/10/2012 9:23	
LDW11-2	1	47 32.23084 N	122 19.64102 W	-21.6	4.8	9:49:00 AM	-16.8	7	23.8	7.1	101.4	10/10/2012 9:49	
LDW12-1	1	47 32.10125 N	122 19.44134 W	-23.1	5.7	10:20:00 AM	-17.4	7	24.4	7.5	107.1	10/10/2012 10:20	
LDW12-2	1	47 32.10153 N	122 19.44221 W	-24.0	6.7	10:47:00 AM	17.3	7	24.3	7.1	101.4	10/10/2012 10:47	
LDW13-1	1	47 31.69945 N	122 18.77423 W	-18.4	10.6	1:26:00 PM	-7.8	14	21.8	12.0	85.7	10/10/2012 13:26	
LDW13-2	1	47 31.70152 N	122 18.77666 W	-19.2	10.9	2:03:00 PM	-8.3	14	22.3	11.4	81.4	10/10/2012 14:03	
LDW13-3	1	47 31.70108 N	122 18.77583 W	-20.4	10.8	10:58:00 AM	-9.6	14	23.6	12.3	87.9	10/10/2012 14:37	
LDW14-1	1	47 31.64420 N	122 18.67700 W	-20.1	12.3	8:41:00 AM	-7.8	14	21.8	10.5	75.0	10/19/2012 8:42	5.0' of free fall - elected to retain
LDW14-2	1	47 31.64438 N	122 18.67738 W	-21.0	12.4	9:14:00 AM	-8.6	14.0	22.6	10.1	72.1	10/19/2012 9:13	
LDW14-3	1	47 31.64464 N	122 18.67832 W	-20.5	12.2	9:48:00 AM	-8.3	14.0	22.3	11.3	80.7	10/19/2012 9:49	
LDW15-1	4	47 31.53083 N	122 18.55900 W	-19.9	7.2	2:58:00 PM	-12.7	7.0	19.7	5.0	71.4	10/18/2012 14:58	Fourth drive: elected to retain
LDW15-2	5	47 31.53103 N	122 18.55701 W	-20.4	7.5	3:19:00 PM	-12.9	7.0	19.9	4.6	65.7	10/18/2012 15:19	Fifth drive: elected to retain
LDW15-3	6	47 31.53080 N	122 18.55381 W	-20.9	8.07	3:40:00 PM	-12.8	7.0	19.8	5.5	78.6	10/18/2012 15:40	Sixth drive: elected to retain
LDW16-1	1	47 31.44920 N	122 18.49762 W	-18.9	6.3	1:46:00 PM	-12.6	7.0	19.6	5.5	78.6	10/18/2012 13:47	All free fall - elected to retain
LDW16-2	1	47 31.44907 N	122 18.49789 W	-19.1	6.5	2:06:00 PM	-12.6	7.0	19.6	5.0	71.4	10/18/2012 14:05	All free fall - elected to retain
LDW16-3	1	47 31.44882 N	122 18.49693 W	-19.3	6.8	2:30:00 PM	-12.5	7.0	19.5	4.6	65.7	10/18/2012 14:30	All free fall - elected to retain
LDW17-1	1	47 31.37643 N	122 18.47560 W	-20.9	8.1	11:47:00 AM	-12.8	7.0	19.8	4.9	70.0	10/18/2012 11:47	All free fall - elected to retain
LDW17-2	1	47 31.37570 N	122 18.46879 W	-19.1	7.6	12:10:00 PM	-11.5	7.0	18.5	5.3	75.7	10/18/2012 12:10	5.5' of free fall - elected to retain
LDW17-3	1	47 31.37636 N	122 18.47204 W	-19.2	7	12:31:00 PM	-12.2	7.0	19.2	5.3	75.7	10/18/2012 12:31	4.5' of free fall - elected to retain
LDW18-1	1	47 31.26909 N	122 18.45810 W	-23.0	10.8	9:56:00 AM	-12.2	7.0	19.2	5.5	78.6	10/18/2012 9:56	6.5' of free fall - elected to retain
LDW18-2	1	47 31.26860 N	122 18.45815 W	-23.2	10.4	10:20:00 AM	-12.8	7.0	19.8	4.9	70.0	10/16/2012 10:21	3.5' free fall/hard stop. Vibrate and then free fall again. Elected to retain
LDW18-3	1	47 31.26866 N	122 18.45792 W	-22.3	9.5	10:58:00 AM	-12.8	7.0	19.8	5.2	74.3	10/18/2012 10:58	5.0' of free fall - elected to retain
LDW18-4	1	47 31.26796 N	122 18.45721 W	-21.7	8.9	11:21:00 AM	-12.8	7.0	19.8	4.6	65.7	10/18/2012 11:21	5.7' of free fall - elected to retain
West Waterway													
WW01-1	1	47 35.13615 N	122 21.67909 W	-32.6	4.34	10:45:00 AM	-28.3	14.0	42.3	12.8	91.4	10/15/2012 10:44	
WW02-2	1	47 35.02203 N	122 21.67951 W	-46.5	6	9:43:00 AM	-40.5	19.0	59.5	19.3	101.6	10/15/2012 13:00	Retained for POS
WW02-1	1	47 35.01359 N	122 21.66610 W	-41.3	9.86	9:43:00 AM	-31.4	20.0	51.4	20.0	100.0	10/16/2012 8:49	
WW03-1	1	47 35.17923 N	122 21.53504 W	-48.5	10.8	3:13:00 PM	-37.7	20.0	57.7	20.3	101.5	10/15/2012 15:13	
WW04-1	1	47 34.86432 N	122 21.52387 W	-42.2	4.2	11:14:00 AM	-38.0	14.0	52.0	12.1	86.4	10/15/2012 11:13	
East Waterway													
EW01-1	1	47 35.44282 N	122 20.60042 W	-40.6	4.4	11:47:00 AM	-36.2	14.0	50.2	11.1	79.3	10/15/2012 11:46	
EW01-2	2	47 35.44263 N	122 20.60252 W	-42.6	4.8	12:16:00 PM	-37.8	14.0	51.8	12.4	88.6	10/15/2012 12:17	
CAD Site													
CAD01-1	1	47 34.62418 N	122 21.60135 W	-65.2	5.2	12:50:00 PM	-60.0	7.0	67.0	5.5	78.6	10/16/2012 12:50	
CAD02-1	1	47 34.62238 N	122 21.57261 W	-62.1	5.8	1:13:00 PM	-56.3	7.0	63.3	5.4	77.1	10/16/2012 13:13	
CAD03-1	1	47 34.62376 N	122 21.55046 W	-65.1	6.4		-58.7	7.0	65.7	4.4	62.9	10/16/2012 13:37	
CAD01-G1	1	47 34.62598 N	122 21.60199 W	-66.9	7.5	2:18:00 PM	-59.4	0.3	59.7	0.3	100.0	10/16/2012 14:18	
CAD01-G2	1	47 34.62372 N	122 21.60040 W	-66.8	7.94	2:33:00 PM	-58.9	0.3	59.2	0.3	100.0	10/16/2012 14:32	
Carr Inlet Reference Stations													
Carr 24-G1	1	47 19.9731 N	122 40.4113 W	-19.0	11.5	1:18:00 PM	-7.5	0.3	-7.8	0.3	100.0	11/26/2012 13:41	
Carr 23-G2	2	47 19.9805 N	122 40.3590 W	-19.5	12.5	2:25:00 PM	-7.0	0.3	-7.3	0.3	100.0	11/26/2012 14:25	

Table 2-3. Target Sampling Locations and Intervals

Station ID	Authorized Federal Channel Depth (ft MLLW)	Nominal Depth of Shoaling (ft below mudline elevation)	Estimated Test Sample Intervals (ft below mudline)	Estimated Z-sample Interval (ft below mudline)	Number of Cores in SAP	Number of Actual Cores	Comments
Lower Duwamish Waterway							
LDW01	-30.0	2	0-2	2-4	2	**3**	Number of cores increased to provide sufficient volume for all required analyses.
LDW02		10	0-10	10-12	2	2	Collected 150' N of original location
LDW03		3	0-3	3-5	2	2	
LDW04		2	0-2	2-4	3	3	
LDW05		---	0-2 composite	---	3	3	
LDW06		5	0-5	5-7	2	2	
LDW07		8	0-2	8-10	3	3	
			2-4				
			4-8				
LDW08		9	0-4	9-11	2	2	
			4-9				
LDW09	-20.0	1	0-1	1-3	5	**4**	
LDW10		5	0-2	5-7	3	3	
			2-5				
LDW11		3	0-3	3-5	2	2	
LDW12		2	0-2	2-4	3	**2**	
LDW13	-15.0	6	0-2	6-8	2	**3**	
			2-6				
LDW14		7	0-2	7-9	3	3	
			2-4				
			4-7				
LDW15		2	0-2	2-4	3	3	
LDW16		2	0-2	2-4	3	3	
LDW17		3	0-3	3-5	2	**3**	
LDW18		4	0-2	4-6	3	**4**	
			2-4				
West Waterway							
WW01	---	---	0-4, 4-8	---	2	**1**	
WW02		---	0-4, 4-8	---	2	**1**	
WW03		---	0-4, 4-8	---	2	**1**	
WW04		---	0-4, 4-8	---	2	**1**	
East Waterway							
EW01	---	---	0-4, 4-8. 8-12	---	2	2	

CAD Site							
CAD01	---	---	+45	---	1	1	
			+30	---			
			+15	---			
			-15	---			
			Surface Sediment Grab	---			
CAD02	---	---	+45	---	1	1	
			+30	---			
			+15	---			
			-15	---			
CAD03	---	---	+45	---	1	1	
			+30	---			
			+15	---			
			-15	---			

Notes:

Red indicates estimated sample number changes to the SAP

Table 2-4. Subsampling Elevations for Stations in the Lower Duwamish, East and West Waterways

Station	Surface Elevation (ft MLLW)	C1 Sample Interval (ft MLLW)			C2 Sample Interval 2 (ft MLLW)			C3 Sample Interval (ft MLLW)			Z-Sample Interval (ft MLLW)		
		Begin Depth	End Depth	Sample ID	Begin Depth	End Depth	Sample ID	Begin Depth	End Depth	Sample ID	Begin Depth	End Depth	Sample ID
Lower Duwamish Waterway													
LDW01-1	-26.7	-26.7	-30.0	LDW01 0-3.4C	---	---	---	---	---	---	-30.0	-32.0	LDW01 Z
LDW01-2	-26.6	-26.6	-30.0		---	---		---	---		-30.0	-32.0	
LDW01-3	-28.9	-28.9	-30.0		---	---		---	---		-30.0	-32.0	
LDW02-1	-25.1	-25.1	-30.0	LDW02 0-4.9C	---	---	---	---	---	---	-30.0	-32.0	LDW02 Z
LDW02-2	-26.1	-26.1	-30.0		---	---		---	---		-30.0	-32.0	
LDW02-3	-25.6	-25.6	-30.0		---	---		---	---		-30.0	-32.0	
LDW03-1	-25.6	-25.6	-30.0	LDW03 0-4.4C	---	---	---	---	---	---	-30.0	-32.0	LDW03 Z
LDW03-2	-26.6	-26.6	-30.0		---	---		---	---		-30.0	-32.0	
LDW04-1	-27.9	-27.9	30.0	LDW04 0-2.1C	---	---	---	---	---	---	30.0	32.0	LDW04 Z
LDW04-2	-28.5	-28.5	30.0		---	---		---	---		30.0	32.0	
LDW04-3	-28.6	-28.6	30.0		---	---		---	---		30.0	32.0	
LDW05-1	-9.6	-9.6	-11.6	LDW05 0-2C	---	---	---	---	---	---	---	---	---
LDW05-2	-10.0	-10.0	-12.0		---	---		---	---		---	---	
LDW05-3	-9.0	-9.0	-11.0		---	---		---	---		---	---	
LDW06-1	-25.1	-25.1	-30.0	LDW06 0-4.9C	---	---	---	---	---	---	-30.0	-32.0	LDW06 Z
LDW06-2	-26.3	-26.3	-30.0		---	---		---	---		-30.0	-32.0	
LDW07-1	-22.5	-22.5	-24.5	LDW07 0-2C1	-24.5	-26.5	LDW07 2-4C2	-26.5	-30.0	LDW07 4-8C3	-30.0	-32.0	LDW07 Z
LDW07-2	-22.6	-22.6	-24.6		-24.6	-26.6		-26.6	-30.2		-30.2	-32.2	
LDW07-3	-22.0	-22.0	-24.0		-24.0	-26.0		-26.0	-30.0		-30.0	-32.0	
LDW08-1	-20.2	-20.2	-24.2	LDW08 0-4C1	-24.2	-30.0	LDW08 4-9.8C2	---	---	---	-30.0	-32.0	LDW08 Z
LDW08-2	-20.9	-20.9	-24.9		-24.9	-30.0		---	---		-30.0	-32.0	
LDW09-1	-18.0	-18.0	-20.1	LDW09 0-2.1C	---	---	---	---	---	---	-20.1	-22.1	LDW09 Z
LDW09-2	-19.0	-19.0	-20.0		---	---		---	---		-20.0	-22.0	
LDW09-3	-18.6	-18.6	-20.1		---	---		---	---		-20.1	-22.1	
LDW09-4	-17.9	-17.9	-20.0		---	---		---	---		-20.0	-22.0	
LDW10-1	-15.0	-15.0	-17.0	LDW10 0-2C1	-17.0	-20.0	LDW10 2-5.5C2	---	---	---	-20.0	-22.0	LDW10 Z
LDW10-2	-14.5	-14.5	-16.5		-16.5	-20.0		---	---		-20.0	-22.0	
LDW10-3	-15.0	-15.0	-17.0		-17.0	-20.0		---	---		-20.0	-22.0	
LDW11-1	-15.8	-15.8	-20.0	LDW11 0-3.2C	---	---	---	---	---	---	-20.0	-22.0	LDW11 Z
LDW11-2	-16.8	-16.8	-20.0		---	---		---	---		-20.0	-22.0	
LDW12-1	-17.4	-17.4	-20.0	LDW12 0-2.6C	---	---	---	---	---	---	-20.0	-22.0	LDW12 Z
LDW12-2	-17.3	-17.3	-20.0		---	---					-20.0	-22.0	
LDW13-1	-7.8	-7.8	-9.8	LDW13 0-2C1	-9.8	-15.0	LDW13 2-7.2C2	---	---	---	-15.0	-17.0	LDW13 Z
LDW13-2	-8.3	-8.3	-10.3		-10.3	-15.0		---	---		-15.0	-17.0	
LDW13-3	-9.6	-9.6	-11.6		-11.6	-15.0		---	---		-15.0	-17.0	
LDW14-1[(1)]	-7.8	-7.8	-9.8	LDW14 0-2C1	-9.8	-11.8	LDW14 2-4C2	-11.8	-14.8	LDW14 4-6.8C3	-15.0	-17.0	LDW14 Z
LDW14-2	-8.6	-8.6	-10.6		-10.6	-12.6		-12.6	-15.0		-15.0	-17.0	
LDW14-3	-8.3	-8.3	-10.3		-10.3	-12.3		-12.3	-15.0		-15.0	-17.0	
LDW15-1	-12.7	-12.7	-15.0	LDW15 0-2.3C	---	---	---	---	---	---	-15.0	-17.0	LDW15 Z
LDW15-2	-12.9	-12.9	-15.0		---	---		---	---		-15.0	-17.0	
LDW15-3	-12.8	-12.8	-15.0		---	---		---	---		-15.0	-17.0	
LDW16-1	-12.6	-12.6	-15.0	LDW16 0-2.5C	---	---	---	---	---	---	-15.0	-17.0	LDW16 Z
LDW16-2	-12.6	-12.6	-15.0		---	---		---	---		-15.0	-17.0	
LDW16-3	-12.5	-12.5	-15.0		---	---		---	---		-15.0	-17.0	
LDW17-1	-12.8	-12.8	-15.0	LDW17 0-3.5C	---	---	---	---	---	---	-15.0	-17.0	LDW17 Z
LDW17-2	-11.5	-11.5	-15.0		---	---		---	---		-15.0	-17.0	
LDW17-3	-12.2	-12.2	-15.0		---	---		---	---		-15.0	-17.0	
LDW18-1	-12.2	-12.2	-15.0	LDW18 0-2.8C	---	---	---	---	---	---	-15.0	-17.0	LDW18 Z
LDW18-2	-12.8	-12.8	-15.0		---	---		---	---		-15.0	-17.0	
LDW18-3	-12.8	-12.8	-15.0		---	---		---	---		-15.0	-17.0	
LDW18-4	-12.8	-12.8	-15.0		---	---		---	---		-15.0	-17.0	
West Waterway [(2)]													
WW01-1	-28.3	-28.3	-32.3	WW01 0-4C1	-32.3	-36.3	WW01 4-8C2	-36.3	-40.3	---	---	---	---
WW02-1	-31.4	-31.4	-35.4	WW02 0-4C1	-35.4	-39.4	WW02 4-8C2	-39.4	-43.4	---	-47.4	-51.4	---
WW03-1	-37.7	-37.7	-41.7	WW03 0-4C1	-41.7	-45.7	WW03 4-8C2	-45.7	-49.7	---	-53.7	-55.0	---
WW04-1	-38.0	-38.0	-42.0	WW04 0-4C1	-42.0	-46.0	WW04 4-8C2	-46.0	-49.6	---	---	---	---
East Waterway													
EW01-1	-36.2	-36.2	-40.2	EW01 0-4C1	-40.2	-44.2	EW01 4-8C2	-44.2	-47.7	EW01 8-12C3	---	---	---
EW01-2	-37.8	-37.8	-41.8		-41.8	-45.8		-45.8	-49.6		---	---	---

Notes:

(1) Gap in sediment core

(2) West Waterway intervals C3, C4 and Z were collected and provided to Port of Seattle. C4 sample interval for WW02-1 was -43.4 to -47.4 ft MLLW and for WW03-1 was -49.7 to 53.7 ft MLLW.

Table 2-5. Analytical and Biological Sample Summary

Sample ID	COC Date	Time	Matrix	No. Containers	Grain Size	TOC, Total Solids, TVS, NH3	Sulfides	Metals	SVOCs, Pest, PCBs	PCBs	TBT (porewater)	Dioxin/Furans	PCB Congeners	PCB Homologues	Black Carbon	Chemical Archive	MS/MSD	Bioassay
Lower Duwamish Waterway																		
LDW01 0-3.4C	10/17/2012	1015	Sediment	20	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW01 Z	10/17/2012	1015	Sediment	20	✓	✓	✓	✓	✓	✓	✓*	✓	A	A	✓	A	---	A
LDW02 0-4.9C	10/16/20212	1545	Sediment	20	✓	✓	✓	✓	✓		✓*	✓	✓	✓	✓	A	---	A
LDW02 Z	10/16/20212	1545	Sediment	20	✓	✓	✓	✓	✓		✓*	✓	A	A	✓	A	---	A
LDW03 0-4.4C	10/12/2012	1700	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW03 Z	10/12/2012	1700	Sediment	17	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW04 0-2.1C	10/17/2012	1124	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW04 Z	10/17/2012	1124	Sediment	16	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW05 0-2C	10/13/2012	1430	Sediment	19	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	A	---	A
LDW06 0-4.9C	10/12/2012	0930	Sediment	19	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW06 Z	10/12/2012	0930	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW07 0-2C1	10/13/2012	1045	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	✓
LDW07 2-4C2	10/13/2012	1045	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	✓
LDW07 4-8C3	10/13/2012	1045	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW07 Z	10/13/2012	1045	Sediment	20	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	A	---	A
LDW08 0-4C1	10/13/2012	0815	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	✓
LDW08 4-9.8C2	10/13/2012	0815	Sediment	25	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	✓	A
LDW08 Z	10/13/2012	0815	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW09 0-2.1C	10/12/2012	1500	Sediment	19	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	A	---	✓
LDW09 Z	10/12/2012	1500	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW10 0-2C1	10/17/2012	1300	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	---	A
LDW10 2-5.5C2	10/17/2012	1300	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW10 Z	10/17/2012	1300	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW11 0-3.2C	10/12/2012	1320	Sediment	19	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	✓
LDW11 Z	10/12/2012	1320	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW12 0-2.6C	10/12/2012	1120	Sediment	19	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW12 Z	10/12/2012	1120	Sediment	18	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW13 0-2C1	10/16/20212	1145	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	A
LDW13 2-7.2C2	10/16/20212	1145	Sediment	20	✓	✓	✓	✓	✓		✓	✓	A	A	✓	A	---	✓
LDW13 Z	10/16/20212	1145	Sediment	20	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	A	---	A
LDW14 0-2C1	10/19/2012	1415	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW14 2-4C2	10/19/2012	1415	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW14 4-6.8C3	10/19/2012	1415	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW14 Z	10/19/2012	1415	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW15 0-2.3C	10/19/2012	1015	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW15 Z	10/19/2012	1015	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW16 0-2.5C	10/19/2012	0820	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	---	✓
LDW16 Z	10/19/2012	0820	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW17 0-3.5C	10/19/2012	1355	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	✓
LDW17 Z	10/19/2012	1355	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW18 0-2.8C	10/19/2012	1150	Sediment	16	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	✓
LDW18 Z	10/19/2012	1150	Sediment	17	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
LDW57 0-3.5C	10/19/2012	1455	Sediment	2	---	---	---	✓	---	✓	---	---	---	---	✓	---	---	---
LDW57 4-8C3	10/13/2012	1200	Sediment	6	---	---	---	✓	✓		✓	✓	---	---	✓	A	---	---
LDW58 0-4C1	10/13/2012	0815	Sediment	10	A	---	---	✓	✓		✓	✓	A	A	✓	A	---	---

Table 2-5. Analytical and Biological Sample Summary

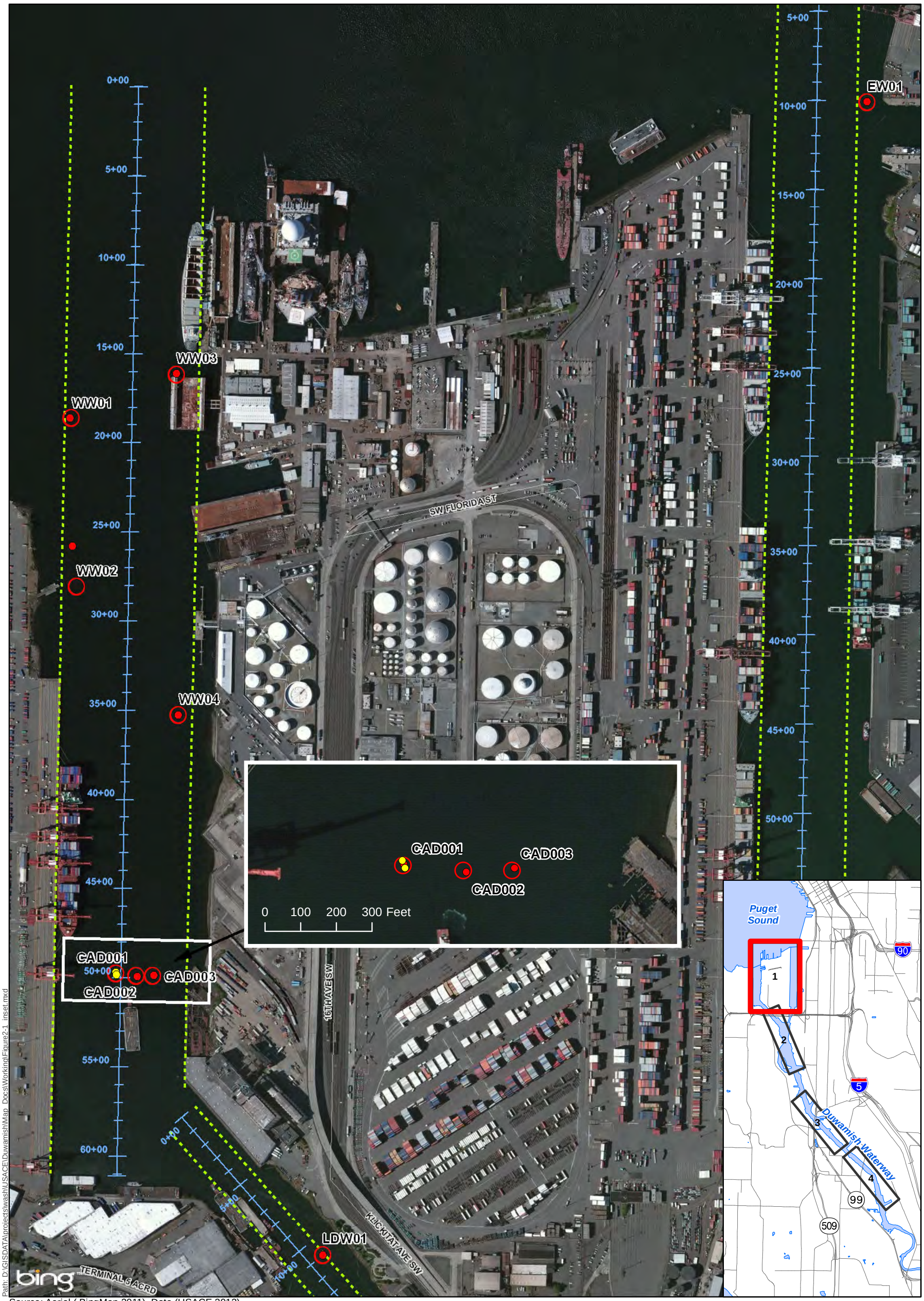
Sample ID	COC Date	Time	Matrix	No. Containers	Grain Size	TOC, Total Solids, TVS, NH3	Sulfides	Metals	SVOCs, Pest, PCBs	PCBs	TBT (porewater)	Dioxin/Furans	PCB Congeners	PCB Homologues	Black Carbon	Chemical Archive	MS/MSD	Bioassay
West Waterway																		
WW01 0-4C1	10/17/2012	1515	Sediment	17	✓	✓	✓	✓	✓	✓	✓*	✓	✓	✓	✓	A	---	A
WW01 4-8C2	10/17/2012	1515	Sediment	16	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	A
WW02 0-4C1	10/18/2012	1600	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
WW02 4-8C2	10/18/2012	1600	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
WW03 0-4C1	10/18/2012	1300	Sediment	13	✓	✓	✓	✓	✓	✓	✓*	✓	A	A	✓	A	---	---
WW03 4-8C2	10/18/2012	1300	Sediment	12	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
WW04 0-4C1	10/18/2012	0845	Sediment	12	✓	✓	---	✓	✓	✓	✓*	✓	A	A	✓	A	---	---
WW04 4-8C2	10/18/2012	0845	Sediment	12	✓	✓	---	✓	✓	✓	✓*	✓	A	A	✓	A	---	---
East Waterway																		
EW01 0-4C1	10/18/2012	1000	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A	✓	---
EW01 4-8C2	10/18/2012	1000	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
EW01 8-12C3	10/18/2012	1000	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
EW51 8-12C3	10/18/2012	1100	Sediment	13	✓	✓	✓	✓	✓	✓	✓	✓	A	A	✓	A	---	---
CAD Site																		
LDW CAD01 Surface Grab	10/16/2012	1418	Sediment	9	✓	✓	---	✓	✓	✓	✓	✓	---	---	---	A	---	---
LDW CAD01 +15C	10/17/2012	0855	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD01 +30C	10/17/2012	0855	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD01 +45C	10/17/2012	0855	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD01 -15C	10/17/2012	0855	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD02 +15C	10/17/2012	0845	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD02 +30C	10/17/2012	0845	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD02 +45C	10/17/2012	0845	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD02 -15C	10/17/2012	0845	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD03 +15C	10/17/2012	0920	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD03 +30C	10/17/2012	0920	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD03 +45C	10/17/2012	0920	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD03 0-10cm	10/17/2012	0920	Sediment	1	---	---	---	---	---	---	---	---	---	---	---	A	---	---
LDW CAD03 -15C	10/17/2012	0920	Sediment	3	---	✓(1)	---	✓	---	✓	---	---	---	---	---	---	---	---
LDW CAD03 20 - 25 cm	10/17/2012	0920	Sediment	1	---	---	---	---	---	---	---	---	---	---	---	A	---	---

Notes:
(1) Total Solids and Total Organic Carbon analysis only

* TBT in Sediment
A = Archive

Table 2-6. Physical Characteristics of Selected Bioassay Stations

Station	Total Organic Carbon (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
LDW07 0-2 C1	2.97	0.7	26.2	56.1	17.1
LDW07 2-4 C2	2.19	0.1	21.1	61.6	17.3
LDW08 0-4 C1	2.98	0.1	33.6	52	14.3
LDW09 0-2.1C	2.62	--	26	59.9	14.1
LDW11 0-4.2 C	2.69	--	25.2	60.8	13.9
LDW13 2-7.2 C2	2.01	--	35.2	54.4	10.4
LDW16 0-2.5C	2.74	--	20.1	66.7	13
LDW17 0-3.5C	2.2	--	26.1	62.5	11.4
LDW18 0-2.8 C	2.83	--	28.1	59.8	11.7
Carr Inlet Reference Sample	0.53	0.1	51.4	43.3	5.3



Source: Aerial (BingMap 2011), Data (USACE 2012)

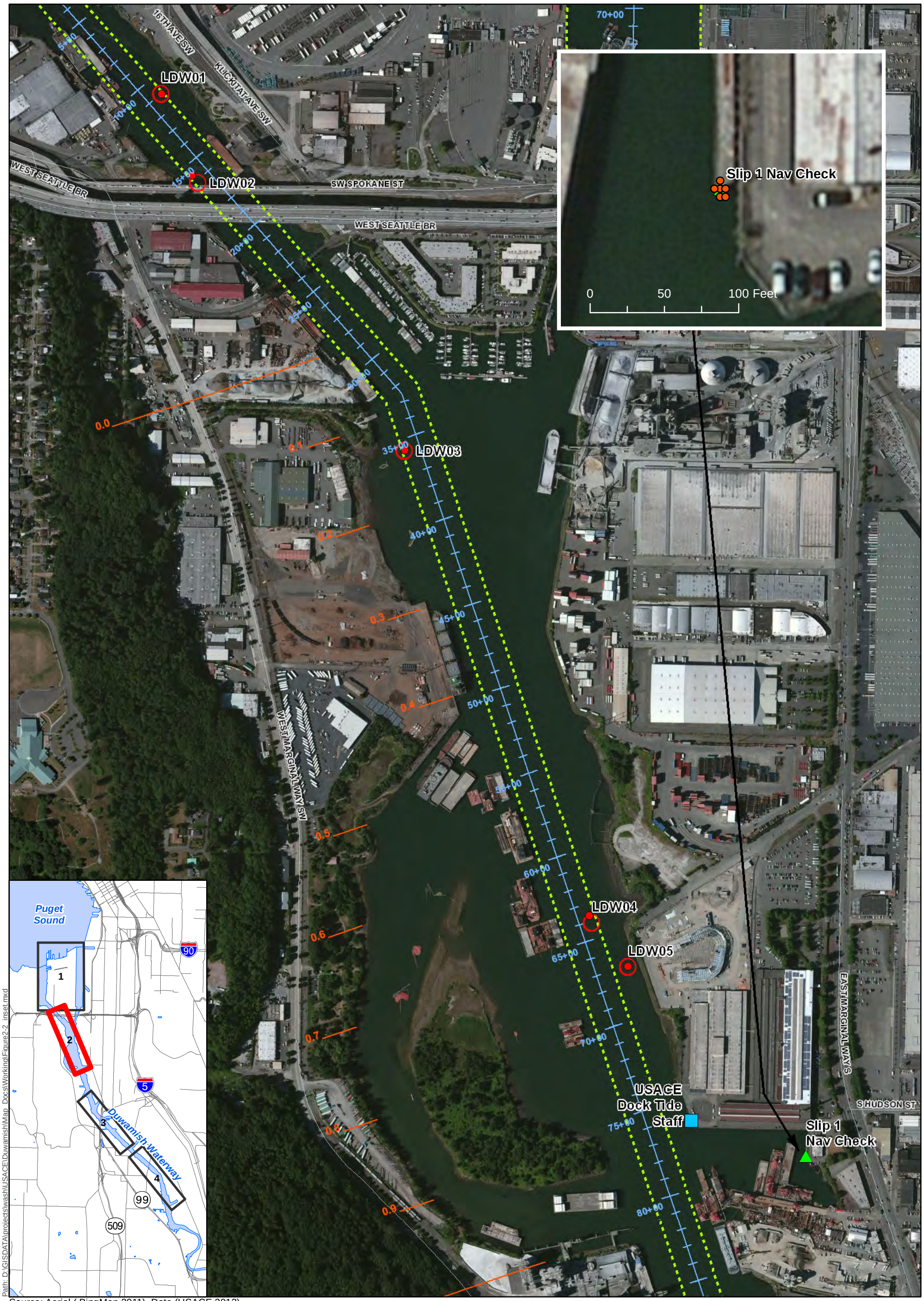
Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

0 250 500 1,000 Feet

Figure 2-1
Target and Final Coring Locations

East and West Waterways



Source: Aerial (BingMap 2011), Data (USACE 2012)

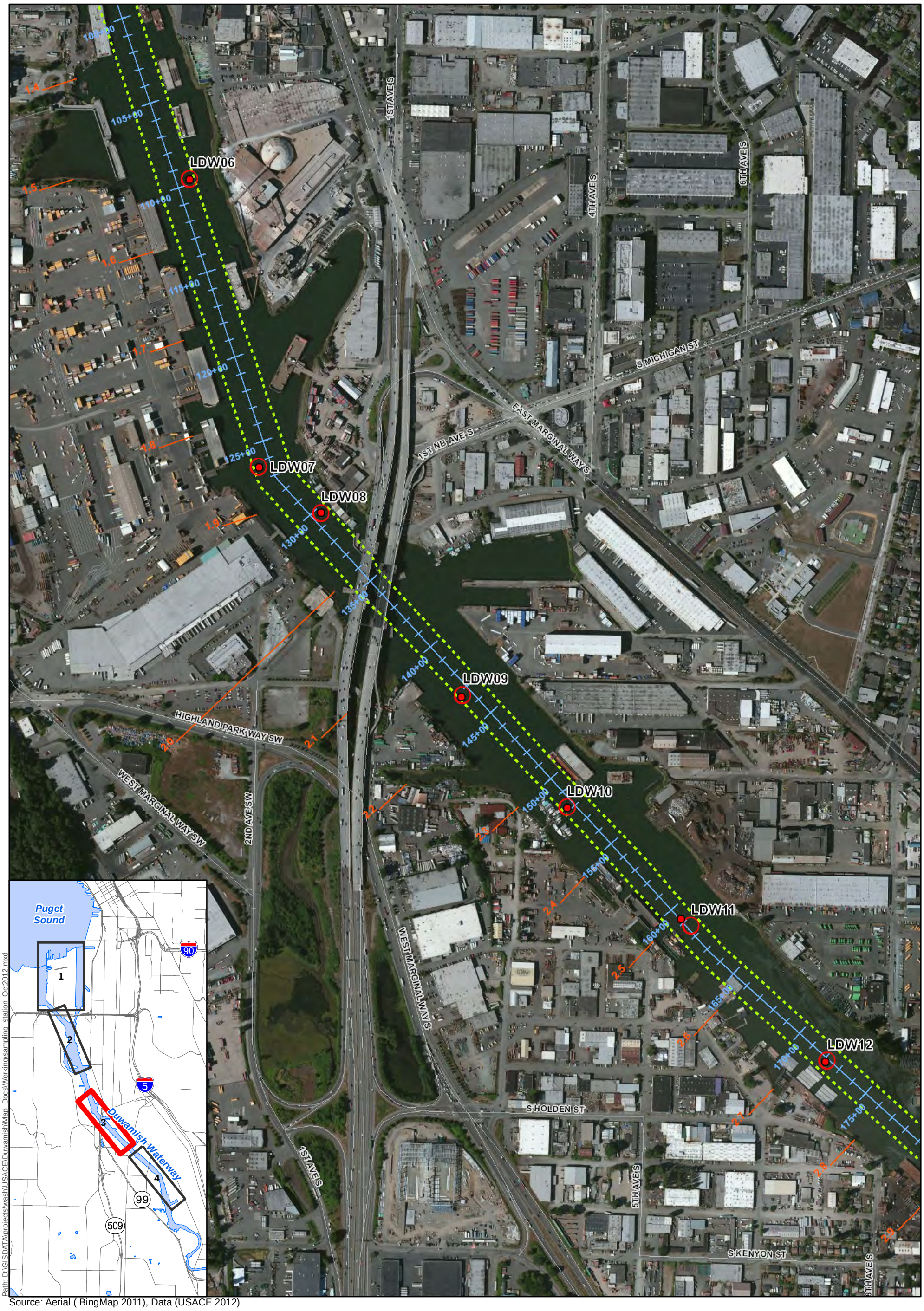
Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

0 250 500 1,000 Feet

Figure 2-2
Target and Final Coring Locations

Lower Duwamish Waterway North



Path: D:\GISDATA\projects\wash\USACE\Duwamish\Map_Docs\Working\sampling_station_Oct2012.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

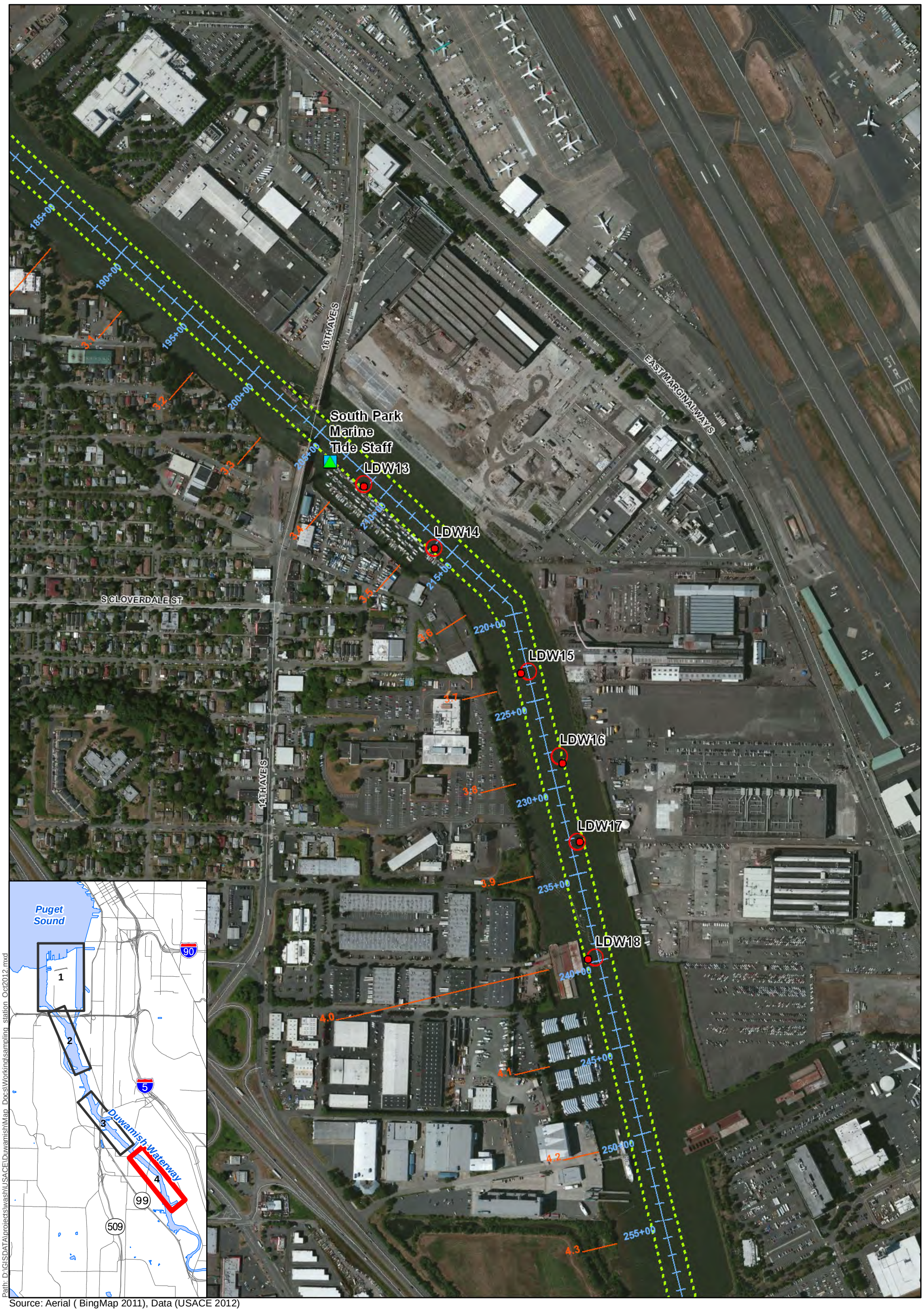
Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

0 250 500 1,000 Feet

Figure 2-3
Target and Final Coring Locations

Lower Duwamish Waterway Central



Path: D:\GIS\DATA\projects\wash\USACE\Duwamish\Map_Docs\Working\sampling_station_Oct2012.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

0 250 500 1,000 Feet

Figure 2-4
Target and Final Coring Locations

Lower Duwamish Waterway South

Source: Aerial (BingMap 2011), Data (USACE 2012)

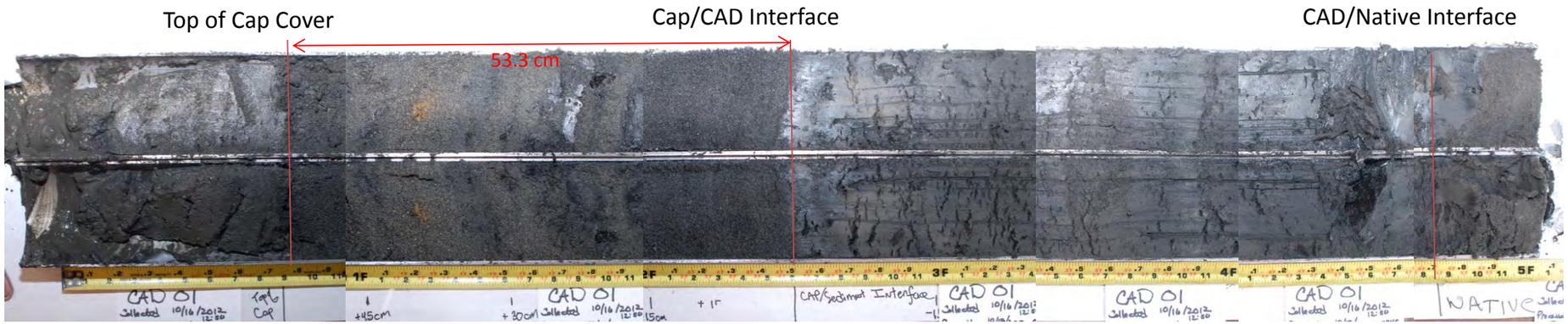
Figure 2-5
Carr Inlet Reference Station Locations

0 250 500 1,000 Feet

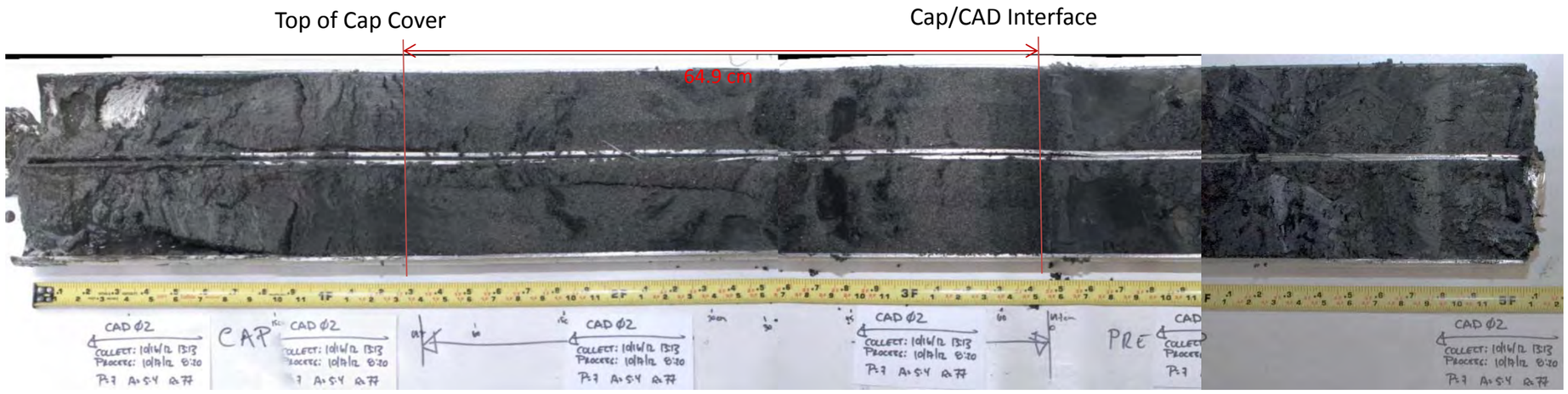
Legend

Reference Station

CAD01



CAD02



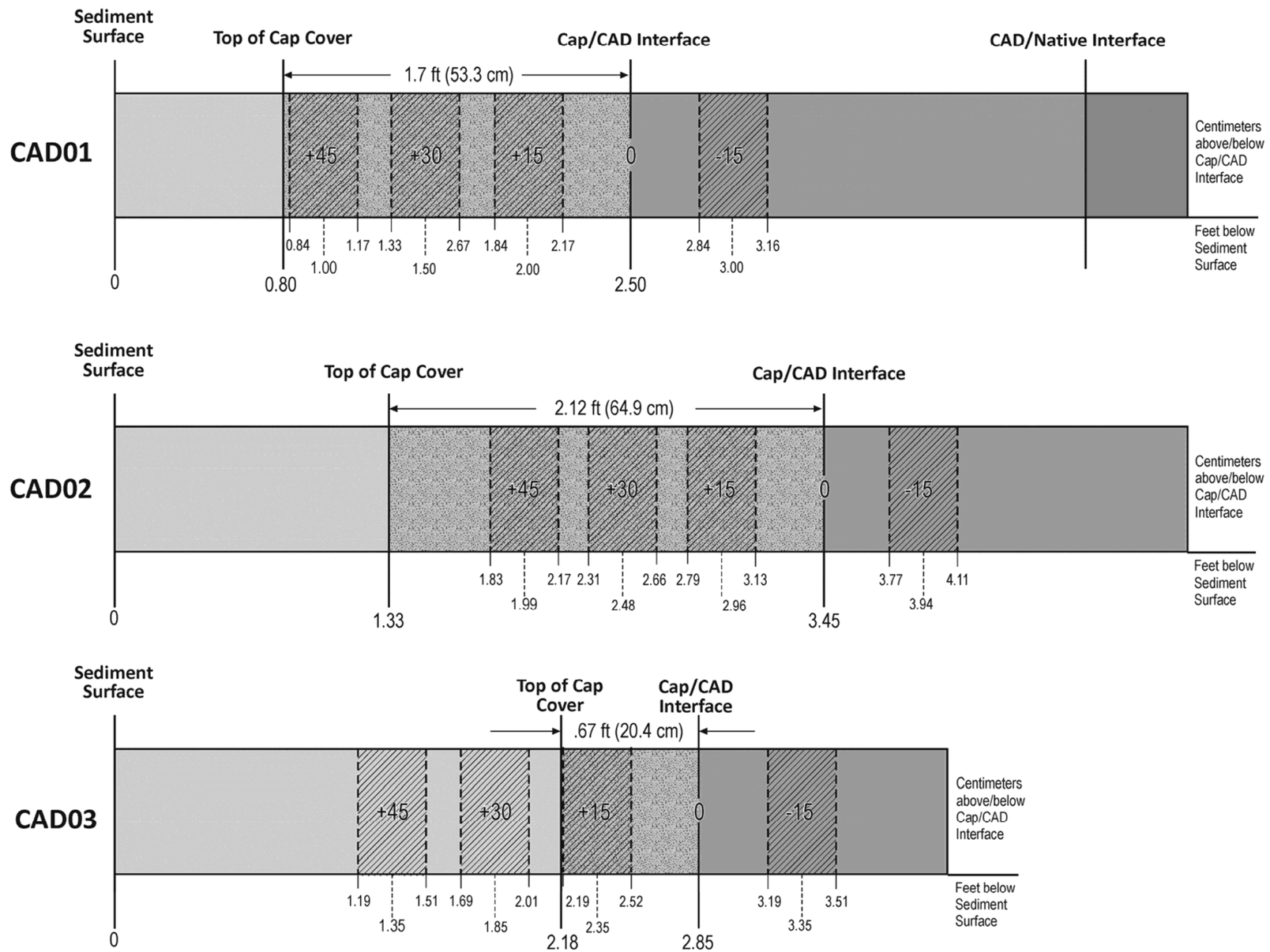
CAD03

SEE LLC Science & Engineering for the Environment

HDR

Data Report
Lower Duwamish Waterway, East Waterway, and West Waterway Subsurface Sediment Characterization

Figure 2-6
CAD Cores 01 – 03 Photo Montage



SEE LLC Science & Engineering for the Environment

HDR

Data Report
Lower Duwamish Waterway, East Waterway, and West Waterway Subsurface Sediment Characterization

Figure 2-7
CAD 01 – 03 Sampling Intervals

3.0 Analytical Results

This section summarizes chemical findings by channel (East, West, and Lower Duwamish Waterways) and CAD site. Consistent with the SAP, the analytical results are grouped as the East and West Waterway, and then LDW North, Central, and South areas. For each sample area, DMMP conventionals and COCs are presented and compared first to DMMP guideline values for the screening level (SL), maximum level (ML) and bioaccumulation trigger (BT), and then to the Washington State SMS sediment quality standards (SQS) and the cleanup screening levels (CSL).

For stations within the Superfund site, the measured sediment COC levels are compared to the proposed Lower Duwamish Superfund site PRGs and RALs. Separate discussions are also included on special studies conducted as part of this program including the CAD site monitoring, results of black carbon analyses, and a comparative analysis of measures of total PCBs by multiple methods.

Chemical analyses were conducted by ARI of Tukwila, Washington, and additional chemical analysis of PCBs by Methods 680 and 1668 were conducted by ALS/CAS Environmental. Black carbon analyses were conducted by Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts. The data were validated by Ken Taylor and Associates, Inc. (KTA) of Seattle, Washington.

All data supporting the chemical analyses are included in Appendices G through J. Appendix G presents the tables of all chemical results: Appendix G-1 presents the results with comparisons to the DMMP chemical guidelines and the SMS guidelines. Appendix G-2 contains the calculation of toxicity equivalents quotients (TEQs) for dioxins and furans, and Appendix G-3 shows the calculation of cPAH TEQs, and Appendix G-4 provides results for the CAD site monitoring. Appendices G-5 through G-7 summarize the results of the different PCB analytical methods. Appendix H provides analytical laboratory reports: Appendix H-1 presents the data deliverable from ARI, Appendix H-2 provides the data deliverable from ALS/CAS, and Appendix H-3 provides the data deliverable from MIT related to black carbon analysis. Validated data in the Environmental Information Management System (EIMS) format are included in Appendix I. Analytical data validation reports from KTA are provided in Appendix J.

3.1 Summary of Data Validation Findings

All analytical data underwent the review and validation procedures defined in the SAP (Section 7.5). A Level III evaluation was conducted for metals and conventional analyses; a Level IV validation was conducted for dioxins and furans, SVOCs, PCB Aroclors, TBT, and pesticides. Data qualifiers assigned during validation by the validator were incorporated into the analytical tables in Appendix G. Definitions for the analytical qualifiers used in this report are included in the SAP (Appendix A). This section summarizes the validator's findings; the complete set of data validation reports are in Appendix J.

PCB congeners and homologs were analyzed separately by ALS/CAS. The results were subjected to a Level IV validation. These data and the validation are discussed in Section 3.5.

All data are considered to be of known quality and acceptable for use as qualified except as follows:

- Heptachlor results were rejected in samples collected from locations WW02 (all samples), WW03 (all samples) and WW04 (all samples); EW01 4-8C2; and EW01 8-12C3 because heptachlor was not recovered in the SRM.
- Hexachlorobenzene and hexachlorobutadiene were rejected in sample LDW08 4-9.8C2 because the percent recovery associated with the MS/MSD was less than 10%.

Two specific analytical issues triggered the need for further evaluation. Elevated reporting limits (RLs) for the chlordanes, dieldrin, and heptachlor resulted in exceedances of the SLs for the respective analytes. RLs for all seven of these compounds were typically elevated in samples where matrix interference was encountered and the laboratory had to dilute the sample extract. At the request of USACE, the laboratory conducted a special study to review the chromatograms and signal to noise ratio of the relevant samples, and was able to lower many of the RLs. The reported RLs for heptachlor, dieldrin, *trans*-chlordane and *cis*-chlordane were reduced to one-half of the original RLs. RLs for *oxy*-chlordane, *cis*-nonachlor, and *trans*-nonachlor were lowered to the reported method detection limits (MDLs) because the lowered RL (1/2 the original RLs) were lower than the respective MDLs. The laboratory also conducted a follow-up study to demonstrate that the actual instrument sensitivity is lower than the reported MDLs. Therefore, the lowered RLs were justified and applied to non-detected results for the referenced compounds. As a conservative measure, all these results were flagged (UJ) to inform data users the potential of bias associated with the reported RLs.

3.2 Comparison to DMMP Guidelines and SMS

Analytical results for each sample were compared to DMMP and SMS guidelines. The summary results for only those chemicals exceeding the DMMP guideline values and/or the SMS values are presented in Tables 3-1 through 3-4. For consistent presentation, those tables include the COCs which had any exceedance (detected or non-detected) at any station of either the DMMP guidelines or the SMS. All comparisons for the DMMP COCs are given in Appendix G-1. Where compounds were not detected, the RLs (or MDLs as noted above) were compared to the DMMP and SMS guidelines.

Comparison of dioxin TEQs to DMMP guidelines is provided in Table 3-5. There are no corresponding SMS values for dioxin. The TEQ results and supporting TEQ calculations by sampling area are given in Appendix Tables G-2.1 through G-2.5. TEQs were calculated using the methodology outlined in the DMMP Users' Manual (DMMP 2009). Consistent with the DMMP requirements, TEQs are calculated two ways: the first method treats non-detect values (U) as "0" for the TEQ calculation; the second method sets non-detects equal to half of the detection limit to calculate the TEQ. Two DMMP guideline values are used for comparison: 4 ng/kg 2,3,7,8-TCDD concentration, and 10 ng/kg TEQ. DMMP guidelines also include a volume weighted average of 4 ng/kg TEQ for disposal of dredged material; any station dioxin TEQ exceeding that value was flagged for discussion.

In general, the principal detected COCs exceeding the DMMP guideline values or the SMS at many stations included mercury, benzyl alcohol, total PCBs, and dioxin/furans as TEQs. Other less frequently detected COCs exceeding the DMMP guidelines included several PAHs, TBT, 2,4-dimethylphenol, and dibenzofuran. Exceedances of the SL occurred for several non-detected chlorinated compounds including several chlorinated pesticides and the chlorobenzenes. These are discussed in more detail in each section below.

3.2.1 East and West Waterway

All physical and analytical results for East and West Waterway are given in Appendix G-1, Table G-1.1. Summary results are given in Table 3-1. One location within East Waterway and four locations within West Waterway were evaluated. Figure 3-1 provides a visual representation of detected exceedances of DMMP guidelines, SMS standards, and dioxin TEQs for COCs within the East and West Waterways.

Generally, all samples collected from the East and West Waterways consisted primarily of sand with minor amounts of silt, clay, and gravel. Total organic carbon (TOC) ranged from 0.687% (WW04 0-4C1) to 1.72% (WW01 4-8C2). Black carbon ranged from 0.06% (WW04 0-4C1) to 0.58% (WW02 0-4C1).

- **EW01**: Samples collected from station EW01 did not exceed DMMP guidelines for any detected analytes. Non-detected dieldrin and total chlordane exceeded the SL in the surface sample (EW01 0-4C1). Samples collected from station EW01 did not exceed the SMS standards for any detected analytes. The RL for 1,2,4-trichlorobenzene exceeded the SQS standard in the surface sample and exceeded the CSL standard in the two deeper samples (EW01 4-8C2 and EW01 8-12C3). Heptachlor results for all East Waterways samples were rejected during data validation because heptachlor was not recovered in the SRM (see Section 3.1).
- **WW01**: No detected COCs exceeded DMMP or SMS guidelines. The reported non-detect values for dieldrin and total chlordane exceeded the SL in both sample intervals. The RL for 1,2,4-trichlorobenzene exceeded the SQS for both sample intervals.
- **WW02**: Mercury in the surface sample at WW02 0-4C1 exceeded the DMMP SL and the SMS CSL. Mercury was not detected in the deeper (4-8C2) sample. Total PCBs exceed the DMMP SL and the SQS in the surface sample but not in the deeper layer. The reported non-detect values for dieldrin and total chlordane exceeded the SL in the surface sample but not in the deeper interval. The RL for 1,2,4-trichlorobenzene exceeded the SQS in the shallow (0-4C1) interval and the CSL at the deeper (4-8C2) interval. Heptachlor results were rejected during data validation (see Section 3.1).
- **WW03**: No detected COCs exceeded DMMP guidelines. The RL for 1,2,4-trichlorobenzene exceeded the CSL in both depth intervals (0-4C1 and 4-8C2). In addition, the RL for 1,2-dichlorobenzene exceeded the CSL in the deeper sample. Heptachlor results were rejected during data validation (see Section 3.1).
- **WW04**: No detected COCs exceeded DMMP guidelines. The RL for 1,2,4-trichlorobenzene exceeded the CSL in the surface interval (0-4C1), and the SQS in the deeper (4-8C2) sample.

In addition, the RL for 1,2-dichlorobenzene exceeded the CSL in the surface sample. Heptachlor results were rejected during data validation (see Section 3.1).

Dioxin TEQ results for the East and West Waterways are as follows:

- **EW01**: The dioxin TEQ guideline values were not exceeded in any samples.
- **WW01**: The guideline value of 4 ng/kg TEQ was exceeded in sample WW01 0-4C1 (Table 3-5).
- **WW02**: The dioxin TEQ guideline values were not exceeded in any samples.
- **WW03**: The dioxin TEQ guideline values were not exceeded in any samples.
- **WW04**: The 10 ng/kg TEQ was exceeded in sample WW04 0-4C1 (Table 3-5).

3.2.2 LDW North

Detailed physical and analytical results for LDW North (Stations LDW01 through LDW05) are given in Appendix Table G-1.2. Summary results are given in Table 3-2. Figure 3-2 provides a visual representation of detected exceedances of DMMP guidelines, SMS standards, and dioxin TEQs for COCs within this reach of the waterway.

Generally, the sediments in this segment are characterized as silty sands and sandy silts, with minor amounts of gravel and clay. TOC ranged from 0.58% (LDW02 0-3.9C) to 2.54% (LDW03 0-4.4C). Black carbon ranged from 0.14% (LDW02 Z) to 0.91% (LDW05 0-2C).

Exceedances of DMMP guidelines and SMS standards within LDW North were observed as follows:

- **LDW01**: No detected COCs exceeded the DMMP guidelines. The RL for dieldrin and total chlordane exceeded the SL in both the surface sample and Z-layer sample. Total PCBs exceeded the SQS in the Z-layer sample. In addition, 1,2,4-trichlorobenzene RL exceeded the SQS in the surface sample and 1,2-dichlorobenzene and 1,2,4-trichlorobenzene RLs exceeded the CSL in the Z-layer sample.
- **LDW02**: No detected COCs exceeded the DMMP or SMS guidelines. RLs for 1,4-dichlorobenzene exceeded the SQS, and 1,2-dichlorobenzene and 1,2,4-trichlorobenzene exceeded the CSL in the surface sample (LDW02 0-3.9C), and 1,2,4-trichlorobenzene exceeded the CSL in the Z-layer sample.
- **LDW03**: Station LDW03 had the greatest number of detected COC exceedances of DMMP guidelines. In the surface sample (LDW03 0-4.4C) mercury, benzyl alcohol, and total PCBs exceeded the SL; mercury and total PCBs exceeded the SQS; and benzyl alcohol exceeded the CSL. In the Z-layer sample (LDW03 Z) benzyl alcohol, 2,4-dimethylphenol, and total PCBs exceeded the SL; mercury exceeded the BT; and dibenzofuran exceeded the ML. Most individual PAHs exceeded their respective SLs, with several exceeding the BT and ML. Total LPAHs exceeded the ML and total HPAHs exceeded the SL. These COCs also exceeded respective SMS standards in the Z-layer sample, with 2,4-dimethylphenol and benzyl alcohol exceeding the SQS and mercury, Dibenzofuran, and total PCBs exceeding the

CSL. Most individual PAHs exceeded the SQS, with the majority of LPAHs also exceeding the CSL. Total LPAHs exceeded the CSL, and total HPAHs exceeded the SQS. In addition, chlorinated hydrocarbons, phenols, and pesticides exceeded DMMP guidelines and SMS due to elevated RLs. For these samples, the elevated RLs were likely due to the interference from high levels of PAHs in the associated samples.

- **LDW04**: Detected COCs exceeding the SL included mercury, benzyl alcohol, and total PCBs in the surface sample (LDW04 0-2.1C); and benzyl alcohol, total PCBs and porewater TBT in the Z-layer sample (LDW04 Z). The reported non-detect values for dieldrin and total chlordane exceeded the SL in both samples. The RL for 1,2,4-trichlorobenzene exceeded the SQS in the surface interval, but not in the Z-layer. In the surface sample, mercury, benzyl alcohol and total PCBs exceeded the CSL. In the Z-layer sample, benzyl alcohol exceeded the CSL and total PCBs exceeded SQS.
- **LDW05**: Mercury and fluoranthene exceeded the SL and total PCBs exceeded the ML in the surface sample (LDW05 0-2C). The reported non-detect values for heptachlor, dieldrin, DDTs, and total chlordane were above the SL. Mercury exceeded the SQS and total PCBs exceeded the CSL. RLs for 1,2,4-trichlorobenzene exceeded the SQS, and the total DDT RL exceeded the CSL. No Z-layer sample was collected at station LDW05.

Dioxin TEQ results for LDW North are as follows:

- **LDW01**: The surface sample collected from station LDW01 exceeded the 4 ng/kg TEQ guideline, while the Z-layer sample exceeded the 10 ng/kg TEQ guideline.
- **LDW02**: The dioxin TEQ guideline values were not exceeded in any samples.
- **LDW03**: All samples exceeded the 10 ng/kg TEQ guideline.
- **LDW04**: All samples exceeded the 10 ng/kg TEQ guideline.
- **LDW05**: All samples exceeded the 10 ng/kg TEQ guideline.

3.2.3 LDW Central

Detailed physical and analytical results for LDW Central (Stations LDW06 through LDW12) are given in Appendix Table G-1.3. Summary results are given in Table 3-3. Figure 3-3 provides a visual representation of detected exceedances of DMMP guidelines, SMS standards, and dioxin TEQs for COCs within the LDW Central channel.

Generally, the sediments are characterized as silty sands, with minor amounts of gravel and clay. TOC ranged from 1.55% (LDW06 Z) to 3.08% (LDW06 0-4.9C). Black carbon ranged from 0.76% (LDW10 0-2C1) to 1.16% (LDW06 0-2C and LDW11 0-3.2C).

Exceedances of DMMP guidelines and SMS standards within LDW Central were observed as follows:

- **LDW06**: Benzyl alcohol and total PCBs exceeded the DMMP SL in both the surface sample (LDW06 0-4.9C) and the Z-layer sample (LDW06 Z). Porewater TBT exceeded the BT in both samples collected. The reported non-detect values for dieldrin, and total chlordane

exceeded the SL in both samples, and the RL for 4,4'-DDT exceeded the SL in the surface sample. Benzyl alcohol exceeded the CSL in both samples collected, and total PCBs exceeded the SQS in the Z-layer sample. In addition, the RL for 1,2,4-trichlorobenzene exceeded the SQS in the Z-layer sample.

- **LDW07**: Benzyl alcohol exceeded the SL and the CSL for all samples (LDW07 0-2C1, LDW07 2-4C2, LDW07 4-8C3, and LDW07 Z). Total PCBs exceeded the SL for all samples and exceeded the SQS for the two deepest samples (LDW07 4-8C3 and LDW07 Z). The reported non-detect values for dieldrin and total chlordane exceeded the SL for all four samples collected, and the RL for 4,4'-DDT exceeded the SL for sample LDW07 4-8C3 and LDW07 Z. The RL for heptachlor exceeded the SL in the second interval (4-8C3) sample. The RL for 1,2,4-trichlorobenzene also exceeded the SQS for samples LDW07 2-4C2 and LDW07 4-8C3.
- **LDW08**: Benzyl alcohol exceeded the SL and the CSL for the surface sample (0-4C1), while total PCBs exceeded the SL and the SQS for all three samples collected (LDW08 0-4C1, LDW08 4-9.8C2, and LDW08 Z). The reported non-detect values for dieldrin and total chlordane exceeded the SL for all three intervals collected, while the RL for heptachlor exceeded the SL in the Z sample. Additionally, the RL for 1,2,4-trichlorobenzene exceeded the SQS for sample LDW08 4-9.8C2.
- **LDW09**: Benzyl alcohol exceeded the SL and the CSL, while total PCBs exceeded the SL and the SQS in both depth intervals (LDW09 0-2.1C and LDW09 Z). The reported non-detect values for dieldrin exceeded the SL for both samples collected, and the RL for 1,2,4-trichlorobenzene exceeded the SQS for sample LDW09 Z.
- **LDW10**: Benzyl alcohol exceeded the SL and the CSL, while total PCBs exceeded the SL and the SQS for the three samples collected (LDW10 0-2C1, LDW10 2-5.5C2, and LDW10 Z). The reported non-detect values for dieldrin and total chlordane exceeded the SL, and the RL for 1,2,4-trichlorobenzene exceeded the SQS in all sample intervals.
- **LDW11**: Benzyl alcohol was detected above the SL and the CSL for both samples collected (LDW11 0-3.2C and LDW11 Z). Total PCBs exceeded the SL in both samples and exceeded the SQS in the surface interval. The RL for dieldrin, and total chlordane exceeded the SL for both samples collected and the RL for 1,2,4-trichlorobenzene exceeded the SQS at sample LDW11 Z.
- **LDW12**: Benzyl alcohol exceeded the SL and the CSL for the surface sample collected (LDW12 0-2.6C); no benzyl alcohol exceedances were noted in the Z-layer sample (LDW12 Z). Total PCBs exceeded the SL in both samples and exceeded the CSL in the Z-layer sample. Non-detected exceedance of the SL occurred in both intervals for dieldrin, 4,4'-DDT, and total chlordane. In addition the RL for 1,2,4-trichlorobenzene exceeded the SQS for both samples.

Dioxin TEQ results for LDW Central are as follows:

- **LDW06**: All samples exceeded the 10 ng/kg TEQ guideline.
- **LDW07**: The two upper samples exceeded the 4 ng/kg TEQ guideline, while the two lowest samples exceeded the 10 ng/kg TEQ guideline.

- **LDW08**: The surface sample exceeded the 4 ng/kg TEQ guideline, while the two lower samples collected exceeded the 10 ng/kg TEQ guideline.
- **LDW09**: Both samples exceeded the 4 ng/kg TEQ guideline.
- **LDW10**: The surface sample exceeded the 4 ng/kg TEQ guideline, while the two lower interval samples exceeded 10 ng/kg TEQ guideline.
- **LDW11**: Both samples exceeded the 4 ng/kg TEQ guideline.
- **LDW12**: The surface sample collected from station LDW12 exceeded the 4 ng/kg TEQ guideline, while the Z-layer sample exceeded 10 ng/kg TEQ guideline.

3.2.4 LDW South

Complete physical and analytical results for LDW South (Stations LDW13 through LDW18) are given in Appendix Table G-1.4. Summary results are given in Table 3-4. Figure 3-4 provides a visual representation of detected exceedances of DMMP guidelines, SMS standards, and dioxin TEQs for COCs within the LDW South channel.

In this section of the waterway, the sediments may be characterized as silty sands, with minor amounts of gravel and clay. TOC ranged from 1.65% (LDW14 0-2C1) to 3.08% (LDW18 Z). Black carbon ranged from 0.63% (LDW14 0-2C1) to 1.16% (LDW14 2-4C2). Exceedances of DMMP guidelines and SMS standards within LDW South were observed as follows:

- **LDW13**: Benzyl alcohol was detected above the SL and the CSL for all three samples collected (LDW13 0-2C1, LDW13 2-7.2C2, and LDW13 Z). Total PCBs exceeded the SL in the two deeper samples (LDW13 2-7.2C2 and LDW13 Z) and exceeded the SQS for the Z-layer sample collected. Non-detected exceedances of the SL for dieldrin and total chlordane occurred in both samples, while the RL for 4,4'-DDT exceeded the SL for the Z-layer sample only. In addition, the RL for 1,2,4-trichlorobenzene exceeded the SQS for all three samples collected.
- **LDW14**: Benzyl alcohol exceeded the SL for all four samples (LDW14 0-2C1, LDW14 2-4C2, LDW14 4-6.8C3, and LDW14 Z). Benzyl alcohol also exceeded the SMS CSL for the upper three samples and exceeded the SQS for the Z-layer sample. Total PCBs exceeded the SL in the two deepest samples (LDW14 4-6.8C3 and LDW14 Z) and exceeded the SQS for the Z-layer sample. Non-detected exceedances of the SL for dieldrin and total chlordanes occurred in all sampled intervals, and the RL for 4,4'-DDT exceeded the SL in the Z-layer sample. The RL for 1,2,4-trichlorobenzene exceeded the SQS for the surface and Z-layer samples.
- **LDW15**: Benzyl alcohol exceeded the SL and the CSL for both samples collected (LDW15 0-2.3C and LDW15 Z). Total PCBs exceeded the SL in the Z-layer sample. The RL for dieldrin and total chlordane exceeded the SL for both samples.
- **LDW16**: Benzyl alcohol exceeded the SL and the CSL and total PCBs exceeded the SL for both samples (LDW16 0-2.5C and LDW16 Z). Non-detected dieldrin and total chlordane exceeded the SL for both samples, and the RL for 1,2,4-trichlorobenzene exceeded the SQS for the Z-layer samples.

- **LDW17**: Benzyl alcohol exceeded the SL and the CSL for both samples collected (LDW17 0-3.5C and LDW17 Z). Total PCBs exceeded the SL also for both samples and exceeded the SQS in the Z-layer sample. Non-detected dieldrin and total chlordane exceeded the SL for both samples, and the RL for 1,2,4-trichlorobenzene exceeded the SQS for the Z-layer samples.
- **LDW18**: Benzyl alcohol exceeded the SL and the CSL for both samples collected (LDW18 0-2.8C and LDW18 Z). Non-detected dieldrin and total chlordane exceeded the SL for both samples.

Dioxin TEQ results for LDW South are as follows:

- **LDW13**: In the surface sample, the dioxin TEQ was below the guideline values. In the two lower samples the 4 ng/kg TEQ guideline value was exceeded.
- **LDW14**: In the upper two samples, the dioxin TEQs were below the guideline values. In the lower mid-column sample (LDW14 4-6.8C3) the 10 ng/kg TEQ guideline was exceeded when calculated with U= ½ RL. The Z-layer sample exceeded the 10 ng/kg TEQ guideline.
- **LDW15**: In the surface sample, the dioxin TEQ was below the guideline values. For the lower two segments the values exceeded the 10 ng/kg TEQ guideline.
- **LDW16**: Both samples exceeded the 4 ng/kg TEQ guideline.
- **LDW17**: In the surface sample, the dioxin TEQ was below the guideline value when calculated with U=0; but exceeded the 4 ng/kg TEQ guideline when calculated with U= ½ RL. The Z-layer sample also exceeded the 4 ng/kg TEQ guideline.
- **LDW18**: The surface sample collected at station LDW18 exceeded the 4 ng/kg TEQ guideline but did not exceed the guideline in the Z-layer sample.

3.3 Analytical Results Compared to the LDW Superfund Site PRGs and RALs

A requirement of this program was to compare the results of sediment analytical chemistry for those stations that are within the Lower Duwamish Superfund site against the proposed PRGs and RALs (Table 1-2). Stations in this program within the LDW Superfund site were LDW03 through LDW18. PRGs and RALs are being considered for remedial actions by the EPA for arsenic, total PCBs, cPAHs expressed as TEQs and dioxin/furan TEQs. EPA has identified the Washington State SMS as both PRGs and RALs for the site. It should be noted that the values discussed here were under consideration at the time the SAP was written, and cannot be considered final values. Final PRGs and RALs for the site will be issued by EPA with the Record of Decision.

Table 3-6 presents a comparison of the results for arsenic, cPAHs, total PCBs, and dioxin/furans; all other SMS comparisons were previously presented in Tables 3-1 through 3-4.

All stations at all elevations sampled and tested exceeded at least one or more of the PRGs and/or RALs. All stations exceeded the arsenic PRG but were all below the proposed RAL.

cPAH TEQs were calculated for the seven PAHs listed under the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation (WAC 173-340-708(8)(e)) and include benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Calculation of the cPAH TEQ followed State guidance[1]. For undetected compounds, the TEQ was calculated two ways: one where the non-detected value was set to 0 (U=0) and the other method where one half the RL (U=1/2 RL) was used. Calculation of the TEQ for all stations may be found in Appendix G-3.

Only stations LDW03, LDW04, and LDW05 had total cPAH TEQs that exceeded the PRG, and the only RAL for cPAH that was exceeded was LDW03 Z. All other stations were below the cPAH PRG.

All stations exceeded the PRG for total PCBs, with many of those stations also exceeding the RAL. In Table 3-6 the total PCB results are presented in two ways: as the dry-weight measured value, and as the organic carbon (OC)-normalized value. The OC-normalized value was needed to compare the results to the SQS for total PCBs. Twenty-six of the samples analyzed had values that exceeded the total PCB dry weight RAL; when OC-normalized, only 20 of those samples exceeded the RAL.

All but one of the LDW samples exceeded the dioxin/furan TEQ PRG (as U=1/2 RL), and of those, just four stations exceeded the RAL.

3.4 CAD Results

3.4.1 Physical Observations of CAD Cores

For all three core sampling locations within the CAD, the cover material was less than the expected 3 ft. Figure 2-6 presents a photo montage of each of the three CAD cores made during processing. The sand cover material is clearly distinct from both the buried contaminated sediments and the surface sediments deposited since the CAD was placed. For cores CAD01 through CAD03 the measured sand cap thickness was 1.7 ft (53.3 cm), 2.1 ft (64.9 cm), and 0.67 ft (20.4 cm), respectively. In CAD01, the interface of the placed contaminated sediment and the underlying native LDW sediment is evident at approximately 4.7 ft BMS.

For CAD01, the upper most interval (+45 cm) was only 0.4 ft (1.2 cm) below the sand cover/surface sediment interface (Figure 2-7). For CAD02, all sand cover samples were collected solely within the cap itself, with approximately 1.33 ft (40.5 cm) of surface sediment overlying the sand cover. In the case of CAD03, the +15 cm was collected just under the sand cover/surface sediment interface (0.3 cm), while the +30 and +45 cm intervals were actually within the more recently deposited surface sediments; i.e., above the CAD cap.

As was found in the 1995 monitoring (SAIC 1996), the thickness of the sand cover was less than the target design thickness of 3 ft. The SAIC core logs (SAIC 1996, Appendix B) show the sand cover to be between 1.5 and 2 ft above the contaminated sediments. As would be expected, additional sedimentation has occurred since the previous monitoring event. The 1995

[1] WDOE. Evaluating the Toxicity and Assessing the Carcinogenic Risk of Environmental Mixtures Using Toxicity Equivalency Factors. Online at https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf

monitoring showed approximately 0.5 ft of recently deposited sediments above the sand, while this study found the sediments deposited over the cap ranged from 0.80 ft (CAD01), 1.33 ft (CAD02), and 2.18 ft (CAD03). These differences may be due in part to spatial variability with the core drive location.

3.4.2 Analytical Results

All core intervals were analyzed for conventionals, metals, and PCBs. All results compared to the SMS are shown in Figure 3-7. Additionally, a single surface sediment composite (two grabs) was collected at CAD01 and analyzed for all DMMP COCs. All results can be found in Appendix G-4.

Samples within the contaminated sediment intervals (-15 cm samples) had concentrations of arsenic, mercury, zinc and total PCBs comparable to what has been found previously. Mercury and total PCBs exceeded the SQS and the CSL (Table 3-7). For the intervals sampled at 15 cm and 30 cm above the Cap/CAD interface in cores CAD02 and CAD03, metals and PCB levels were substantively less than the levels measured in CAD-placed sediments and are below the SQS. It is notable that the CAD01 +15 cm interval was collected within the sand cover, but the CAD01 +30 cm and +40 cm intervals were taken above the placed sand and likely represent sediments deposited over the CAD cell post-construction. The +15 cm sample interval in CAD01 exhibited mercury and total PCBs at levels similar to those in the CAD-placed sediments (-15 cm) and at levels exceeding the SQS. In that same core, the +30 and +45 cm intervals were substantively lower, with the levels of mercury and total PCBs below the SQS.

The surface sediment grab sample taken at CAD01 was principally silty sand, consistent with the surface intervals collected from the other West Waterway stations. All measured metal levels were below the SQS, while total PCBs exceeded the SQS.

3.5 Results of Congener and Homolog Analyses for Select LDW Stations

All samples collected were initially analyzed by EPA Method 8082A for PCB Aroclors, and the results of those analyses are presented in Table 3-1 through 3-4. Nine samples were chosen for analysis by both EPA Method 1668 (for the 209 PCB congeners) and EPA Method 680 (for the 10 PCB homologs). In addition, the Puget Sound SRM was also included for both QA/QC purposes (for EPA 8082A and 1668 congeners) but also to begin establishing a baseline set of homolog data for future use. All data are included in Appendix Tables G5 through G7, and in the separate electronic data deliverable. See Section 2.4 for more detail.

Results of the analysis for PCB congeners by EPA Method 1668 and PCB homologs by EPA Method 680, are summarized in Table 3-8; the supporting data may be found in Appendix G Tables G-5 (EPA 680 homologs), G-6 (EPA 1668 homologs), and G-7 (EPA 1668 individual congeners).

3.5.1 Data Review and Validation

A Level IV validation was performed on the congener and homolog data. Congener data were determined acceptable for use as qualified via the data validation. Homolog analysis was performed three times on these samples, and all three sets of data were reported by the laboratory. The data validation determined that the results reported from the most recent analysis were acceptable for use. The determination of data quality and the justification of optimal homolog data is discussed below.

As described in Section 2.4, the initial analysis of homologs was performed on January 31, 2013; the laboratory re-analyzed the extracts on February 12, 2013 due to the extreme low recovery for one of the surrogate spikes, 4,4'-DDT during the January analysis. The re-analysis showed homolog results and low 4,4'-DDT recovery similar to the January analysis (Table 3-8). Both sets of homolog results by EPA 680 were much lower than both the homolog or congener results determined by EPA 1668 (Table G-6 and G-7) and the Aroclor results by EPA 8082A (Figure 3.6). The HDR team conducted a further data review and had extensive discussions with the analytical laboratories. A potential for sulfur interference in the EPA 680 analysis was suggested through this investigative process. This was based in part on the fact that the samples with the greatest difference between the reported homolog values and the congener and Aroclor results also had the highest sulfide levels (Table 3-8). A sulfur cleanup procedure (SW846 Method 3660A) was applied to sample extracts for Aroclors analysis by EPA 8082A and congeners analysis by EPA 1668A but not to homolog analysis by EPA 680.

All of the test sediments were therefore re-extracted, the extracts subjected to a cleanup procedure (SW846 Method 3660A) to remove sulfur, and re-analyzed on April 11, 2013 for PCB homologs by EPA 680. The data validation determined that the results reported from the April 23, 2013 should be reported for this study, and both sets of results from January and February be discarded based on the fact that the April results were much less biased by the sulfur interference and these homolog results were, compared to the January and February results, more in line with congeners and Aroclor results (see further discussion below).

Consistent with the January and February results, very low recovery (<10%) of surrogate 4,4'-DDT was still observed with the April results. The %R values for the second surrogate spike, gamma-BHC, was also less than the lower control limits, but only in selected samples. However, the recovery of both surrogate spikes was well within the control limits in the associated method blanks and laboratory control samples. This would indicate that insufficient extraction was not the cause of the low %R. Rather, the lower 4,4'-DDT recovery was most likely a combination of DDT breakdown (also observed in EPA 8081B pesticides analysis by ARI) at the GC injection port and severe sample matrix interference; the lower gamma-BHC recovery was a result of matrix interference. Other than the low surrogate recovery, no other significant QC anomalies were found in association with the data; therefore, the April homolog results were determined acceptable for use. However, as a conservative measure, all homolog data by EPA 680 were qualified (J) for detections and (UJ) for non-detects to indicate the potential low-bias associated with the data.

3.5.2 Results

Table 3-8 presents the congener, homolog and Aroclor data arrayed from lowest to highest Aroclor concentration. Both the March and April (re-extracted) homolog data are provided. The table highlights in red those data for five stations in the March 680 analyses that exhibited the greatest difference between the homologue results and both the congener and Aroclor analysis. Those five stations were also observed to have the highest levels of total sulfides (Table 3-8). While the measured sulfide values were obtained for the purpose of informing the bioassay results, in this study they were indicative of apparently high levels of total sulfur in the sediment samples that interfered with the 680 analysis. Homolog results from the April re-extraction and sulfur cleanup, showed that the stations with the lowest sulfides (WW01, LDW02, EW01 and LDW05) did not exhibit significant changes to the reported sum of the homologs from March, while the homolog concentration in the five stations with high sulfides were between 2 – 6.6 times higher when re-analyzed with the sulfur cleanup. The resultant values tracked very closely with those of the homolog values as reported by EPA 1668.

EPA method 1668 requires that the laboratory report both the individual congeners and the homologs. Thus comparisons in the tables below include both congeners and homologs reported by Method 1668 and homologs as reported from Method 680. The comparative results for the separate test methods are provided in Table 3-9. Total PCBs by 1668 are presented as:

- **Sum Congeners U= ½RL** is the sum of the congeners where non-detected values were assumed to have a value of one-half of the RL.
- **Lab-Reported Sum of the Homolog Values** is the laboratory reported sum of the homologs.

The 1668 data show that except for station WW01, which was largely non-detected for all homologs and congeners, both methods for summing total PCBs provide a relatively consistent total PCB value.

Figure 3-5 provides a graphical comparison of the sum of congeners (at ½ RL), the sum of homologs by EPA method 680, and total Aroclors by EPA 8082A. For all reported stations, the graph shows that the congeners and 680 homologs are closely related and are consistently lower than total Aroclors. Figure 3-6 shows a plot of sum of PCBs by 1668 and by 680 against the sum of total Aroclors by EPA 8082A. The regression equation on the graph shows that the reported sums for both measures are highly correlated with total Aroclors (coefficient of correlation square R^2= 0.99), but that the regression lines are consistently lower than the Aroclors when compared to the 1:1 ratio line shown on the figure. For these data total, Aroclors consistently over-report the levels of total PCBs in the samples. Figure 3-6 also plots the March EPA 680 sum of homologs; the graph further demonstrates that the samples with high sulfides had no correlation with either the sum of congeners or sum of Aroclors.

Figure 3-7 plots the sum of congeners against the total PCB homologs by EPA 680. The regression line plots close to the 1:1 ratio line on the graph and has an R^2 value of 0.998.

Table 3-1. East and West Waterway: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		EW01 0-4C1			EW01 4-8C2			EW01 8-12C3			EW51 8-12C3			WW01 0-4C1			WW01 4-8C2		
						-36.2 to -40.2 ft MLLW			-40.2 to -44.2 ft MLLW			-44.2 to -47.7 ft MLLW			-44.2 to -47.7 ft MLLW			-28.3 to -32.3 ft MLLW			-32.3 to -36.3 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventional																							
Total Solids (%)	--	--	--	--	--	74		--	71.6		--	74.3		--	74.4		--	80.2		--	75.4		--
Total Volatile Solids (%)	--	--	--	--	--	2.67		--	2.31		--	1.84		--	1.96		--	2.49		--	1.96		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	15.7		--	42.2		--	45		--	45.8		--	3.66		--	22.3		--
Sulfide (mg/kg dw)	--	--	--	--	--	60.5	J	--	268	J	--	251	J	--	211	J	--	448		--	268		--
Total Organic Carbon (%)	--	--	--	--	--	1.19		--	0.916		--	0.934		--	0.951		--	1.34		--	1.72		--
Gravel (%)	--	--	--	--	--	0.0		--	0.2		--			--	0.1		--	0.3		--	0.2		--
Sand (%)	--	--	--	--	--	61.4		--	67.5		--	76		--	75.6		--	81.5		--	78.7		--
Silt (%)	--	--	--	--	--	27.2		--	26.1		--	19.5		--	19.6		--	15		--	15.3		--
Clay (%)	--	--	--	--	--	11.4		--	6.2		--	4.6		--	4.7		--	3.3		--	5.7		--
Black Carbon (%)	--	--	--	--	--	0.55		--	0.37		--	0.32		--	0.44		--	0.36		--	0.47		--
Metals				mg/kg dw		mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw		
Mercury	0.41	1.5	2.3	0.41	0.59	0.23		0.23	0.03	U	0.03	0.02	U	0.02	0.03	U	0.03	0.28		0.28	0.03		0.03
PAHs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Naphthalene	2,100	--	2,400	99	170	86		7.23	10		1.09	8.3		0.89	10		1.05	84		6.27	81		4.71
2-Methylnaphthalene	670	--	1,900	38	64	39		3.28	12		1.31	10		1.07	12		1.26	20		1.49	15		0.87
Acenaphthene	500	--	2,000	16	57	62		5.21	40		4.37	36		3.85	32		3.36	28		2.09	19		1.10
Fluorene	540	--	3,600	23	79	73		6.13	38		4.15	38		4.07	37		3.89	30		2.24	19		1.10
Phenanthrene	1,500	--	21,000	100	480	250		21.01	130		14.19	140		14.99	140		14.72	120		8.96	69		4.01
Anthracene	960	--	13,000	220	1200	97		8.15	17		1.86	35		3.75	36		3.79	50		3.73	33		1.92
Total LPAH[(1)]	5,200	--	29,000	370	780	595		50.00	237.5		25.93	260.9		27.93	270.6		28.45	335		25.00	245		14.24
Fluoranthene	1,700	4,600	30,000	160	1,200	270		22.69	130		14.19	180		19.27	160		16.82	220		16.42	110		6.40
Pyrene	2,600	11,980	16,000	1,000	1,400	600	J	50.42	94		10.26	110	J	11.78	120	J	12.62	580	J	43.28	160		9.30
Benzo(a)anthracene	1,300	--	5,100	110	270	120		10.08	32		3.49	57		6.10	47		4.94	95		7.09	36		2.09
Chrysene	1,400	--	21,000	110	460	160		13.45	32		3.49	61		6.53	51		5.36	110		8.21	39		2.27
Total HPAH	12,000	--	69,000	960	5,300	1,933		162.44	353.4		38.58	503.3		53.89	451.6		47.49	1,656		123.58	489.7		28.47
Chlorinated Hydrocarbons	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	1.60	18	U	1.97	18	U	1.93	19	U	2.00	19	U	1.42	19	U	1.10
1,4-Dichlorobenzene	110	--	120	3.1	9	12	J	1.01	18	U	1.97	18	U	1.93	19	U	2.00	19	U	1.42	19	U	1.10
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	**1.60**	18	U	**1.97**	18	U	**1.93**	19	U	**2.00**	19	U	**1.42**	19	U	**1.10**
Phenols				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	18	UJ	18	18	UJ	18	19	UJ	19	19	UJ	19	19	UJ	19
Pentachlorophenol	400	504	690	400	690	190	U	190	180	U	180	180	U	180	190	U	190	190	U	190	190	U	190
Miscellaneous Extractables				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Benzyl Alcohol	57	--	870	57	73	26		26	22		22	16	J	16	12	J	12	19	U	19	19	U	19
Benzoic Acid	650	--	760	650	650	380	U	380	360	U	360	370	U	370	390	U	390	370	U	370	380	U	380
Miscellaneous Extractables	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Dibenzofuran	540	--	1,700	15	58	57		4.79	30		3.28	27		2.89	25		2.63	23		1.72	15		0.87
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	1.60	18	U	1.97	18	U	1.93	19	U	2.00	19	U	1.42	19	U	1.10
Pesticides				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Heptachlor	1.5	--	--	--	--	1.2	R	--	0.24	R	--	0.24	R	--	0.25	R	--	1.2	UJ	--	1.2	UJ	--
Dieldrin	1.9	--	--	--	--	**2.5**	UJ	--	0.48	UJ	--	0.49	UJ	--	0.49	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.9	UJ	--	0.96	U	--	0.98	U	--	0.98	U	--	4.8	U	--	4.8	U	--
4,4'-DDT	12	--	--	--	--	4.9	UJ	--	0.96	UJ	--	0.98	UJ	--	0.98	UJ	--	9.5	U	--	4.8	U	--
Sum of DDTs	--	50	69	--	69	4.9	UJ	4.9	0.96	UJ	0.96	0.98	UJ	0.98	0.98	UJ	0.98	9.5	U	9.5	4.8	U	4.8
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4.1**	UJ	--	0.79	UJ	--	0.81	UJ	--	0.81	UJ	--	**3.9**	UJ	--	**4**	UJ	--
PCBs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Total PCBs	130	38[(2)]	3,100	12	65	55		4.62	9.2	U	1.00	8.8	U	0.94	9	U	0.95	81		6.04	16		0.93
TBT in Porewater (µg/L)	(µg/L)					(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)		
Total TBT in Porewater	0.15	0.15	--	--	--	0.024		--	0.013		--	0.01		--	0.012		--	--		--	0.052		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level — **>SL**
BT = Bioaccumulation Trigger — **>BT**
ML = Maximum Level — **>ML**
SQS = Sediment Quality Standard — **> SQS**
CSL = Cleanup Screening Level — **>CSL**

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-1. East and West Waterway: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		WW02 0-4C1			WW02 4-8C2			WW03 0-4C1			WW03 4-8C2			WW04 0-4C1			WW04 4-8C2		
						-31.4 to -35.4 ft MLLW			-35.4 to -39.4 ft MLLW			-37.7 to -41.7 ft MLLW			-41.7 to -45.7 ft MLLW			-38.0 to -42.0 ft MLLW			-42.0 to -46.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventional																							
Total Solids (%)	--	--	--	--	--	67.9		--	79.5		--	84.9		--	75.7		--	91		--	83.7		--
Total Volatile Solids (%)	--	--	--	--	--	3.59		--	1.49		--	1.81		--	1.51		--	0.86		--	1.24		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	2.65		--	2.39		--	1.92		--	5.53		--	0.1	U	--	0.47		--
Sulfide (mg/kg dw)	--	--	--	--	--	224	J	--	5.46	J	--	28.9	J	--	55.1	J	--	--		--	--		--
Total Organic Carbon (%)	--	--	--	--	--	1.34		--	0.876		--	0.837		--	0.808		--	0.687		--	1.66		--
Gravel (%)	--	--	--	--	--	1.2		--	0.1		--	0.0		--	0.1		--	2.7		--	0.1		--
Sand (%)	--	--	--	--	--	52.6		--	75.7		--	82		--	83.4		--	92.8		--	95.7		--
Silt (%)	--	--	--	--	--	35		--	19.3		--	15.4		--	12.8		--	3.1		--	3.2		--
Clay (%)	--	--	--	--	--	11.3		--	4.8		--	2.6		--	3.5		--	1.4		--	0.9		--
Black Carbon (%)	--	--	--	--	--	0.58		--	0.22		--	0.34		--	0.35		--	0.06		--	0.17		--
Metals				**mg/kg dw**		**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**		
Mercury	0.41	1.5	2.3	0.41	0.59	**1.18**		**1.18**	0.02	U	0.02	0.02	U	0.02	0.03	U	0.03	0.05		0.05	0.02	U	0.02
PAHs	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Naphthalene	2,100	--	2,400	99	170	250		18.66	6.8		0.78	3.9	J	0.47	3.4	J	0.42	8.5		1.24	2.7	J	0.16
2-Methylnaphthalene	670	--	1,900	38	64	64		4.78	2.6	J	0.30	6.8		0.81	2.9	J	0.36	4.5	J	0.66	4.8	U	0.29
Acenaphthene	500	--	2,000	16	57	83		6.19	3.1	J	0.35	2.9	J	0.35	4.8	U	0.59	5.2		0.76	4.8	U	0.29
Fluorene	540	--	3,600	23	79	90		6.72	4.6	U	0.53	4.9	U	0.59	4.8	U	0.59	5.8		0.84	4.8	U	0.29
Phenanthrene	1,500	--	21,000	100	480	420		31.34	12		1.37	8.8		1.05	2.8	J	0.35	20		2.91	3.1	J	0.19
Anthracene	960	--	13,000	220	1200	130		9.70	2.6	J	0.30	4.9	U	0.59	4.8	U	0.59	7.6		1.11	4.8	U	0.29
Total LPAH[(1)]	5,200	--	29,000	370	780	1,054		78.66	27.5		3.14	15.6		1.86	6.2		0.77	51.1		7.44	5.8		0.35
Fluoranthene	1,700	4,600	30,000	160	1,200	640		47.76	10		1.14	2.8	J	0.33	4.8	U	0.59	27		3.93	4.8	U	0.29
Pyrene	2,600	11,980	16,000	1,000	1,400	1,200	J	89.55	22	J	2.51	3.4	J	0.41	4.8	U	0.59	72		10.48	2.8	J	0.17
Benzo(a)anthracene	1,300	--	5,100	110	270	250		18.66	4.2	J	0.48	4.9	U	0.59	4.8	U	0.59	14		2.04	4.8	U	0.29
Chrysene	1,400	--	21,000	110	460	300		22.39	5.7		0.65	4.9	U	0.59	4.8	U	0.59	21		3.06	4.8	U	0.29
Total HPAH	12,000	--	69,000	960	5,300	4,055		302.61	72.5		8.28	6.2		0.74	4.8	U	0.59	303.4		44.16	2.8		0.17
Chlorinated Hydrocarbons	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
1,2-Dichlorobenzene	35	--	110	2.3	2.3	18	U	1.34	18	U	2.05	19	U	2.27	19	U	**2.35**	19	U	**2.77**	19	U	1.14
1,4-Dichlorobenzene	110	--	120	3.1	9	9.9	J	0.74	18	U	2.05	19	U	2.27	19	U	2.35	19	U	2.77	19	U	1.14
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	18	U	**1.34**	18	U	**2.05**	19	U	**2.27**	19	U	**2.35**	19	U	**2.77**	19	U	**1.14**
Phenols				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
2,4-Dimethylphenol	29	--	210	29	210	18	UJ	18	18	UJ	18	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19
Pentachlorophenol	400	504	690	400	690	180	U	180	180	U	180	190	U	190	190	U	190	190	U	190	190	U	190
Miscellaneous Extractables				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Benzyl Alcohol	57	--	870	57	73	38		38	18	U	18.00	19	U	19	19	U	19	19	U	19	19	U	19.00
Benzoic Acid	650	--	760	650	650	120	J	120	350	U	350.00	380	U	380	380	U	380	390	U	390	380	U	380.00
Miscellaneous Extractables	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Dibenzofuran	540	--	1,700	15	58	77		5.75	2.5	J	0.29	2.6	J	0.31	4.8	U	0.59	5.2		0.76	4.8	U	0.29
N-Nitrosodiphenylamine	28	--	130	11	11	18	U	1.34	18	U	2.05	19	U	2.27	19	U	2.35	19	U	2.77	19	U	1.14
Pesticides				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Heptachlor	1.5	--	--	--	--	1.2	R	--	0.24	R	--	0.24	R	--	0.24	R	--	0.24	R	--	0.24	R	--
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	0.47	UJ	--	0.49	UJ	--	0.48	UJ	--	0.48	UJ	--	0.48	UJ	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	0.94	U	--	0.98	U	--	0.96	U	--	0.96	U	--	0.97	U	--
4,4'-DDT	12	--	--	--	--	4.8	UJ	--	0.94	UJ	--	0.98	UJ	--	0.96	UJ	--	0.96	UJ	--	0.97	UJ	--
Sum of DDTs	--	50	69	--	69	4.8	UJ	4.8	0.94	UJ	0.94	0.98	UJ	0.98	0.96	UJ	0.96	0.96	UJ	0.96	0.97	UJ	0.97
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	--	0.77	UJ	--	0.81	UJ	--	0.79	UJ	--	0.79	UJ	--	0.8	UJ	--
PCBs	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Total PCBs	130	38[(2)]	3,100	12	65	**620**		**46.27**	8.3	U	0.95	9.7	U	1.16	9	U	1.11	24		3.49	9.6	U	0.58
TBT in Porewater (µg/L)				**(µg/L)**		**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**		
Total TBT in Porewater	0.15	0.15	--	--	--	0.102		--	0.046		--	--		--	0.011		--	--		--	--		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level
BT = Bioaccumulation Trigger
ML = Maximum Level
SQS = Sediment Quality Standard
CSL = Cleanup Screening Level

>SL
>BT
>ML
> SQS
>CSL

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-2. LDW North: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW01 0-3.4C			LDW01 Z			LDW02 0-3.9C			LDW02 Z			LDW03 0-4.4C			LDW03 Z		
						-26.6 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW			-25.1 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW			-25.6 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals (%)																							
Total Solids (%)	--	--	--	--	--	77		--	80.3		--	89.7		--	92.5		--	52.8		--	52.3		--
Total Volatile Solids (%)	--	--	--	--	--	1.57		--	1.34		--	1.01		--	0.55		--	6.09		--	7.19		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	0.83		--	1.07		--	0.38		--	0.12		--	39.8		--	113		--
Sulfide (mg/kg dw)	--	--	--	--	--	94.9		--	164		--	12.9		--	5.4	U	--	2,690		--	6,330		--
Total Organic Carbon (%)	--	--	--	--	--	1.33		--	0.695		--	0.578		--	0.905		--	2.54		--	1.67		--
Gravel (%)	--	--	--	--	--	4.6		--	5.9		--	37.2		--	41.8		--	--		--	0.6		--
Sand (%)	--	--	--	--	--	90.9		--	90.5		--	60.1		--	57.3		--	20		--	12.6		--
Silt (%)	--	--	--	--	--	2.7		--	14.4		--	--		--	--		--	50.1		--	57.8		--
Clay (%)	--	--	--	--	--	1.8		--	10.8		--	--		--	--		--	29.9		--	29		--
Black Carbon (%)	--	--	--	--	--	0.19		--	0.30		--	0.19		--	0.14		--	0.81		--	---		--
Metals				mg/kg dw		mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw		
Mercury	0.41	1.5	2.3	0.41	0.59	0.06		0.06	0.06		0.06	0.03		0.03	0.03	U	0.03	**0.45**		**0.45**	2.06		2.06
PAHs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Naphthalene	2,100	--	2,400	99	170	13		0.98	11		1.58	18		3.11	4.6	U	0.51	120		4.72	**60,000**		**3,592.81**
2-Methylnaphthalene	670	--	1,900	38	64	8.7		0.65	6.2		0.89	9.4		1.63	4.6	U	0.51	25		0.98	**13,000**		**778.44**
Acenaphthene	500	--	2,000	16	57	5.2		0.39	7.9		1.14	8.1		1.40	4.6	U	0.51	28		1.10	**11,000**		**658.68**
Fluorene	540	--	3,600	23	79	7.6		0.57	6.9		0.99	8.2		1.42	4.6	U	0.51	28		1.10	**9,900**		**592.81**
Phenanthrene	1,500	--	21,000	100	480	50		3.76	46		6.62	37		6.40	4.6	U	0.51	160		6.30	**27,000**		**1,616.77**
Anthracene	960	--	13,000	220	1200	13		0.98	12		1.73	21		3.63	5		0.55	59		2.32	**7,000**		**419.16**
Total LPAH(1)	5,200	--	29,000	370	780	94.5		7.11	87.2		12.55	97.7		16.90	7.6		0.84	411		16.18	**115,150**		**6,895.21**
Fluoranthene	1,700	4,600	30,000	160	1,200	57		4.29	50		7.19	88		15.22	5		0.55	330		12.99	**11,000**		**658.68**
Pyrene	2,600	11,980	16,000	1,000	1,400	88		6.62	74		10.65	190		32.87	8.3	J	0.92	660		25.98	**8,700**		520.96
Benzo(a)anthracene	1,300	--	5,100	110	270	26		1.95	19		2.73	56		9.69	12	J	1.33	150		5.91	**2,400**		**143.71**
Chrysene	1,400	--	21,000	110	460	32		2.41	22		3.17	82		14.19	25		2.76	230		9.06	**2,200**		**131.74**
Total HPAH	12,000	--	69,000	960	5,300	447		33.61	308.8		44.43	782		135.29	157.8		17.44	2,461		96.89	**28,960**		**1,734.13**
Chlorinated Hydrocarbons	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	1.43	19	U	**2.73**	19	U	**3.29**	20	U	2.21	**57**	U	2.24	**59**	U	**3.53**
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	1.43	19	U	2.73	19	U	**3.29**	20	U	2.21	57	U	2.24	59	U	**3.53**
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	**1.43**	19	U	**2.73**	19	U	**3.29**	20	U	**2.21**	**57**	U	**2.24**	**59**	U	**3.53**
Phenols				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	19	UJ	19	20	UJ	20	**57**	UJ	**57**	**200**		**200**
Pentachlorophenol	400	504	690	400	690	190	U	190	190	U	190	190	U	190	200	U	200	**570**	UJ	**570**	**590**	UJ	**590**
Miscellaneous Extractables				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Benzyl Alcohol	57	--	870	57	73	19	U	19	19	U	19	19	U	19	20	U	20	**80**		**80**	**62**		**62**
Benzoic Acid	650	--	760	650	650	370	U	370	370	U	370	380	U	380	390	U	390	**1,100**	UJ	**1,100**	**1,200**	UJ	**1,200**
Miscellaneous Extractables	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Dibenzofuran	540	--	1,700	15	58	5.8		0.44	4.5	J	0.65	12		2.08	4.6	U	0.51	24		0.94	**7,400**		**443.11**
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	1.43	19	U	2.73	19	U	3.29	20	U	2.21	**57**	U	2.24	**59**	U	3.53
Pesticides				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.40	0.23	UJ	0.46	0.24	UJ	0.48	**4.1**	UJ	4.10	**9.7**	UJ	9.70
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.4**	UJ	--	0.46	UJ	--	0.48	UJ	--	**4**	UJ	--	**27**	U	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	4.7	U	--	0.92	U	--	0.96	U	--	4.9	U	--	**31**	U	--
4,4'-DDT	12	--	--	--	--	4.8	U	--	4.7	U	--	1.6		--	0.96	U	--	4.9	UJ	--	**88**	UJ	--
Sum of DDTs	--	50	69	--	69	4.8	U	4.8	4.7	U	4.7	1.6		1.6	0.96	U	0.96	4.9	UJ	4.9	**88**	UJ	**88**
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	4.8	**3.9**	UJ	--	0.76	UJ	--	0.79	UJ	--	**9.8**	U	--	**20**	U	--
PCBs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC															
Total PCBs	130	38(2)	3,100	12	65	87		6.54	120		**17.27**	34.7		6.00	8.2	U	0.91	**1,110**		**43.70**	**3,800**		**227.54**
TBT in Porewater				(µg/L)		(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)		
Total TBT in Porewater	0.15	0.15	--	--	--	0.046	U	--	--		--	--		--	--		--	0.056		--	0.032		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level
BT = Bioaccumulation Trigger
ML = Maximum Level
SQS = Sediment Quality Standard
CSL = Cleanup Screening Level

>SL
>BT
>ML
> SQS
>CSL

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value
J Estimated concentration when the value is less than ARI's established reporting limit
R - The reported result was rejected.

Table 3-2. LDW North: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW04 0-2.1C -27.9 to -30.0 ft MLLW			LDW04 Z -30.0 to -32.0 ft MLLW			LDW05 0-2C -9.0 to -12.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals (%)														
Total Solids (%)	--	--	--	--	--	53.2		--	61		--	55.5		--
Total Volatile Solids (%)	--	--	--	--	--	6.8		--	5.07		--	6.22		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	135		--	15.3		--	39.7		--
Sulfide (mg/kg dw)	--	--	--	--	--	1,430		--	5,980		--	606		--
Total Organic Carbon (%)	--	--	--	--	--	2.24		--	2.43		--	1.98		--
Gravel (%)	--	--	--	--	--	3		--	11.5		--	0.5		--
Sand (%)	--	--	--	--	--	21.7		--	34.1		--	42.5		--
Silt (%)	--	--	--	--	--	48.1		--	37.3		--	38.7		--
Clay (%)	--	--	--	--	--	27.1		--	17.2		--	18.2		--
Black Carbon (%)	--	--	--	--	--	0.78		--	0.86		--	0.91		--
Metals				**mg/kg dw**		**mg/kg dw**			**mg/kg dw**			**mg/kg dw**		
Mercury	0.41	1.5	2.3	0.41	0.59	**0.62**		**0.62**	0.22		0.22	**0.48**	J	**0.48**
PAHs		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Naphthalene	2,100	--	2,400	99	170	600		26.79	30		1.23	270		13.64
2-Methylnaphthalene	670	--	1,900	38	64	98		4.38	13		0.53	96		4.85
Acenaphthene	500	--	2,000	16	57	120		5.36	19		0.78	100		5.05
Fluorene	540	--	3,600	23	79	83		3.71	18		0.74	110		5.56
Phenanthrene	1,500	--	21,000	100	480	320		14.29	120		4.94	400		20.20
Anthracene	960	--	13,000	220	1200	140		6.25	44		1.81	160		8.08
Total LPAH[1]	5,200	--	29,000	370	780	1,283		57.28	242		9.96	1,082		54.65
Fluoranthene	1,700	4,600	30,000	160	1,200	870		38.84	280		11.52	1,200		60.61
Pyrene	2,600	11,980	16,000	1,000	1,400	770		34.38	430		17.70	**2,900**		146.46
Benzo(a)anthracene	1,300	--	5,100	110	270	310		13.84	120		4.94	360		18.18
Chrysene	1,400	--	21,000	110	460	430		19.20	180		7.41	580		29.29
Total HPAH	12,000	--	69,000	960	5,300	3,793		169.33	1,950		80.25	6,905		348.74
Chlorinated Hydrocarbons		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
1,2-Dichlorobenzene	35	--	110	2.3	2.3	15	J	0.67	19	U	0.78	20	U	1.01
1,4-Dichlorobenzene	110	--	120	3.1	9	23		1.03	11	J	0.45	15	J	0.76
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	**0.85**	19	U	0.78	20	U	**1.01**
Phenols				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	11	J	11
Pentachlorophenol	400	504	690	400	690	190	U	190	190	U	190	200	UJ	200
Miscellaneous Extractables				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Benzyl Alcohol	57	--	870	57	73	**100**		**100**	**80**		**80**	20	U	20
Benzoic Acid	650	--	760	650	650	390		390	120	J	120	390	UJ	390
Miscellaneous Extractables		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Dibenzofuran	540	--	1,700	15	58	62		2.77	16		0.66	90		4.55
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	0.85	19	U	0.78	20	U	1.01
Pesticides				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.50	1.2	UJ	2.40	**12**	UJ	12.00
Dieldrin	1.9	--	--	--	--	**2.5**	UJ	--	**2.4**	UJ	--	**31**	U	--
4,4'-DDE	16	--	--	--	--	4.9	U	--	4.8	U	--	**36**	U	--
4,4'-DDT	12	--	--	--	--	4.9	U	--	4.8	U	--	**95**	UJ	--
Sum of DDTs	--	50	69	--	69	6.4	U	6.4	4.8	U	4.8	**95**	UJ	**95**
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4.1**	UJ	--	**3.9**	UJ	--	**22**	U	--
PCBs		**µg/kg dw**		**mg/kg OC**										
Total PCBs	130	38[2]	3,100	12	65	**1,800**		**80.36**	**460**		**18.93**	**3,110**		**157.07**
TBT in Porewater				**(µg/L)**		**(µg/L)**			**(µg/L)**			**(µg/L)**		
Total TBT in Porewater	0.15	0.15	--	--	--	0.065		--	**0.184**		--	0.059		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level
BT = Bioaccumulation Trigger
ML = Maximum Level
SQS = Sediment Quality Standard
CSL = Cleanup Screening Level

>SL
>BT
>ML
> SQS
>CSL

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value
J Estimated concentration when the value is less than ARI's established reporting limit
R - The reported result was rejected.

Table 3-3. LDW Central: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW06 0-4.9C			LDW06 Z			LDW07 0-2C1			LDW07 2-4C2			LDW07 4-8C3			LDW57 4-8C3			LDW07 Z		
						-25.1 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW			-22.0 to -24.0 ft MLLW			-24.0 to -26.0 ft MLLW			-26.0 to -30.0 ft MLLW			-26.0 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals (%)																					Field Replicate LDW07					
Total Solids (%)	--	--	--	--	--	51.9		--	55		--	51.6		--	53.6		--	56.1		--	--		--	57.6		--
Total Volatile Solids (%)	--	--	--	--	--	7.42		--	6.68		--	7.39		--	6.89		--	6.77		--	--		--	8.91		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	65.4		--	91.4		--	73.7		--	70.3		--	101		--	--		--	110		--
Sulfide (mg/kg dw)	--	--	--	--	--	1,760		--	1,320		--	2,990		--	2,870		--	3,280		--	--		--	2,360		--
Total Organic Carbon (%)	--	--	--	--	--	3.08		--	1.55		--	2.97		--	2.19		--	2.32		--	--		--	2.66		--
Gravel (%)	--	--	--	--	--	0.2		--	0.2		--	0.7		--	0.1		--	0.1		--	--		--	0.9		--
Sand (%)	--	--	--	--	--	17.6		--	19.6		--	26.2		--	21.1		--	33.7		--	--		--	24.4		--
Silt (%)	--	--	--	--	--	62.4		--	59.3		--	56.1		--	61.6		--	50.1		--	--		--	56.4		--
Clay (%)	--	--	--	--	--	19.9		--	20.9		--	17.1		--	17.3		--	16.1		--	--		--	18.2		--
Black Carbon (%)	--	--	--	--	--	1.16		--	0.80		--	1.15		--	0.82		--	0.78		--	1.05		1.05	1.28		--
Metals				mg/kg dw		mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw		
Mercury	0.41	1.5	2.3	0.41	0.59	0.21		0.21	0.22		0.22	0.14	J	0.14	0.14	J	0.14	0.17	J	0.17	0.13	J	0.13	0.21	J	0.21
PAHs		µg/kg dw		mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Naphthalene	2,100	--	2,400	99	170	37		1.20	20		1.29	120		4.04	21		0.96	21		0.91	16		--	28		1.05
2-Methylnaphthalene	670	--	1,900	38	64	4.8	U	0.16	4.7	U	0.30	27		0.91	8.2		0.37	11		0.47	4.9	U	--	11		0.41
Acenaphthene	500	--	2,000	16	57	24		0.78	10		0.65	22		0.74	13		0.59	14		0.60	14		--	16		0.60
Fluorene	540	--	3,600	23	79	35		1.14	15		0.97	22		0.74	10		0.46	17		0.73	11		--	19		0.71
Phenanthrene	1,500	--	21,000	100	480	190		6.17	85		5.48	78		2.63	64		2.92	110		4.74	79		--	70		2.63
Anthracene	960	--	13,000	220	1200	66		2.14	34		2.19	24		0.81	23		1.05	34		1.47	26		--	27		1.02
Total LPAH(1)	5,200	--	29,000	370	780	370		12.01	170.8		11.02	271		9.12	136.7		6.24	202.1		8.71	151.1		--	167.2		6.29
Fluoranthene	1,700	4,600	30,000	160	1,200	380		12.34	240		15.48	130		4.38	170		7.76	280		12.07	190		--	120		4.51
Pyrene	2,600	11,980	16,000	1,000	1,400	370	J	12.01	300	J	19.35	120		4.04	200		9.13	360		15.52	290		--	140		5.26
Benzo(a)anthracene	1,300	--	5,100	110	270	150		4.87	88		5.68	46		1.55	76		3.47	110		4.74	93		--	39		1.47
Chrysene	1,400	--	21,000	110	460	250		8.12	120		7.74	64		2.15	110		5.02	150		6.47	120		--	50		1.88
Total HPAH	12,000	--	69,000	960	5,300	1,788		58.05	1,232		79.48	605.9		20.40	973		44.43	1,454		62.67	1,251		--	517.1		19.44
Chlorinated Hydrocarbons		µg/kg dw		mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	0.62	19	U	1.23	19	U	0.64	19	U	0.87	20	U	0.86	20	U	--	19	U	0.71
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	0.62	19	U	1.23	19	U	0.64	19	U	0.87	20	U	0.86	20	U	--	19	U	0.71
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	0.62	19	U	**1.23**	19	U	0.64	19	U	**0.87**	20	U	**0.86**	20	U	--	19	U	0.71
Phenols				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19	20	UJ	20	20	UJ	20	19	UJ	19
Pentachlorophenol	400	504	690	400	690	190	UJ	190	190	UJ	190	190	UJ	190	190	UJ	190	200	UJ	200	200	UJ	200	190	UJ	190
Miscellaneous Extractables				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Benzyl Alcohol	57	--	870	57	73	**180**		**180**	**92**		**92**	**200**		**200**	**84**		**84**	**77**		**77**	**60**		**60**	**78**		**78**
Benzoic Acid	650	--	760	650	650	230	J	230	150	J	150	180	J	180	380	UJ	380	120	J	120	390	UJ	390	390	UJ	390
Miscellaneous Extractables		µg/kg dw		mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Dibenzofuran	540	--	1,700	15	58	25		0.81	12		0.77	20		0.67	10		0.46	14		0.60	11		--	15		0.56
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	0.62	19	U	1.23	19	U	0.64	19	U	0.87	20	U	0.86	20	U	--	19	U	0.71
Pesticides				µg/kg dw		µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.50	**1.6**	UJ	2.40	1.2	UJ	2.40	**1.9**	UJ	2.40
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.5**	U	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	4.9	U	--	4.9	U	--	5	U	--	4.8	U	--	4.8	U	--	15	J	--
4,4'-DDT	12	--	--	--	--	**13**	UJ	--	12	UJ	--	7	UJ	--	8.3	UJ	--	**18**	UJ	--	**15**	UJ	--	**31**	UJ	--
Sum of DDTs	--	50	69	--	69	13	UJ	13	12	UJ	12	7	UJ	7	8.3	UJ	8.3	18	UJ	18	15	UJ	15	15	J	15
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**3.9**	UJ	--	**4**	UJ	--	**4**	UJ	--	**4.1**	UJ	--	**3.9**	UJ	--	**3.9**	UJ	--	**3.9**	UJ	--
PCBs		µg/kg dw		mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Total PCBs	130	38(2)	3,100	12	65	**362**		11.75	**342**		**22.06**	**239**		8.05	**254**		11.60	**366**		**15.78**	**570**		--	**1250**		**46.99**
TBT in Porewater				(µg/L)		(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)		
Total TBT in Porewater	0.15	0.15	--	--	--	0.231		--	0.227		--	0.02		--	0.011		--	0.02		--	0.018		--	0.026		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level	>SL
BT = Bioaccumulation Trigger	>BT
ML = Maximum Level	>ML
SQS = Sediment Quality Standard	> SQS
CSL = Cleanup Screening Level	>CSL

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-3. LDW Central: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW08 0-4C1			LDW58 0-4C1			LDW08 4-9.8C2			LDW08 Z			LDW09 0-2.1C			LDW09 Z			LDW10 0-2C1		
						-20.2 to -24.2 ft MLLW			-20.2 to -24.2 ft MLLW			-24.2 to -30.0 ft MLLW			-30.0 to -32.0 ft MLLW			-17.9 to -20.0 ft MLLW			-20.0 to -22.0 ft MLLW			-14.5 to -16.5 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals (%)									**Field Replicate LDW08**																	
Total Solids (%)	--	--	--	--	--	52.5		--	--		--	56.2		--	56.4		--	50.9		--	50.3		--	57.6		--
Total Volatile Solids (%)	--	--	--	--	--	7.34		--	--		--	6.95		--	7.14		--	8.1		--	7.77		--	5.5		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	62.3		--	--		--	103		--	138		--	67.5		--	103		--	15.9		--
Sulfide (mg/kg dw)	--	--	--	--	--	2,100		--	--		--	2,670		--	2,520		--	2,860		--	2,390		--	787		--
Total Organic Carbon (%)	--	--	--	--	--	2.98		--	--		--	2.15		--	2.51		--	2.62		--	1.69		--	1.8		--
Gravel (%)	--	--	--	--	--	0.1		--	--		--	0.1		--	0.1		--			--	0.5		--	0		--
Sand (%)	--	--	--	--	--	33.6		--	--		--	28		--	22.3		--	26		--	23.9		--	39.2		--
Silt (%)	--	--	--	--	--	52		--	--		--	53		--	53.4		--	59.9		--	60.9		--	50.3		--
Clay (%)	--	--	--	--	--	14.3		--	--		--	18.9		--	24.3		--	14.1		--	14.6		--	10.5		--
Black Carbon (%)	--	--	--	--	--	1.07		--	1.14		1.14	0.82		--	0.94		--	1.09		--	1.05		--	0.76		--
Metals				**mg/kg dw**		**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**		
Mercury	0.41	1.5	2.3	0.41	0.59	0.18	J	0.18	0.28	J	0.28	0.25	J	0.25	0.29	J	0.29	0.14		0.14	0.16		0.16	0.1		0.1
PAHs		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Naphthalene	2,100	--	2,400	99	170	22		0.74	15		--	22		1.02	22		0.88	14		0.53	36		2.13	12		0.67
2-Methylnaphthalene	670	--	1,900	38	64	7.8		0.26	4.9	U	--	23		1.07	5.1		0.20	6.3		0.24	8.6		0.51	2	J	0.11
Acenaphthene	500	--	2,000	16	57	32		1.07	23		--	20		0.93	13		0.52	9.6		0.37	8.9		0.53	8.5		0.47
Fluorene	540	--	3,600	23	79	27		0.91	23		--	20		0.93	19		0.76	8.6		0.33	10		0.59	10		0.56
Phenanthrene	1,500	--	21,000	100	480	120		4.03	96		--	94		4.37	69		2.75	51		1.95	80		4.73	87		4.83
Anthracene	960	--	13,000	220	1200	35		1.17	25		--	31		1.44	61		2.43	18		0.69	21		1.24	22		1.22
Total LPAH[(1)]	5,200	--	29,000	370	780	242.7		8.14	188.4		--	195		9.07	190.1		7.57	105.8		4.04	159.1		9.41	142.5		7.92
Fluoranthene	1,700	4,600	30,000	160	1,200	240		8.05	180		--	220		10.23	180		7.17	140		5.34	180		10.65	200		11.11
Pyrene	2,600	11,980	16,000	1,000	1,400	230		7.72	190		--	330		15.35	190		7.57	180	J	6.87	200	J	11.83	260		14.44
Benzo(a)anthracene	1,300	--	5,100	110	270	110	J	3.69	66	J	--	90		4.19	60		2.39	68		2.60	65		3.85	84		4.67
Chrysene	1,400	--	21,000	110	460	130		4.36	92		--	110		5.12	67		2.67	97		3.70	110		6.51	110		6.11
Total HPAH	12,000	--	69,000	960	5,300	1,186		39.80	917		--	1,277		59.40	732.2		29.17	863		32.94	880		52.07	1,131		62.83
Chlorinated Hydrocarbons		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	0.64	19	U	--	19	U	0.88	19	U	0.76	20	U	0.76	19	U	1.12	19	U	1.06
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	0.64	19	U	--	19	U	0.88	19	U	0.76	20	U	0.76	19	U	1.12	19	U	1.06
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	0.64	19	U	--	19	U	**0.88**	19	U	0.76	20	U	0.76	19	U	**1.12**	19	U	**1.06**
Phenols				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19	20	UJ	20	19	UJ	19	19	UJ	19
Pentachlorophenol	400	504	690	400	690	190	UJ	190	190	UJ	190	190	UJ	190	190	UJ	190	200	UJ	200	190	UJ	190	190	U	190
Miscellaneous Extractables				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Benzyl Alcohol	57	--	870	57	73	**84**	J	**84**	**210**	J	**210**	38		38	40		40	**120**		**120**	**210**		**210**	**76**		**76**
Benzoic Acid	650	--	760	650	650	390	UJ	390	170	J	170	380	UJ	380	390	UJ	390	130	J	130	360	J	360	380	U	380
Miscellaneous Extractables		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Dibenzofuran	540	--	1,700	15	58	22		0.74	19		--	15		0.70	15		0.60	8.4		0.32	9.7		1	11		0.61
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	0.64	19	U	--	19	U	0.88	19	U	0.76	20	U	0.76	19	U	1.12	19	U	1.06
Pesticides				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	**1.7**	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.50
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**4.5**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.5**	UJ	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	4.8	U	--	4.9	U	--	4.7	U	--	4.9	U	--	4.8	U	--	4.9	U	--
4,4'-DDT	12	--	--	--	--	11	UJ	--	4.8	UJ	--	4.9	UJ	--	4.7	UJ	--	11	UJ	--	10	UJ	--	7.4	U	--
Sum of DDTs	--	50	69	--	69	11	UJ	11	4.8	UJ	4.8	4.9	UJ	4.9	4.7	UJ	4.7	11	UJ	11	10	UJ	10	7.4	U	7.4
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	--	**4**	U	--	**4**	U	--	**18**	U	--	**4**	UJ	--	**3.9**	UJ	--	**4**	UJ	--
PCBs		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Total PCBs	130	38[(2)]	3,100	12	65	**330**		11.07	**292**		--	**470**		**21.86**	**1560**		**62.15**	**365**		**13.93**	**326**		**19.29**	**236**		**13.11**
TBT in Porewater				**(µg/L)**		**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**		
Total TBT in Porewater	0.15	0.15	--	--	--	0.008		--	0.019		--	0.034		--	0.031		--	0.022		--	0.015		--	0.01		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level	**>SL**
BT = Bioaccumulation Trigger	**>BT**
ML = Maximum Level	**>ML**
SQS = Sediment Quality Standard	**> SQS**
CSL = Cleanup Screening Level	**>CSL**

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-3. LDW Central: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW10 2-5.5C2			LDW10 Z			LDW11 0-3.2C			LDW11 Z			LDW12 0-2.6C			LDW12 Z		
						-16.5 to -20.0 ft MLLW			-20.0 to -22.0 ft MLLW			-15.8 to -20.0 ft MLLW			-20.0 to -22.0 ft MLLW			-17.3 to -20.0 ft MLLW			-20.0 to -22.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals (%)																							
Total Solids (%)	--	--	--	--	--	57.9		--	56.3		--	52.2		--	54		--	57		--	60.6		--
Total Volatile Solids (%)	--	--	--	--	--	5.92		--	7.2		--	7.31		--	6.86		--	6.35		--	5.94		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	43.7		--	94.7		--	27		--	54.3		--	17.9		--	65.7		--
Sulfide (mg/kg dw)	--	--	--	--	--	2,400		--	1,400		--	2,100		--	2,030		--	1,950		--	1,550		--
Total Organic Carbon (%)	--	--	--	--	--	1.61		--	2.31		--	2.69		--	2.03		--	2.14		--	1.67		--
Gravel (%)	--	--	--	--	--	0		--	0		--			--			--	0.2		--	0.4		--
Sand (%)	--	--	--	--	--	27.8		--	18.2		--	25.2		--	19.1		--	33		--	36.6		--
Silt (%)	--	--	--	--	--	58.7		--	63.7		--	60.8		--	65.3		--	54		--	49.3		--
Clay (%)	--	--	--	--	--	13.5		--	18		--	13.9		--	15.5		--	12.8		--	13.7		--
Black Carbon (%)	--	--	--	--	--	0.79		--	1.14		--	1.16		--	1.12		--	0.78		--	0.82		--
Metals				**mg/kg dw**		**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**			**mg/kg dw**		
Mercury	0.41	1.5	2.3	0.41	0.59	0.15		0.15	0.15		0.15	0.16		0.16	0.13		0.13	0.12		0.12	0.17		0.17
PAHs		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Naphthalene	2,100	--	2,400	99	170	13		0.81	14		0.61	24		0.89	12		0.59	14		0.65	25		1.50
2-Methylnaphthalene	670	--	1,900	38	64	4.3	J	0.27	4.7	U	0.20	9.8		0.36	4.9	U	0.24	6		0.28	10		0.60
Acenaphthene	500	--	2,000	16	57	20		1.24	22		0.95	80		2.97	12		0.59	9.6		0.45	68		4.07
Fluorene	540	--	3,600	23	79	21		1.30	22		0.95	60		2.23	13		0.64	7.2		0.34	45		2.69
Phenanthrene	1,500	--	21,000	100	480	190		11.80	120		5.19	260		9.67	77		3.79	50		2.34	140		8.38
Anthracene	960	--	13,000	220	1200	41		2.55	42		1.82	42		1.56	22		1.08	14		0.65	29		1.74
Total LPAH[(1)]	5,200	--	29,000	370	780	291.2		18.09	223.3		9.67	472.8		17.58	141.4		6.97	99.5		4.65	314		18.80
Fluoranthene	1,700	4,600	30,000	160	1,200	350		21.74	320		13.85	450		16.73	160		7.88	120		5.61	180		10.78
Pyrene	2,600	11,980	16,000	1,000	1,400	490	J	30.43	320		13.85	380	J	14.13	260	J	12.81	280	J	13.08	230	J	13.77
Benzo(a)anthracene	1,300	--	5,100	110	270	140		8.70	110		4.76	110		4.09	73		3.60	52		2.43	65		3.89
Chrysene	1,400	--	21,000	110	460	180		11.18	120		5.19	180		6.69	110		5.42	68		3.18	97		5.81
Total HPAH	12,000	--	69,000	960	5,300	1,881		116.83	1,324		57.32	1,598		59.41	1,038		51.13	823		38.46	927		55.51
Chlorinated Hydrocarbons		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	1.18	19	U	0.82	20	U	0.74	19	U	0.94	20	U	0.93	19	U	1.14
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	1.18	19	U	0.82	20	U	0.74	19	U	0.94	20	U	0.93	19	U	1.14
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	**1.18**	19	U	**0.82**	20	U	0.74	19	U	**0.94**	20	U	**0.93**	19	U	**1.14**
Phenols				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	20	UJ	20	19	UJ	19	20	UJ	20	19	UJ	19
Pentachlorophenol	400	504	690	400	690	190	U	190	190	U	190	200	UJ	200	190	UJ	190	200	UJ	200	190	UJ	190
Miscellaneous Extractables				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Benzyl Alcohol	57	--	870	57	73	**95**		**95**	**150**		**150**	**130**		**130**	**95**		**95**	**90**		**90**	50		50
Benzoic Acid	650	--	760	650	650	220	J	220	290	J	290	130	J	130	120	J	120	390	UJ	390	380	UJ	380
Miscellaneous Extractables		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Dibenzofuran	540	--	1,700	15	58	17		1.06	14		0.61	53		1.97	13		0.64	10		0.47	48		2.87
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	1.18	19	U	0.82	20	U	0.74	19	U	0.94	20	U	0.93	19	U	1.14
Pesticides				**µg/kg dw**		**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**			**µg/kg dw**		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**3.8**	UJ	--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	4.9	U	--	4.9	U	--	4.8	U	--	4.7	U	--	4.8	U	--
4,4'-DDT	12	--	--	--	--	11	U	--	8.2	U	--	9.4	UJ	--	8.2	UJ	--	**16**	UJ	--	**30**	UJ	--
Sum of DDTs	--	50	69	--	69	11	U	11	8.2	U	8.2	9.4	UJ	9.4	8.2	UJ	8.2	16	UJ	16	30	UJ	30
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	--	**4**	UJ	--	**4**	UJ	--	**4**	UJ	--	**3.9**	UJ	--	**3.9**	UJ	--
PCBs		**µg/kg dw**		**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Total PCBs	130	38[(2)]	3,100	12	65	**418**		**25.96**	**351**		**15.19**	**283**		10.52	**271**		**13.35**	**248**		11.59	**1130**		**67.66**
TBT in Porewater				**(µg/L)**		**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**			**(µg/L)**		
Total TBT in Porewater	0.15	0.15	--	--	--	0.019		--	0.009		--	0.019		--	0.049		--	0.024		--	0.034		--

Notes:
1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level	**>SL**
BT = Bioaccumulation Trigger	**>BT**
ML = Maximum Level	**>ML**
SQS = Sediment Quality Standard	**> SQS**
CSL = Cleanup Screening Level	**>CSL**

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-4. LDW South: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW13 0-2C1			LDW13 2-7.2C2			LDW13 Z			LDW14 0-2C1			LDW14 2-4C2			LDW14 4-6.8C3			LDW14 Z		
						-7.8 to -9.8 ft MLLW			-9.8 to -15.0 ft MLLW			-15.0 to -17.0 ft MLLW			-7.8 to -9.8 ft MLLW			-9.8 to -11.8 ft MLLW			-11.8 to -14.8 ft MLLW			-15.0 to 17.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals																										
Total Solids (%)	--	--	--	--	--	55.7		--	56.3		--	62.7		--	63		--	55.5		--	56		--	56.7		--
Total Volatile Solids (%)	--	--	--	--	--	6.05		--	6.17		--	6.36		--	5.29		--	8.84		--	8.63		--	8.5		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	39.4		--	83.8		--	122		--	61.8		--	135		--	171		--	207		--
Sulfide (mg/kg dw)	--	--	--	--	--	1,770		--	1,710		--	928		--	1,990		--	3,270		--	1,430		--	2,660		--
Total Organic Carbon (%)	--	--	--	--	--	1.79		--	2.01		--	2.15		--	1.65		--	2.44		--	2.74		--	1.71		--
Gravel (%)	--	--	--	--	--	0.1		--			--	0.2		--			--	0.1		--	0.5		--			--
Sand (%)	--	--	--	--	--	34.8		--	35.2		--	34.3		--	69.1		--	49.5		--	35.5		--	25.5		--
Silt (%)	--	--	--	--	--	55.3		--	54.4		--	51.7		--	25.1		--	41.4		--	50.7		--	54.7		--
Clay (%)	--	--	--	--	--	9.9		--	10.4		--	14		--	5.9		--	9.1		--	13.2		--	19.8		--
Black Carbon (%)	--	--	--	--	--	1.05		--	0.77		--	0.90		--	0.63		--	1.16		--	1.08		--	1.00		--
Metals	mg/kg dw					mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw		
Mercury	0.41	1.5	2.3	0.41	0.59	0.09		0.09	0.15		0.15	0.14		0.14	0.05		0.05	0.08		0.08	0.11		0.11	0.15		0.15
PAHs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Naphthalene	2,100	--	2,400	99	170	12		0.67	8.8		0.44	16		0.74	7.2		0.44	12		0.49	13		0.47	26		1.52
2-Methylnaphthalene	670	--	1,900	38	64	11		0.61	4.9		0.24	16		0.74	4	U	0.24	4.6	J	0.19	4.8	U	0.18	5.6		0.33
Acenaphthene	500	--	2,000	16	57	10		0.56	8.2		0.41	18		0.84	7.6		0.46	9.9		0.41	18		0.66	23		1.35
Fluorene	540	--	3,600	23	79	13		0.73	9.6		0.48	24		1.12	5.8		0.35	9.9		0.41	20		0.73	25		1.46
Phenanthrene	1,500	--	21,000	100	480	61		3.41	55		2.74	110		5.12	58		3.52	63		2.58	100		3.65	120		7.02
Anthracene	960	--	13,000	220	1200	17		0.95	13		0.65	40		1.86	7.4		0.45	14		0.57	33		1.20	29		1.70
Total LPAH[(1)]	5,200	--	29,000	370	780	120.9		6.75	98.6		4.91	216.2		10.06	86		5.21	112.3		4.60	190		6.93	226.2		13.23
Fluoranthene	1,700	4,600	30,000	160	1,200	140		7.82	150		7.46	250		11.63	98		5.94	140		5.74	200		7.30	200		11.70
Pyrene	2,600	11,980	16,000	1,000	1,400	150		8.38	180		8.96	250		11.63	82	J	4.97	120	J	4.92	170	J	6.20	180	J	10.53
Benzo(a)anthracene	1,300	--	5,100	110	270	49		2.74	51		2.54	130		6.05	27		1.64	44		1.80	83		3.03	53		3.10
Chrysene	1,400	--	21,000	110	460	68		3.80	68		3.38	140		6.51	37		2.24	64		2.62	100		3.65	64		3.74
Total HPAH	12,000	--	69,000	960	5,300	655		36.59	745		37.06	1,285		59.77	364.7		22.10	590		24.18	855		31.20	708.8		41.45
Chlorinated Hydrocarbons	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	1.06	19	U	0.95	19	U	0.88	19	U	1.15	19	U	0.78	20	U	0.73	20	U	1.17
1,4-Dichlorobenzene	110	--	120	3.1	9	22		1.23	14	J	0.70	11	J	0.51	19	U	1.15	19	U	0.78	20	U	0.73	20	U	1.17
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	**1.06**	19	U	**0.95**	19	U	**0.88**	19	U	**1.15**	19	U	0.78	20	U	0.73	20	U	**1.17**
Phenols	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19	20	UJ	20	20	UJ	20
Pentachlorophenol	400	504	690	400	690	190	U	190	190	U	190	190	U	190	190	UJ	190	190	UJ	190	200	UJ	200	200	UJ	200
Miscellaneous Extractables	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Benzyl Alcohol	57	--	870	57	73	**170**		**170**	**100**		**100**	**130**		**130**	**220**		**220**	**170**		**170**	**82**		**82**	**65**		**65**
Benzoic Acid	650	--	760	650	650	230	J	230	160	J	160	280	J	280	270	J	270	130	J	130	120	J	120.00	130	J	130
Miscellaneous Extractables	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Dibenzofuran	540	--	1,700	15	58	13		0.73	8.2		0.41	17		0.79	7.4		0.45	11		0.45	15		0.55	19		1.11
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	1.06	19	U	0.95	19	U	0.88	19	U	1.15	19	U	0.78	20	U	0.73	20	U	1.17
Pesticides	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.50	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.5**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.9	U	--	5	U	--	4.7	U	--	4.8	U	--	4.9	U	--	4.8	U	--	4.8	U	--
4,4'-DDT	12	--	--	--	--	4.9	U	--	7.2	U	--	**20**	J	--	4.8	UJ	--	4.9	UJ	--	10	UJ	--	**13**	UJ	--
Sum of DDTs	--	50	69	--	69	4.9	U	4.9	7.2	U	7.2	20	J	20	4.8	UJ	4.8	4.9	UJ	4.9	10	UJ	10	13	UJ	13
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	--	**4.1**	UJ	--	**3.9**	UJ	--	**4**	UJ	--	**4**	UJ	--	**4**	UJ	--	**4**	UJ	--
PCBs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Total PCBs	130	38[(2)]	3,100	12	65	85		4.75	**201**		10.00	**536**		**24.93**	39.3		2.38	91		3.73	**275**		10.04	**460**		**26.90**
TBT in Porewater	(µg/L)					(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)		
Total TBT in Porewater	0.15	0.15	--	--	--	0.007		--	0.011		--	0.007		--	0.008		--	0.009		--	0.006		--	0.014		--

Notes:

1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level	**>SL**
BT = Bioaccumulation Trigger	**>BT**
ML = Maximum Level	**>ML**
SQS = Sediment Quality Standard	**> SQS**
CSL = Cleanup Screening Level	**>CSL**

U Indicates that the target analyte was not detected at the reported concentration

UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

J Estimated concentration when the value is less than ARI's established reporting limits

R - The reported result was rejected.

Table 3-4. LDW South: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW15 0-2.3C			LDW15 Z			LDW16 0-2.5C			LDW16 Z			LDW17 0-3.5C			LDW57 0-3.5C			LDW17 Z		
						-12.7 to -15.0 ft MLLW			-15.0 to -17.0 ft MLLW			-12.5 to -15.0 ft MLLW			-15.0 to -17.0 ft MLLW			-11.5 to -15.0 ft MLLW			-11.5 to -15.0 ft MLLW			-15.0 to -17.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals																					Field Replicate LDW17					
Total Solids (%)	--	--	--	--	--	54.7		--	54.8		--	51.1		--	53.4		--	53.6		--	--		--	54.1		--
Total Volatile Solids (%)	--	--	--	--	--	6.91		--	7.08		--	7.05		--	6.97		--	6.97		--	--		--	7.22		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	43.5		--	103		--	38.2		--	83.6		--	63.6		--	--		--	120		--
Sulfide (mg/kg dw)	--	--	--	--	--	2,100		--	2,430		--	2,750		--	2,230		--	2,920		--	--		--	3,610		--
Total Organic Carbon (%)	--	--	--	--	--	2.43		--	2.47		--	2.74		--	2.16		--	2.2		--	--		--	1.59		--
Gravel (%)	--	--	--	--	--	0.2		--	0.4		--			--			--			--	--		--			--
Sand (%)	--	--	--	--	--	38		--	30.4		--	20.1		--	26.3		--	26.1		--	--		--	24.9		--
Silt (%)	--	--	--	--	--	51		--	55.8		--	66.7		--	62.1		--	62.5		--	--		--	62.7		--
Clay (%)	--	--	--	--	--	11.1		--	13.5		--	13		--	11.6		--	11.4		--	--		--	12.5		--
Black Carbon (%)	--	--	--	--	--	0.78		--	1.06		--	0.99		--	0.83		--	1.14		--	0.89		--	1.02		--
Metals	mg/kg dw					mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw			mg/kg dw		
Mercury	0.41	1.5	2.3	0.41	0.59	0.09		0.09	0.15		0.15	0.12		0.12	0.13		0.13	0.11		0.11	0.13		0.13	0.15		0.15
PAHs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Naphthalene	2,100	--	2,400	99	170	7.5		0.31	16		0.65	13		0.47	19		0.88	12		0.55	--		--	13		0.82
2-Methylnaphthalene	670	--	1,900	38	64	4.6	U	0.19	7.5		0.30	4.7	U	0.17	2.8	J	0.13	2.6	J	0.12	--		--	7.9		0.50
Acenaphthene	500	--	2,000	16	57	5.7		0.23	18		0.73	8.2		0.30	15		0.69	7.4		0.34	--		--	14		0.88
Fluorene	540	--	3,600	23	79	5		0.21	13		0.53	8.8		0.32	15		0.69	6.5		0.30	--		--	13		0.82
Phenanthrene	1,500	--	21,000	100	480	36		1.48	89		3.60	64		2.34	140		6.48	64		2.91	--		--	110		6.92
Anthracene	960	--	13,000	220	1200	8.8		0.36	25		1.01	12		0.44	32		1.48	14		0.64	--		--	28		1.76
Total LPAH(1)	5,200	--	29,000	370	780	66.2		2.72	164.8		6.67	113.5		4.14	226.6		10.49	108.1		4.91	--		--	183.7		11.55
Fluoranthene	1,700	4,600	30,000	160	1,200	93		3.83	180		7.29	160		5.84	280		12.96	150		6.82	--		--	270		16.98
Pyrene	2,600	11,980	16,000	1,000	1,400	100	J	4.12	240	J	9.72	190	J	6.93	360	J	16.67	170	J	7.73	--		--	330	J	20.75
Benzo(a)anthracene	1,300	--	5,100	110	270	34		1.40	70		2.83	60		2.19	120		5.56	55		2.50	--		--	100		6.29
Chrysene	1,400	--	21,000	110	460	48		1.98	89		3.60	83		3.03	150		6.94	76		3.45	--		--	130		8.18
Total HPAH	12,000	--	69,000	960	5,300	479.1		19.72	975		39.47	873		31.86	1,456		67.41	765		34.77	--		--	1,443		90.75
Chlorinated Hydrocarbons	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	0.78	19	U	0.77	19	U	0.69	19	U	0.88	20	U	0.91	--		--	19	U	1.19
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	0.78	19	U	0.77	19	U	0.69	19	U	0.88	20	U	0.91	--		--	19	U	1.19
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	0.78	19	U	0.77	19	U	0.69	19	U	**0.88**	20	U	**0.91**	--		--	19	U	**1.19**
Phenols	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	19	UJ	19	19	UJ	19	19	UJ	19	20	UJ	20	--		--	19	UJ	19
Pentachlorophenol	400	504	690	400	690	190	UJ	190	190	UJ	190	190	UJ	190	190	UJ	190	200	UJ	200	--		--	190	UJ	190
Miscellaneous Extractables	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Benzyl Alcohol	57	--	870	57	73	**170**		**170**	**88**		**88**	**130**		**130**	**100**		**100**	**160**		**160**	--		--	**200**		**200**
Benzoic Acid	650	--	760	650	650	200	J	200	170	J	170	180	J	180	200	J	200	180	J	180	--		--	270	J	270
Miscellaneous Extractables	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Dibenzofuran	540	--	1,700	15	58	6.6		0.27	13		0.53	9.1		0.33	13		0.60	10		0.45	--		--	13		0.82
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	0.78	19	U	0.77	19	U	0.69	19	U	0.88	20	U	0.91	--		--	19	U	1.19
Pesticides	µg/kg dw					µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw			µg/kg dw		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.50	1.2	UJ	2.50	1.2	UJ	2.40	1.2	UJ	2.40	1.2	UJ	2.40	--		--	1.2	UJ	2.40
Dieldrin	1.9	--	--	--	--	**2.5**	UJ	--	**2.5**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	**2.4**	UJ	--	--		--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.9	U	--	4.9	U	--	4.8	U	--	4.8	U	--	4.9	U	--	--		--	4.8	U	--
4,4'-DDT	12	--	--	--	--	4.9	UJ	--	11	UJ	--	5.2	UJ	--	8.9	UJ	--	4.9	UJ	--	--		--	8.7	UJ	--
Sum of DDTs	--	50	69	--	69	4.9	UJ	4.9	11	UJ	11	5.2	UJ	5.2	8.9	UJ	8.9	4.9	UJ	4.9	--		--	8.7	UJ	8.7
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4.1**	UJ	--	**4.1**	UJ	--	**4**	UJ	--	**4**	UJ	--	**4**	UJ	--	--		--	**3.9**	UJ	--
PCBs	µg/kg dw			mg/kg OC		µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC	µg/kg dw		mg/kg OC
Total PCBs	130	38(2)	3,100	12	65	98		4.03	**265**		10.73	**170**		6.20	**218**		10.09	**146**		6.64	**139**		--	**273**		**17.17**
TBT in Porewater	(µg/L)					(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)			(µg/L)		
Total TBT in Porewater	0.15	0.15	--	--	--	0.013		--	0.013		--	0.016		--	0.02		--	0.011		--	--		--	0.006		--

Notes:

1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level	**>SL**
BT = Bioaccumulation Trigger	**>BT**
ML = Maximum Level	**>ML**
SQS = Sediment Quality Standard	**> SQS**
CSL = Cleanup Screening Level	**>CSL**

U Indicates that the target analyte was not detected at the reported concentration

UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.

J Estimated concentration when the value is less than ARI's established reporting limits

R - The reported result was rejected.

Table 3-4. LDW South: Analytical Results for Select COCs compared to DMMP Guidelines and Sediment Management Standards

	DMMP Guideline Values			Sediment Management Standards		LDW18 0-2.8C -12.2 to -15.0 ft MLLW			LDW18 Z -15.0 to -17.0 ft MLLW		
	SL	BT	ML	SQS	CSL	Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS
Conventionals											
Total Solids (%)	--	--	--	--	--	51.1		--	56		--
Total Volatile Solids (%)	--	--	--	--	--	7.72		--	6.51		--
N-Ammonia (mg/kg dw)	--	--	--	--	--	72.8		--	110		--
Sulfide (mg/kg dw)	--	--	--	--	--	2,700		--	2,570		--
Total Organic Carbon (%)	--	--	--	--	--	2.83		--	3.08		--
Gravel (%)	--	--	--	--	--			--			--
Sand (%)	--	--	--	--	--	28.1		--	34.8		--
Silt (%)	--	--	--	--	--	59.8		--	54		--
Clay (%)	--	--	--	--	--	11.7		--	11.2		--
Black Carbon (%)	--	--	--	--	--	0.95		--	0.83		--
Metals	**mg/kg dw**					**mg/kg dw**			**mg/kg dw**		
Mercury	0.41	1.5	2.3	0.41	0.59	0.11		0.11	0.12		0.12
PAHs	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Naphthalene	2,100	--	2,400	99	170	13		0.46	9.5		0.31
2-Methylnaphthalene	670	--	1,900	38	64	14		0.49	4.8	U	0.16
Acenaphthene	500	--	2,000	16	57	18		0.64	8.9		0.29
Fluorene	540	--	3,600	23	79	10		0.35	9.1		0.30
Phenanthrene	1,500	--	21,000	100	480	97		3.43	68		2.21
Anthracene	960	--	13,000	220	1200	17		0.60	17		0.55
Total LPAH[(1)]	5,200	--	29,000	370	780	161.7		5.71	116.2		3.77
Fluoranthene	1,700	4,600	30,000	160	1,200	170		6.01	170		5.52
Pyrene	2,600	11,980	16,000	1,000	1,400	170	J	6.01	180	J	5.84
Benzo(a)anthracene	1,300	--	5,100	110	270	58		2.05	59		1.92
Chrysene	1,400	--	21,000	110	460	83		2.93	78		2.53
Total HPAH	12,000	--	69,000	960	5,300	803		28.37	826		26.82
Chlorinated Hydrocarbons	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
1,2-Dichlorobenzene	35	--	110	2.3	2.3	19	U	0.67	20	U	0.65
1,4-Dichlorobenzene	110	--	120	3.1	9	19	U	0.67	20	U	0.65
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8	19	U	0.67	20	U	0.65
Phenols	**µg/kg dw**					**µg/kg dw**			**µg/kg dw**		
2,4-Dimethylphenol	29	--	210	29	210	19	UJ	19	20	UJ	20
Pentachlorophenol	400	504	690	400	690	190	UJ	190	200	UJ	200
Miscellaneous Extractables	**µg/kg dw**					**µg/kg dw**			**µg/kg dw**		
Benzyl Alcohol	57	--	870	57	73	**290**		**290**	**84**		**84**
Benzoic Acid	650	--	760	650	650	370	J	370	150	J	150
Miscellaneous Extractables	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Dibenzofuran	540	--	1,700	15	58	22		0.78	8.2		0.27
N-Nitrosodiphenylamine	28	--	130	11	11	19	U	0.67	20	U	0.65
Pesticides	**µg/kg dw**					**µg/kg dw**			**µg/kg dw**		
Heptachlor	1.5	--	--	--	--	1.2	UJ	2.40	1.2	UJ	2.40
Dieldrin	1.9	--	--	--	--	**2.4**	UJ	--	**2.4**	UJ	--
4,4'-DDE	16	--	--	--	--	4.8	U	--	4.8	U	--
4,4'-DDT	12	--	--	--	--	4.8	UJ	--	4.8	UJ	--
Sum of DDTs	--	50	69	--	69	4.8	UJ	4.8	4.8	UJ	4.8
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonchlor, oxychlordane)	2.8	37	--	--	--	**4**	UJ	--	**3.9**	UJ	--
PCBs	**µg/kg dw**			**mg/kg OC**		**µg/kg dw**		**mg/kg OC**	**µg/kg dw**		**mg/kg OC**
Total PCBs	130	38[(2)]	3,100	12	65	90		3.18	117		3.80
TBT in Porewater	**(µg/L)**					**(µg/L)**			**(µg/L)**		
Total TBT in Porewater	0.15	0.15	--	--	--	0.011		--	0.015		--

Notes:

1. 2-methylnaphthalene is not included in the summation for total LPAH.
2. This value is normalized to total organic carbon and is expressed as mg/kg carbon

SL = Screening Level
BT = Bioaccumulation Trigger
ML = Maximum Level
SQS = Sediment Quality Standard
CSL = Cleanup Screening Level

>SL
>BT
>ML
> SQS
>CSL

U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value.
J Estimated concentration when the value is less than ARI's established reporting limits
R - The reported result was rejected.

Table 3-5. Summary of Dioxin TEQs Compared to DMMP

DMMU	2,3,7,8-TCDD (ng/kg)	Q	Total Dioxin TEQ	
			TEQ (U = 0)	TEQ (U=1/2 DL)
LDW North				
LDW01 0-3.4C	0.21	U	**5.75**	**5.89**
LDW01 Z	0.24	U	**11.18**	**11.34**
LDW02 0-3.9C	0.44	U	1.25	1.62
LDW02 Z	0.14	U	0.01	0.17
LDW03 0-4.4C	1.83		**33.91**	**34.16**
LDW03 Z	2.07		**167.73**	**167.73**
LDW04 0-2.1C	1.78		**41.01**	**41.01**
LDW04 Z	0.59	U	**13.25**	**13.54**
LDW05 0-2C	1.84		**77.97**	**77.97**
LDW Central				
LDW06 0-4.9C	0.51	U	**10.11**	**10.43**
LDW06 Z	0.79	U	**12.66**	**13.05**
LDW07 0-2 C1	0.52	U	**5.91**	**6.17**
LDW07 2-4 C2	0.52	U	**6.26**	**6.57**
LDW07 4-8 C3	0.92		**14.12**	**14.12**
LDW07 Z	1.68	U	**21.77**	**22.61**
LDW08 0-4 C1	0.58	U	**8.63**	**8.92**
LDW08 4-9.8 C2	1.20		**19.93**	**20.10**
LDW08 Z	1.95	U	**67.06**	**68.04**
LDW09 0-2.1C	0.51	U	**6.55**	**6.95**
LDW09 Z	0.64	U	**7.80**	**8.12**
LDW10 0-2 C1	0.37	U	**4.72**	**4.96**
LDW10 2-5.5 C2	0.79		**11.75**	**11.75**
LDW10 Z	1.63	U	**14.37**	**15.26**
LDW11 0-4.2 C	0.40	U	**5.33**	**5.58**
LDW11 Z	0.53	U	**5.54**	**5.84**
LDW12 0-2.6 C	0.51	U	**5.10**	**5.42**
LDW12 Z	1.21	U	**14.42**	**15.03**
LDW South				
LDW13 0-2 C1	0.38	U	1.56	2.28
LDW13 2-7.2 C2	0.61	U	**4.36**	**4.76**
LDW13 Z	1.14		**8.40**	**8.40**
LDW14 0-2 C1	0.28	U	1.12	1.38
LDW14 2-4 C2	0.44	U	3.33	3.67
LDW14 4-6.8 C3	1.85	U	**8.99**	**10.09**
LDW14 Z	2.61		**16.54**	**16.54**
LDW15 0-2.3C	0.42	U	2.50	3.27
LDW15 Z	1.47		**10.89**	**10.90**
LDW16 0-2.5C	0.58	U	**5.48**	**5.88**
LDW16 Z	0.71	U	**6.58**	**7.06**
LDW17 0-3.5 C	0.40	U	3.82	**4.05**
LDW17 Z	0.64	U	**6.93**	**7.30**
LDW18 0-2.8 C	0.39	U	**4.07**	**4.41**
LDW18 Z	0.41	U	3.58	3.94
West Waterway				
WW01 0-4 C1	0.32	U	**5.11**	**5.42**
WW01 4-8 C2	0.20	U	0.07	0.27
WW02 0-4 C1	0.48	U	**10.38**	**10.69**
WW02 4-8 C2	0.40	U	0.04	0.35
WW03 0-4C1	0.17	U	0.01	0.25
WW03 4-8 C2	0.29	U	0.02	0.32
WW04 0-4 C1	0.33	U	0.63	0.94
WW04 4-8 C2	0.31	U	0.01	0.30
East Waterway				
EW01 0-4 C1	0.23	U	1.53	2.05
EW01 4-8 C2	0.32	U	0.22	0.47
EW01 8-12 C3	0.43	U	0.39	0.82

For the Elliott Bay Non-Dispersive Site Total TEQs exceeding 4 ng/kg
For the Elliott Bay Non-Dispersive Site Total TEQs exceeding 10 ng/kg

Table 3-6. Comparison of Results to the Lower Duwamish Superfund Site Proposal Remedial Action Levels and Preliminary Remediation Goals

Arsenic		
Lowest Arsenic PRG >		7.0
Arsenic RAL >		57.0
DMMU	Arsenic µg/kg dry weight	Q
LDW 03 - 05		
LDW03 0-4.4C	20.0	
LDW03 Z	22.0	
LDW04 0-2.1C	25.0	
LDW04 Z	14.0	
LDW05 0-2C	15.0	
LDW 06 - 10		
LDW06 0-4.9C	14.0	
LDW06 Z	13.0	
LDW07 0-2 C1	10.0	
LDW07 2-4 C2	11.0	
LDW07 4-8 C3	13.0	
LDW07 Z	14.0	
LDW08 0-4 C1	11.0	
LDW08 4-9.8 C2	12.0	
LDW08 Z	16.0	
LDW09 0-2.1C	12.0	
LDW09 Z	12.0	
LDW10 0-2 C1	12.0	
LDW10 2-5.5 C2	15.0	
LDW10 Z	17.0	
LDW11 0-4.2 C	12.0	
LDW11 Z	11.0	
LDW12 0-2.6 C	10.0	
LDW12 Z	11.0	
LDW 13 - 18		
LDW13 0-2 C1	9.0	
LDW13 2-7.2 C2	10.0	
LDW13 Z	9.0	
LDW14 0-2 C1	8.0	U
LDW14 2-4 C2	10.0	
LDW14 4-6.8 C3	10.0	
LDW14 Z	11.0	
LDW15 0-2.3C	9.0	
LDW15 Z	10.0	
LDW16 0-2.5C	10.0	
LDW16 Z	12.0	
LDW17 0-3.5 C	9.0	
LDW17 Z	11.0	
LDW18 0-2.8 C	10.0	
LDW18 Z	10.0	

cPAH TEQs		
Lowest PAH TEQ PRG =		380.0
PAH TEQ RAL =		1000.0
DMMU	cPAH TEQ TEQ (U = 0)	TEQ (U=1/2 DL)
LDW 03 - 05		
LDW03 0-4.4C	316.4	316.4
LDW03 Z	1870.0	1870.0
LDW04 0-2.1C	431.6	431.6
LDW04 Z	273.8	273.8
LDW05 0-2C	604.3	604.3
LDW 06 - 10		
LDW06 0-4.9C	192.2	192.2
LDW06 Z	145.5	145.5
LDW07 0-2 C1	69.3	69.3
LDW07 2-4 C2	121.5	121.5
LDW07 4-8 C3	162.3	162.3
LDW07 Z	50.3	50.3
LDW08 0-4 C1	147.6	147.6
LDW08 4-9.8 C2	149.1	149.1
LDW08 Z	71.3	71.3
LDW09 0-2.1C	108.3	108.3
LDW09 Z	94.7	94.7
LDW10 0-2 C1	134.3	134.3
LDW10 2-5.5 C2	223.4	223.4
LDW10 Z	145.5	145.5
LDW11 0-4.2 C	131.7	131.7
LDW11 Z	123.6	123.6
LDW12 0-2.6 C	87.5	87.5
LDW12 Z	100.8	100.8
LDW 13 - 18		
LDW13 0-2 C1	70.7	70.7
LDW13 2-7.2 C2	81.4	81.4
LDW13 Z	161.9	161.9
LDW14 0-2 C1	34.6	34.6
LDW14 2-4 C2	58.2	58.2
LDW14 4-6.8 C3	95.5	95.5
LDW14 Z	63.6	63.6
LDW15 0-2.3C	55.8	55.8
LDW15 Z	111.7	111.7
LDW16 0-2.5C	107.2	107.2
LDW16 Z	162.5	162.5
LDW17 0-3.5 C	88.3	88.3
LDW17 Z	174.3	174.3
LDW18 0-2.8 C	88.4	88.4
LDW18 Z	98.6	98.6

Total PCBs dry weight and OC Normalized			
Lowest PCB PRG >		dw	2.0
Dry Weight PCB RAL >		dw	240.0
OC Norm PCB RAL >		OC	12.0
DMMU	PCBs µg/kg dry weight	Q	mg/kg OC
LDW 03 - 05			
LDW03 0-4.4C	1,110.0		43.7
LDW03 Z	3,800.0		227.5
LDW04 0-2.1C	1,800.0		80.4
LDW04 Z	460.0		18.9
LDW05 0-2C	3,110.0		157.1
LDW 06 - 10			
LDW06 0-4.9C	362.0		11.8
LDW06 Z	342.0		22.1
LDW07 0-2 C1	239.0		8.0
LDW07 2-4 C2	254.0		11.6
LDW07 4-8 C3	366.0		15.8
LDW07 Z	1,250.0		47.0
LDW08 0-4 C1	330.0		11.1
LDW08 4-9.8 C2	470.0		21.9
LDW08 Z	1,560.0		62.2
LDW09 0-2.1C	365.0		13.9
LDW09 Z	326.0		19.3
LDW10 0-2 C1	236.0		13.1
LDW10 2-5.5 C2	418.0		26.0
LDW10 Z	351.0		15.2
LDW11 0-4.2 C	283.0		10.5
LDW11 Z	271.0		13.3
LDW12 0-2.6 C	248.0		11.6
LDW12 Z	1,130.0		67.7
LDW 13 - 18			
LDW13 0-2 C1	85.0		4.7
LDW13 2-7.2 C2	201.0		10.0
LDW13 Z	536.0		24.9
LDW14 0-2 C1	39.3		2.4
LDW14 2-4 C2	91.0		3.7
LDW14 4-6.8 C3	275.0		10.0
LDW14 Z	460.0		26.9
LDW15 0-2.3C	98.0		4.0
LDW15 Z	265.0		10.7
LDW16 0-2.5C	170.0		6.2
LDW16 Z	218.0		10.1
LDW17 0-3.5 C	146.0		6.6
LDW17 Z	273.0		17.2
LDW18 0-2.8 C	90.0		3.2
LDW18 Z	117.0		3.8

Dioxin/Furan TEQs		
Lowest Dioxin TEQ PRG >		2.0
Dioxin TEQ RAL >		25.0
DMMU	Dioxin TEQ TEQ (U = 0)	TEQ (U=1/2 DL)
LDW 03 - 05		
LDW03 0-4.4C	33.9	34.2
LDW03 Z	167.7	167.7
LDW04 0-2.1C	41.0	41.0
LDW04 Z	13.2	13.5
LDW05 0-2C	78.0	78.0
LDW 06 - 10		
LDW06 0-4.9C	10.1	10.4
LDW06 Z	12.7	13.1
LDW07 0-2 C1	5.9	6.2
LDW07 2-4 C2	6.3	6.6
LDW07 4-8 C3	14.1	14.1
LDW07 Z	21.8	22.6
LDW08 0-4 C1	8.6	8.9
LDW08 4-9.8 C2	19.9	20.1
LDW08 Z	67.1	68.0
LDW09 0-2.1C	6.5	6.9
LDW09 Z	7.8	8.1
LDW10 0-2 C1	4.7	5.0
LDW10 2-5.5 C2	11.7	11.7
LDW10 Z	14.4	15.3
LDW11 0-4.2 C	5.3	5.6
LDW11 Z	5.5	5.8
LDW12 0-2.6 C	5.1	5.4
LDW12 Z	14.4	15.0
LDW 13 - 18		
LDW13 0-2 C1	1.6	2.3
LDW13 2-7.2 C2	4.4	4.8
LDW13 Z	8.4	8.4
LDW14 0-2 C1	1.1	1.4
LDW14 2-4 C2	3.3	3.7
LDW14 4-6.8 C3	9.0	10.1
LDW14 Z	16.5	16.5
LDW15 0-2.3C	2.5	3.3
LDW15 Z	10.9	10.9
LDW16 0-2.5C	5.5	5.9
LDW16 Z	6.6	7.1
LDW17 0-3.5 C	3.8	4.0
LDW17 Z	6.9	7.3
LDW18 0-2.8 C	4.1	4.4
LDW18 Z	3.6	3.9

Table 3-7. Summary of CAD Analytical Results

Conventionals	Sediment Management Standards SQS	Sediment Management Standards CSL	LDW CAD01 Surface Grab	CAD01+45C 45 cm CAD/Cap Interface	CAD01+30C 30 cm CAD/Cap Interface	CAD01+15C 15 cm CAD/Cap Interface	CAD01-15C -15 cm CAD/Cap Interface	CAD02+45C 45 cm CAD/Cap Interface	CAD02+30C 30 cm CAD/Cap Interface	CAD02+15C 15 cm CAD/Cap Interface	CAD02-15C -15 cm CAD/Cap Interface	CAD03+45C 45 cm CAD/Cap Interface	CAD03+30C 30 cm CAD/Cap Interface	CAD03+15C 15 cm CAD/Cap Interface	CAD03-15C -15 cm CAD/Cap Interface
Total Solids (%)	--	--	60.2	77.5	71.5	74.6	62.3	79.5	71.5	73.7	58.2	53	63.5	76.8	56.9
Total Volatile Solids (%)	--	--	3.94	--	--	--	--	--	--	--	--	--	--	--	--
N-Ammonia (mg/kg dw)	--	--	10	--	--	--	--	--	--	--	--	--	--	--	--
Sulfide (mg/kg dw)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (mg/kg)	--	--	1.31	0.679	3.17	3.7	2.12	1.13	1.94	5.77	2.71	2.5	2.72	0.915	2.39
Gravel (%)	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
Sand (%)	--	--	61.4	--	--	--	--	--	--	--	--	--	--	--	--
Silt (%)	--	--	25.9	--	--	--	--	--	--	--	--	--	--	--	--
Clay (%)	--	--	12.5	--	--	--	--	--	--	--	--	--	--	--	--
Black Carbon (%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals	**mg/kg dw**		**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**	**mg/kg dw**
Antimony	--	--	8 UJ	6 UJ	6 UJ	7 UJ	8 UJ	6 UJ	7 UJ	6 UJ	8 UJ	9 UJ	8 UJ	6 UJ	15 J
Arsenic	57	93	8 U	6 U	6 U	8	39	6 U	7 U	6 U	18	19	13	6 U	**77**
Cadmium	5.1	6.7	0.3	0.3 U	0.3	1.2	1.4	0.3 U	0.8	0.3	3.4	0.6	0.5	0.2 U	1.6
Chromium	260	270	21.6	15.1	16.8	39.4	45.5	13.7	27.2	14.8	89.2	41.4	30.4	12.8	81
Copper	390	390	54.1	19.6	17	32.5	153	14.4	27.3	17.3	90.4	284	119	14.5	231
Lead	450	530	30 J	11	9	29	165	6	21	7	98	84	152	11	253
Mercury	0.41	0.59	0.22	0.02 U	0.05	**0.47**	**0.57**	0.02 U	0.17	0.06	**0.85**	**0.46**	0.35	0.02	**1.12**
Selenium	--	--	0.8 U	0.6 U	0.6 U	0.7 U	0.8 U	0.6 U	0.7 U	0.6 U	0.8 U	0.9 U	0.8 U	0.6 U	0.9 U
Silver	6.1	6.1	0.5 U	0.4 U	0.4 U	2.4	1.2	0.4 U	0.6	0.4 U	4.8	0.5 U	0.5 U	0.4 U	1.8
Zinc	410	960	84	56	59	108	297	53	80	54	205	217	144	54	**816**
PCBs	**mg/kg OC**		**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**	**mg/kg OC**
Aroclor 1016	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Aroclor 1221	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Aroclor 1232	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Aroclor 1242	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Aroclor 1248	--	--	78	16	15	180	350	12	150	28	1,100	240	110	9.1 J	1,100
Aroclor 1254	--	--	120	12	14	250	500	14	170	28	1,500	330	180	7.2 J	1,400
Aroclor 1260	--	--	55	7.8 J	8.7 J	220	250	9.5 J	100	15	940	240	130	8.6 U	620
Aroclor 1262	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Aroclor 1268	--	--	9.4 U	7.7 U	8.7 U	46 U	41 U	8.2 U	41 U	8.9 U	45 U	87 U	46 U	8.6 U	90 U
Total PCBs[1]	12	65	**19.31**	5.27	1.19	**17.57**	**51.89**	3.14	**21.65**	1.23	**130.63**	**32.40**	**15.44**	1.78	**130.54**

Notes:
1. This value is normalized to total organic carbon and is expressed as mg/kg carbor
SQS = Sediment Quality Standard
CSL = Cleanup Screening Level
U Indicates that the target analyte was not detected at the reported concentration
UJ - The analyte was analyzed for, and the associated quantitation limit was an estimated value
J Estimated concentration when the value is less than ARI's established reporting limit
R - The reported result was rejected.

> SQS
> CSL

Table 3-8. Total PCBs from Aroclor, Congener, and Homolog Analyses (ng/kg)

Sample_ID	EPA 1668	EPA 680		Sum PCBs Aroclors	Total Sulfides (mg/kg)
	Sum Congeners U=1/2 RL	Sum Homologs 04/2013 Data	Sum Homologs 03/2013 Data		
WW01 4-8C2	1,077	22,920	25,400	16,000	268.0
LDW02 0-3.9C	12,718	22,870	35,700	34,700	12.9
EW01 0-4C1	26,454	37,640	41,800	55,000	60.5
LDW16 0-2.5C	90,869	101,650	39,400	170,000	2,750.0
LDW10 0-2C1	128,425	141,070	69,000	236,000	787.0
LDW09 0-2.1C	188,806	144,450	40,420	365,000	2,860.0
LDW13 Z	391,291	380,300	57,920	536,000	1,710.0
LDW07 Z	619,312	595,900	185,640	1,250,000	2,360.0
LDW05 0-2C	1,741,037	1,544,900	1,408,500	3,110,000	606.0

Notes:

Congeners by EPA Method 1668

Homologs by EPA Method 680

Aroclors by EPA Method 8082

Red font indicates samples high in total sulfides.

Table 3-9. Total PCBs Concentrations from Aroclor, Congener, and Homolog Analyses (ng/kg)

Sample_ID	EPA 1668		EPA 680	Sum PCBs Aroclors
	Sum Congeners U=1/2 RL	Lab-Reported Sum Homologs Validated Value	Sum Homologs 04/2013 Data	
WW01 4-8C2	1,077	130	22,920	16,000
LDW02 0-3.9	12,718	12,100	22,870	34,700
EW01 0-4C1	26,454	27,200	37,640	55,000
LDW16 0-2.5C	90,869	90,800	101,650	170,000
LDW10 0-2C1	128,425	127,000	141,070	236,000
LDW09 0-2.1C	188,806	195,000	144,450	365,000
LDW13 Z	391,291	392,000	380,300	536,000
LDW07 Z	619,312	620,000	595,900	1,250,000
LDW05 0-2C	1,741,037	1,740,000	1,544,900	3,110,000

Notes:

Congeners by EPA Method 1668

Homologs by EPA Method 680

Aroclors by EPA Method 8082

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
EW01 0-4C1							
EW01 4-8C2							
EW01 8-12C3							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
WW01 0-4C1							
WW01 4-8C2							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
WW03 0-4C1							
WW03 4-8C2							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
WW02 0-4C1							
WW02 4-8C2							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
WW04 0-4C1							
WW04 4-8C2							

Path: D:\GISDATA\Projects\wash\USACE\Duwamish\Map_Docs\Working\COCEExc_EWandWW.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

Legend

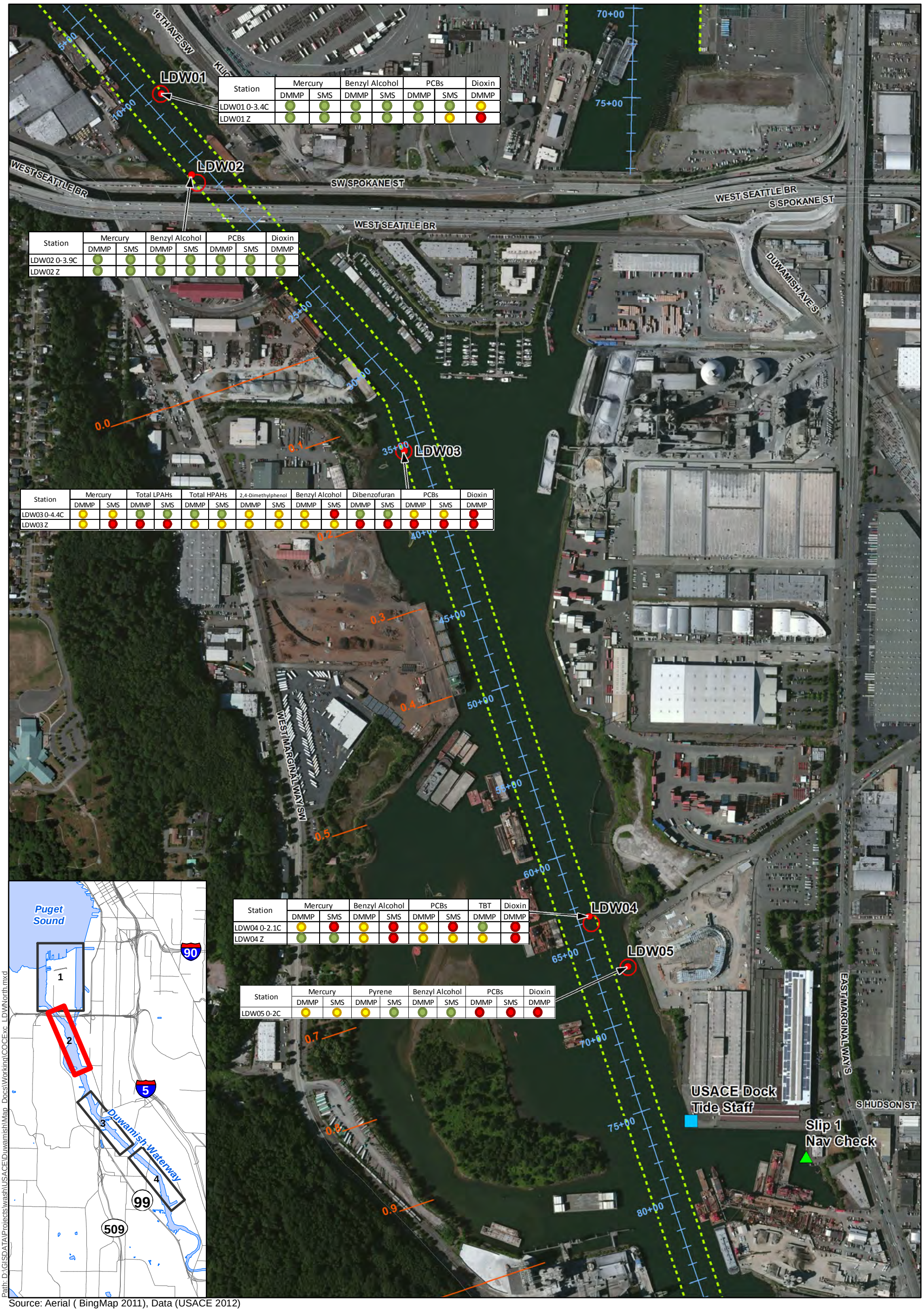
- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

	DMMP	SMS	Dioxin
	< SL	<SQS	<4 ng/kg
	>SL, <ML	>SQS, <CSL	>4 ng/kg, <10 ng/kg
	>ML	>CSL	>10 ng/kg

0 250 500 1,000 Feet

Figure 3-1
Detected COC Exceedances

East and West Waterways



Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW01 0-3.4C							
LDW01 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW02 0-3.9C							
LDW02 Z							

Station	Mercury		Total LPAHs		Total HPAHs		2,4-Dimethylphenol		Benzyl Alcohol		Dibenzofuran		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW03 0-4.4C															
LDW03 Z															

Station	Mercury		Benzyl Alcohol		PCBs		TBT	Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	DMMP
LDW04 0-2.1C								
LDW04 Z								

Station	Mercury		Pyrene		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW05 0-2C									

Path: D:\GISDATA\Projects\wash\USACE\Duwamish\Map_Docs\Working\COCExc_LDWNorth.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

0 250 500 1,000 Feet

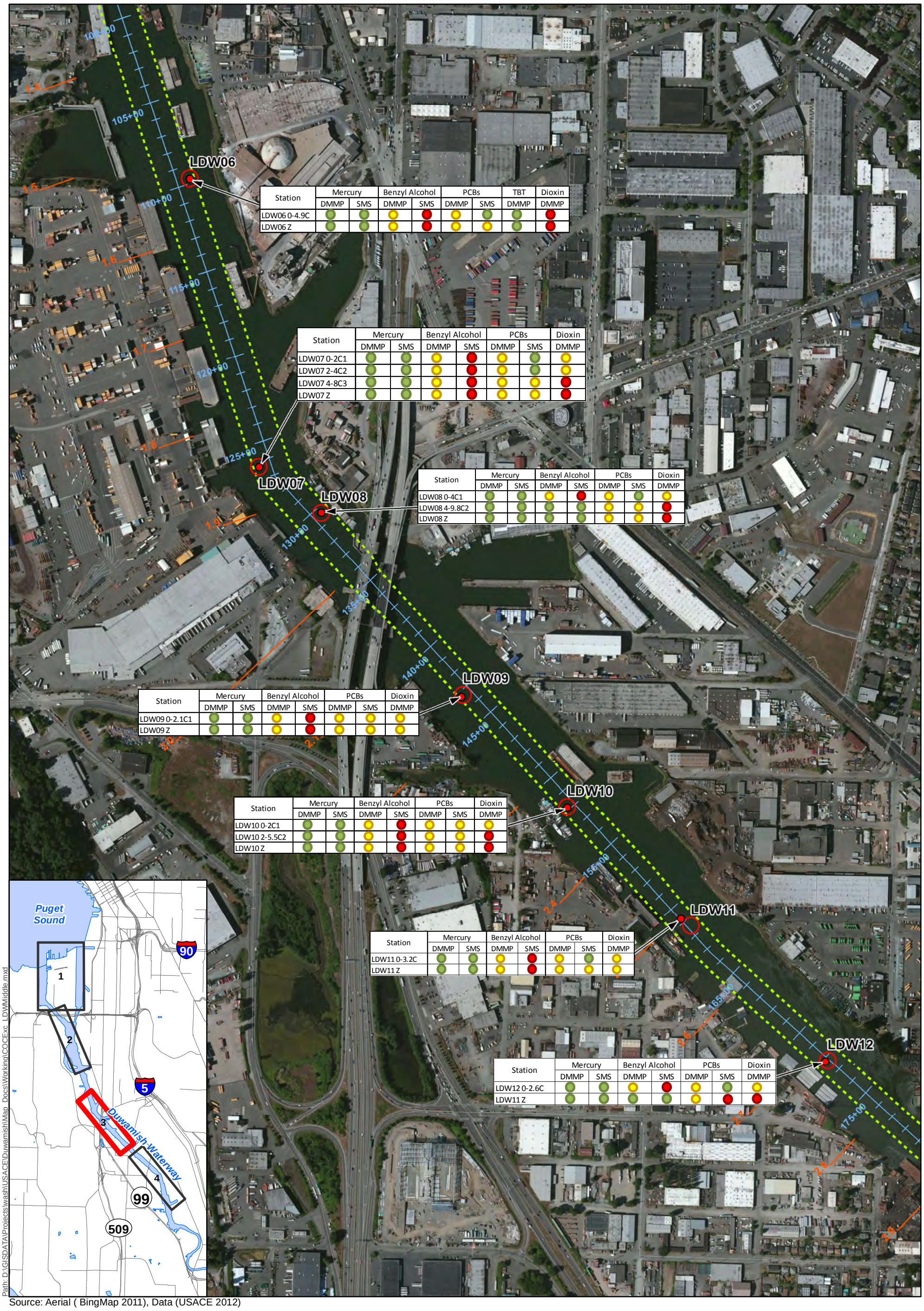
Legend

- Average Actual Sample
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

	DMMP	SMS	Dioxin
	<SL	<SQS	<4 ng/kg
	>SL, <ML	>SQS, <CSL	>4 ng/kg, <10 ng/kg
	>ML	>CSL	>10 ng/kg

Figure 3-2
Detected COC Exceedances

Lower Duwamish Waterway North



Station	Mercury		Benzyl Alcohol		PCBs		TBT	Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP	DMMP
LDW06 0-4.9C								
LDW06 Z								

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW07 0-2C1							
LDW07 2-4C2							
LDW07 4-8C3							
LDW07 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW08 0-4C1							
LDW08 4-9.8C2							
LDW08 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW09 0-2.1C1							
LDW09 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW10 0-2C1							
LDW10 2-5.5C2							
LDW10 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW11 0-3.2C							
LDW11 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW12 0-2.6C							
LDW11 Z							

Path: D:\GISDATA\Projects\wash\USACE\Duwamish\Map_Docs\Working\COCExc_LDWMiddle.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

	DMMP	SMS	Dioxin
	< SL	<SQS	<4 ng/kg
	>SL, <ML	>SQS, <CSL	>4 ng/kg, <10 ng/kg
	>ML	>CSL	>10 ng/kg

0 250 500 1,000 Feet

Figure 3-3
Detected COC Exceedances

Lower Duwamish Waterway Central

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW13 0-2C1							
LDW13 2-7.2C2							
LDW13 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW14 0-2C1							
LDW14 2-4C2							
LDW14 4-6.8C3							
LDW14 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW15 0-2.3C							
LDW15 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW16 0-2.5C							
LDW16 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW17 0-3.5C							
LDW17 Z							

Station	Mercury		Benzyl Alcohol		PCBs		Dioxin
	DMMP	SMS	DMMP	SMS	DMMP	SMS	DMMP
LDW18 0-2.8C							
LDW18 Z							

Path: D:\GISDATA\Projects\wash\USACEDuwamish\Map_Docs\Working\COCExc_LDWSouth.mxd

Source: Aerial (BingMap 2011), Data (USACE 2012)

Legend

- Average Actual Sample Location
- Actual Grab Location
- Proposed Core Location
- Navigation Channel
- 10+00 Federal Channel Station Marker
- 0.1 LDW Superfund Site River Mile Marker
- Navigation Check Station
- Tide Gauge

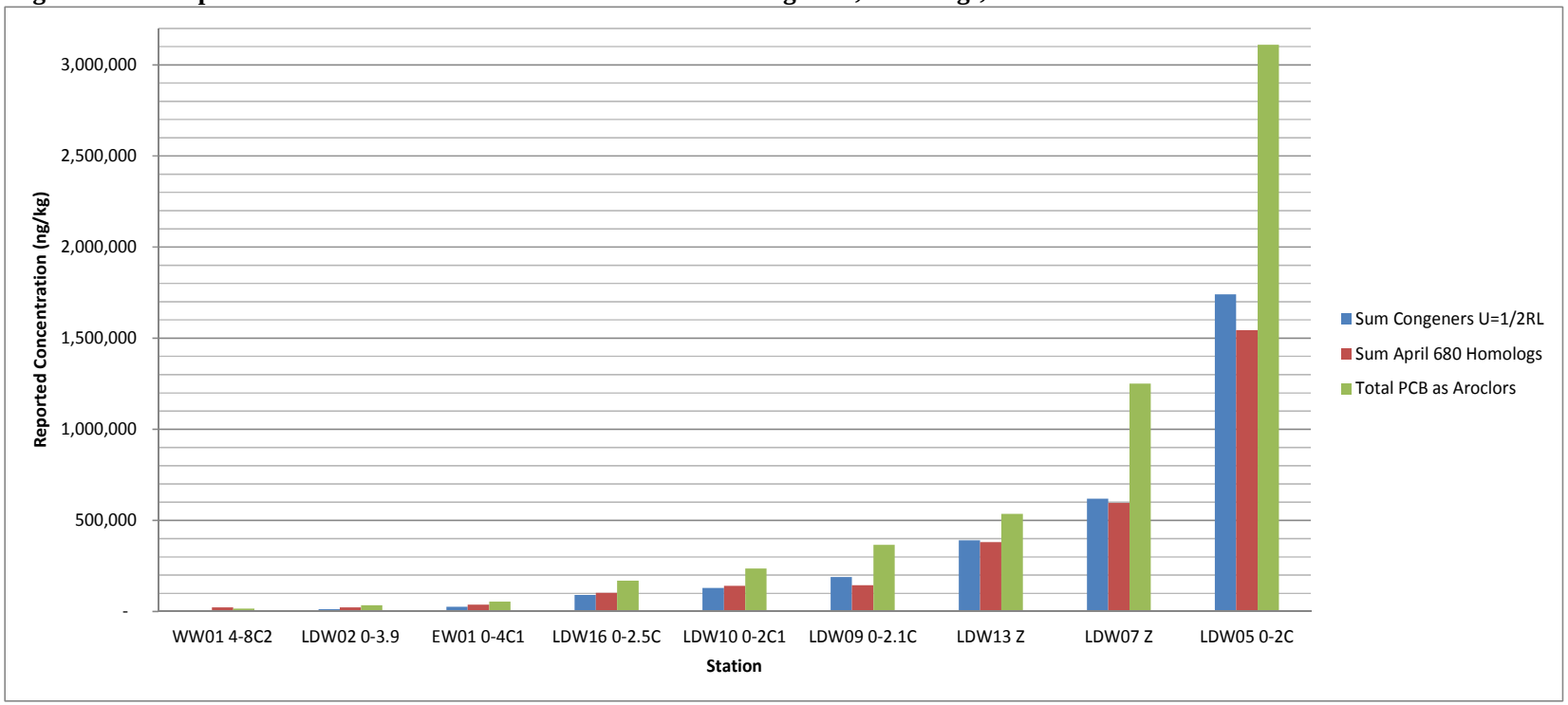
	DMMP	SMS	Dioxin
	< SL	<SQS	<4 ng/kg
	>SL, <ML	>SQS, <CSL	>4 ng/kg, <10 ng/kg
	>ML	>CSL	>10 ng/kg

0 250 500 1,000 Feet

Figure 3-4
Detected COC Exceedances

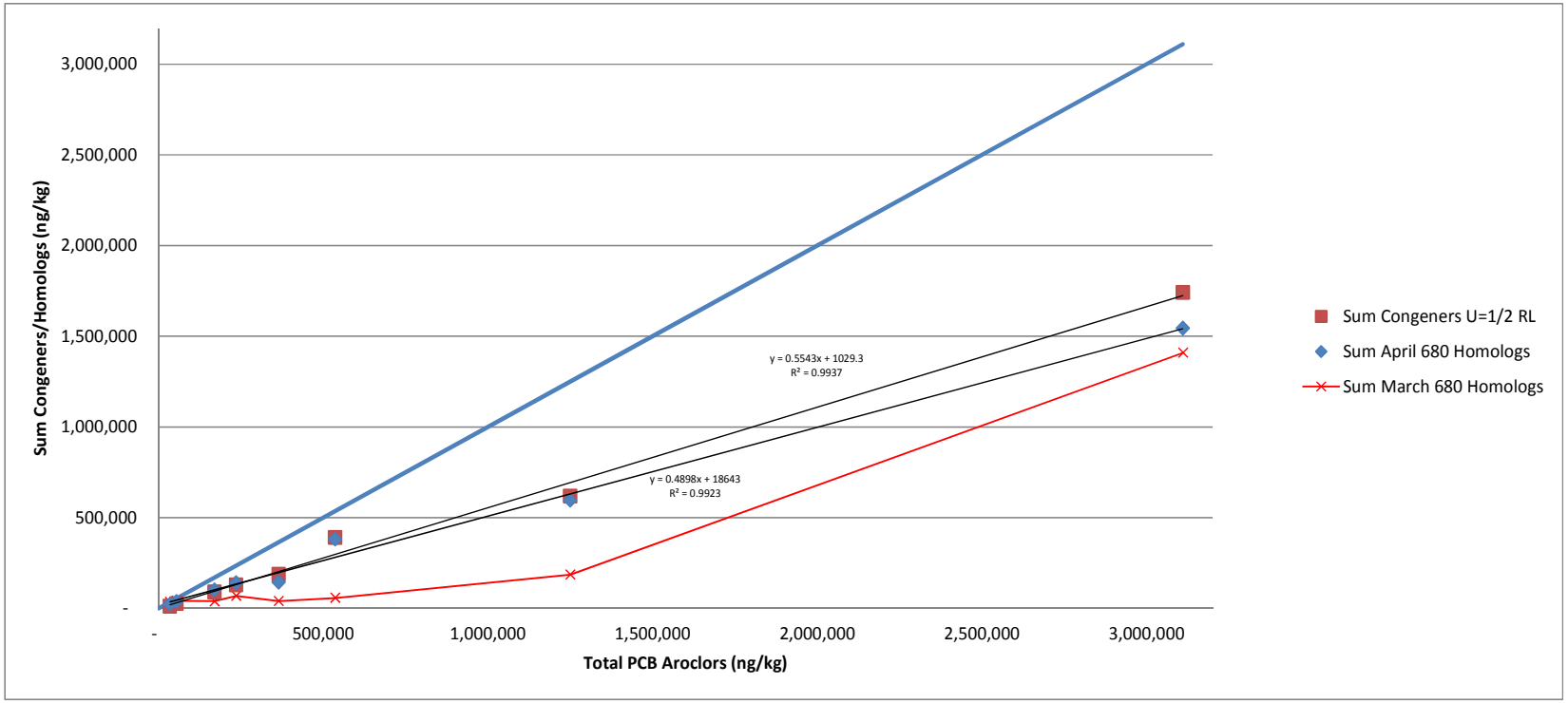
Lower Duwamish Waterway South

Figure 3-5. Comparison of Total PCB Concentrations as Sum of Congeners, Homologs, and Aroclors



Notes:
Congeners from EPA Method 1668
Homologs from EPA Method 680
Arochlors from EPA Method 8080

Figure 3-6. Regression of Total PCBs as Sum of Congeners (U=1/2RL), Homologs (April and March Data) against Sum of Aroclors



Notes:

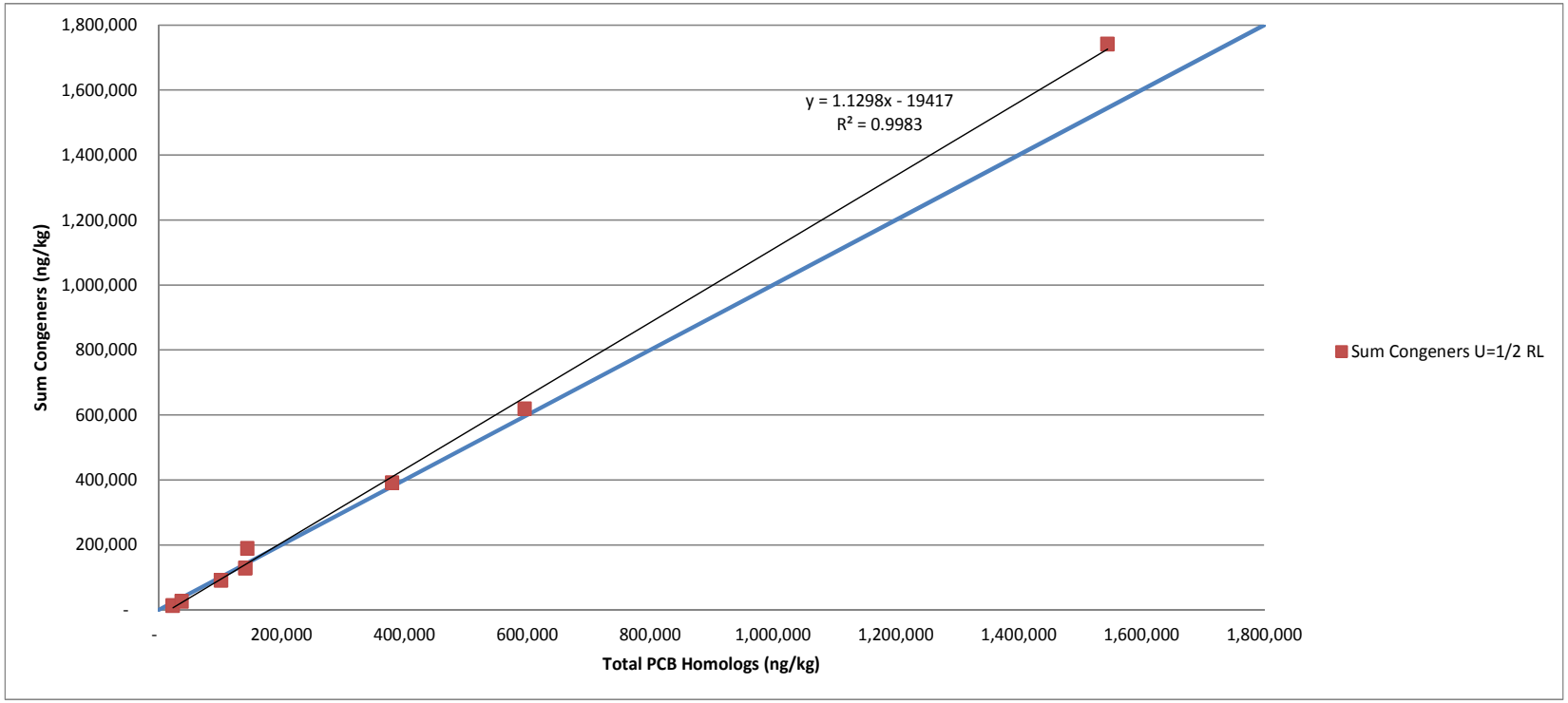
Blue line represents a 1:1 correspondance of congener/homologs with total PCB Aroclors

Congeners from EPA Method 1668

Homologs from EPA Method 680

Arochlors from EPA Method 8080

Figure 3-7. Regression of Total PCBs as Sum of Congeners (U=1/2RL) against Homologs (April Data)



Notes:

Blue line represents a 1:1 correspondance of the sum of congeners (1/2 the RL) by EPA 1668 with sum of homologs by EPA 680

Congeners from EPA Method 1668

Homologs from EPA Method 680

Arochlors from EPA Method 8080

4.0 Results of Biological Tests

This section discusses the rationale for the selection of bioassay test stations and summarizes the results of the biological testing. The standard suite of three bioassay tests (amphipod mortality, larval development, and polychaete growth) was performed. As described in the SAP, for this program the normal Puget Sound Estuary Program protocol for the 48-hour larval bioassay was followed, and for the *Neanthes* growth-test, the DMMP-modified ash-free dry weight (AFDW) protocol was used.

For each station tested, the results of the bioassays were compared to the DMMP guidelines for non-dispersive disposal sites (Table 4-1). The DMMP Users' Manual (2008) defines criteria for single-hit (major) and two-hit (minor) failures. A single-hit failure occurs when any one biological test exhibits a test sediment response that exceeds the bioassay-specific guidelines relative to the negative control and reference, and which is statistically significant in comparison to the reference. A two-hit failure occurs when any two biological tests (amphipod, juvenile infaunal growth, and/or sediment larval) exhibit test sediment responses that exceed the bioassay-specific guidelines relative to the negative control and are significant compared to the reference sediment but are less than the bioassay-specific reference comparison guidelines noted above for a single-hit failure. In the event of one hit under the single-hit rule or two hits under the two-hit rule, the Dredged Material Management Unit is judged to be unsuitable for unconfined open-water disposal.

A summary of the overall results is given in Table 4-2. Specifics of the biological station selection and individual test results are discussed below.

4.1 Selection of Bioassay Stations

Nine samples for bioassays were chosen by the DMMP agencies using a tiered framework. First, the samples had to have sufficient material archived for bioassays, which limited the choices to the samples within the LDW. Second, the dioxin TEQ values needed to be below 10 ng/kg TEQ, as that is the upper limit allowed for open-water disposal. Third, from the remaining possible samples, the DMMP agencies chose samples for bioassays based on the location and depth of the sample and the number and level of detected screening level exceedances. The targeted range of PCB concentrations was between 146 and 365 µg/kg dw and a range of benzyl alcohol concentrations between 84 and 290 µg/kg dw.

Station Carr 23 was selected as the best reference station for these bioassays based on grain size results. All selected bioassay stations and supporting chemical data are given in Table 4-2.

4.2 Results of Individual Bioassays

All biological testing was conducted by NWAS. The data reports from NWAS are given in Appendix K-1. Bioassay data validation checklists are given in Appendix K-2. Raw data and statistical analyses supporting the bioassay interpretation are given in Appendix K-3. The review found that all data are of known quality and are suitable for regulatory decision-making.

4.2.1 Amphipod Results

Results of the 10-day amphipod testing using *Eohaustorius estuarius* are presented in Table 4-3. For all test stations, mortality never exceeded the DMMP guideline of greater than 20% over the control. As such, all tested stations were considered to have passed the DMMP guideline values for open water disposal.

4.2.2 Larval Results

Results of the larval bioassay using the bivalve *Mytilus galloprovincialis* are presented in Table 4-3. For all test stations, the mean number of normal (prodissoconch stage) surviving larvae was less than 80% of that observed in the seawater control samples. The individual station results were than statistically compared to the reference sediment results using the DMMP's BioStat program (Appendix K); all stations were statistically significantly different (p=0.1) from the reference. All stations exceeded the DMMP two-hit (minor) guideline. Of these stations, three had less than 70% survival relative to the reference sediment: LDW13 2-7.2 C2, LDW16 0-2.5 C1, and LDW17 0-3.5C1. Those three stations then are deemed to have exceeded the single-hit (major) DMMP guideline and would be considered to be unsuitable for open water disposal. The remaining six stations, while being minor hits, would require a minor bioassay failure in one of the other two test organisms to be considered unsuitable for open water disposal.

4.2.3 *Neanthes* Results

Results of the 20-day juvenile polychaete growth test with the polychaete *Neanthes arenaceodentata* are presented in Table 4-3. Only the AFDW measures were taken for this test. All stations are considered to have passed the DMMP guidelines for this test. While in two stations, LDW07 0-2C1 and LDW08 0-4C1, the mean individual growth was less than 80% of that observed in the controls, and for both stations the growth was statistically significant from that observed in the reference station, the mean individual growth rate was not less than the DMMP guideline of <70% of that observed in the Carr 23 reference sediment. As a result, these two stations are also considered to have passed the DMMP guideline values.

4.3 Biological Testing Summary

Of the nine tested stations within the LDW, six stations passed the DMMP biological testing guideline values and would be considered suitable for open water disposal at the Elliot Bay non-dispersive site (Table 4-2). Three stations failed those same guideline values as a result of a major hit with the larval bioassay.

Table 4-1. Bioassay QA/QC Performance Standards and Interpretive Criteria for Non-Dispersive Disposal Sites

Bioassay	Negative Control Standard	Reference Sediment Standard	Non-Dispersive Disposal Site Interpretive Guidelines	
			1-Hit Rule	2-Hit Rule
Amphipod	Mortality ≤ 10%	≤ 20 percent absolute over the mean control sediment mortality	Mortality > 20% over control Mortality > 30% over reference Statistically different from reference sediment (p = 0.05)	Mortality >20% over control Statistically different from reference sediment (p=0.05)
Neanthes	Mortality ≤ 10% Mean individual growth/day ≥ 0.38 mg/day	Mortality ≤ 20% Mean growth rate ≥ 80 percent of the control sediment	Mean growth rate < 80% control Mean growth rate < 50% reference Statistically different from reference sediment (p = 0.05)	Mean growth rate < 80% control Mean growth rate < 70% reference Statistically different from reference sediment (p = 0.05)
Larval Development	Combined endpoint (mortality + abnormality) is ≤ 30%	Combined endpoint (mortality + abnormality) normalized to seawater control ≤ 35%	Normal larvae < 80% control Normal larvae < 70% reference Statistically different from reference sediment (p = 0.1)	Normal larvae < 80% control Statistically different from reference sediment (p = 0.1)

Table 4-2. Summary of Bioassay Results Relative to the DMMP Non-Dispersive Site Guidelines and SMS Guidelines

Station	Amphipods *Eohaustorius*	Neanthes AFDW	Larval *Mytilus*	Summary Interpretation	Dioxin TEQ (U=0)	Benzyl Alcohol			PCBs			N-Ammonia (mg-N/kg)	Sulfide (mg/kg)	Total Organic Carbon (%)
						Results vs. DMMP	Q	Results vs. SMS	Results vs. DMMP	Q	Results vs. SMS			
						µg/kg dw			µg/kg dw		mg/kg OC			
LDW07 0-2C1	Pass	Pass	X	Pass	6.43	**200**		**200**	**239**		8.05	73.7	2,990	2.97
LDW07 2-4C2	Pass	Pass	X	Pass	6.88	**84**		**84**	**254**		11.60	70.3	2,870	2.19
LDW08 0-4C1	Pass	Pass	X	Pass	9.21	**84**	J	**84**	**330**		11.07	62.3	2,100	2.98
LDW09 0-2.1C	Pass	Pass	X	Pass	7.35	**120**		**120**	**365**		**13.93**	67.5	2,860	2.62
LDW11 0-3.2C	Pass	Pass	X	Pass	5.82	**130**		**130**	**283**		10.52	27	2,100	2.69
LDW13 2-7.2C2	Pass	Pass	**XX**	**Fail**	5.15	**100**		**100**	**201**		10.00	83.8	1,710	2.01
LDW16 0-2.5C	Pass	Pass	**XX**	**Fail**	5.50	**130**		**130**	**170**		6.20	38.2	2,750	2.74
LDW17 0-3.5C	Pass	Pass	**XX**	**Fail**	3.80	**160**		**160**	**146**		6.64	63.6	2,920	2.2
LDW18 0-2.8C	Pass	Pass	X	Pass	4.75	**290**		**290**	90		3.18	72.8	2,700	2.83

"Pass" = passes DMMP Guideline	
X = hit under the minor hit rule	
XX = hit under the major hit rule	
SL = Screening Level	**>SL**
BT = Bioaccumulation Trigger	**>BT**
ML = Maximum Level	**>ML**
SQS = Sediment Quality Standard	**> SQS**
CSL = Cleanup Screening Level	**>CSL**

Table 4-3. Comparative Bioassay Results Relative to the DMMP Non-Dispersive Site Interpretive Guidelines

Amphipod (Eohaustorius estuarius):

Station	Mean Amphipod Mortality (%)	Transformation used for Statistical Analysis	Is the test mortality statistically greater than reference?	$M_T - M_C$	$M_T - M_C > 20\%$?	$M_T - M_R$	$M_T - M_R > 30\%$?	Interpretation
LDW07 0-2C1	10.00	Statistical analyses not required.		9	no	8	no	Pass
LDW07 2-4C2	15.00			14	no	13	no	Pass
LDW08 0-4C1	17.00			16	no	15	no	Pass
LDW09 0-2.1C	7.00			6	no	5	no	Pass
LDW11 0-3.2C	18.00			17	no	16	no	Pass
LDW13 2-7.2C2	7.00			6	no	5	no	Pass
LDW16 0-2.5C	6.00			5	no	4	no	Pass
LDW17 0-3.5C	5.00			4	no	3	no	Pass
LDW18 0-2.8C	9.00			8	no	7	no	Pass
Reference	2.00	---	---	---	---	---	---	---
Control	1.00	---	---	---	---	---	---	---

M_T Mean **Test Mortality** (%) M_T Mean **Test Mortality** (%)
M_C Mean **Control Mortality** (%) M_R Mean **Reference Mortality** (%)

Standard larval protocol (Mytilus galloprovincialis):

Station	Mean Normal Larval Count	Transformation used for Statistical Analysis	Is the test larval survival statistically less than reference?	N_T/N_C	$N_T/N_C < 0.80$?	$N_R/N_C - N_T/N_C$	$N_R/N_C - N_T/N_C > 0.30$?	Interpretation
LDW07 0-2C1	179.60	none	yes	0.70	yes	0.16	no	X
LDW07 2-4C2	170.80	none	yes	0.67	yes	0.20	no	X
LDW08 0-4C1	196.60	none	yes	0.77	yes	0.09	no	X
LDW09 0-2.1C	144.60	none	yes	0.57	yes	0.30	no	X
LDW11 0-3.2C	155.40	none	yes	0.61	yes	0.26	no	X
LDW13 2-7.2C2	138.00	none	yes	0.54	yes	0.32	yes	**XX**
LDW16 0-2.5C	124.40	none	yes	0.49	yes	0.38	yes	**XX**
LDW17 0-3.5C	109.40	none	yes	0.43	yes	0.44	yes	**XX**
LDW18 0-2.8C	145.60	none	yes	0.57	yes	0.29	no	X
Reference	220.60	---	---	---	---	---	---	---
Control	255.20	---	---	---	---	---	---	---

N_T Mean Number **Normal Test** Larvae N_R Mean Number **Normal Reference** Larvae
N_C Mean Number **Normal Control** Larvae N_C Mean Number **Normal Control** Larvae

Neanthes growth - AFDW endpoint:

Station	Mean Individual Growth Rate	Transformation used for Statistical Analysis	Is the Mean Test Individual Growth Rate less than the Reference?	MIG_T/MIG_C	$MIG_T/MIG_C < 0.80$?	MIG_T/MIG_R	$MIG_T/MIG_R < 0.50$?	$MIG_T/MIG_R < 0.70$?	Interpretation
LDW07 0-2C1	0.50	none	yes	0.78	yes	0.76	no	no	Pass
LDW07 2-4C2	0.61	Statistical analyses not required		0.95	no	0.92	no	no	Pass
LDW08 0-4C1	0.50	none	yes	0.78	yes	0.76	no	no	Pass
LDW09 0-2.1C	0.54	Statistical analyses not required		0.84	no	0.82	no	no	Pass
LDW11 0-3.2C	0.57			0.89	no	0.86	no	no	Pass
LDW13 2-7.2C2	0.53			0.83	no	0.80	no	no	Pass
LDW16 0-2.5C	0.60			0.94	no	0.91	no	no	Pass
LDW17 0-3.5C	0.59			0.92	no	0.89	no	no	Pass
LDW18 0-2.8C	0.60			0.94	no	0.91	no	no	Pass
Reference	0.66	---	---	---	---	---	---	---	---
Control	0.64	---	---	---	---	---	---	---	---

MIG_T **Mean Individual Growth Test** Worms MIG_T **Mean Individual Growth Test** Worms
MIG_C **Mean Individual Growth Control** Worms MIG_R **Mean Individual Growth Reference** Worms

no	Below DMMP Guideline	Pass = passes DMMP Guideline
yes	Exceeds DMMP Guideline	X = hit under the minor hit rule
---	= not applicable	XX = hit under the major hit rule

5.0 References

DMMP. 2009. Dredged Material Evaluation and Disposal Procedures (Users' Manual). Dredged Materials Management Program, Corps of Engineers, Seattle District; EPA Region 10, WDNR, and Ecology. July 2008 (with minor updates November 2009). Prepared by: Dredged Materials Management Office, US Army Corps of Engineers, Seattle District.

Lower Duwamish Waterway Group. 2010. Draft Final Lower Duwamish Waterway Feasibility Study. Prepared by the Lower Duwamish Waterway Group (LDWG), consisting of the City of Seattle, King County, the Port of Seattle, and The Boeing Company, and AECOM. October 2010.

SAIC. 1996. Year 11 Monitoring of the Duwamish CAD Site, Seattle, WA. Prepared for USACE, Seattle District. Prepared by SAIC, Bothell, WA. February 29, 1996.

SEA. 2000. PSDDA Sediment Characterization of Duwamish River Navigation Channel: FY2000 Operations and Maintenance Dredging Data Report. Prepared for US Army Corps of Engineers, Seattle District. Striplin Environmental Associates, Inc., Olympia, WA.

USACE/WDNR. 2002. Dredge Material Management Program Biennial Report, Dredging Years 2000/2001. March 2002.