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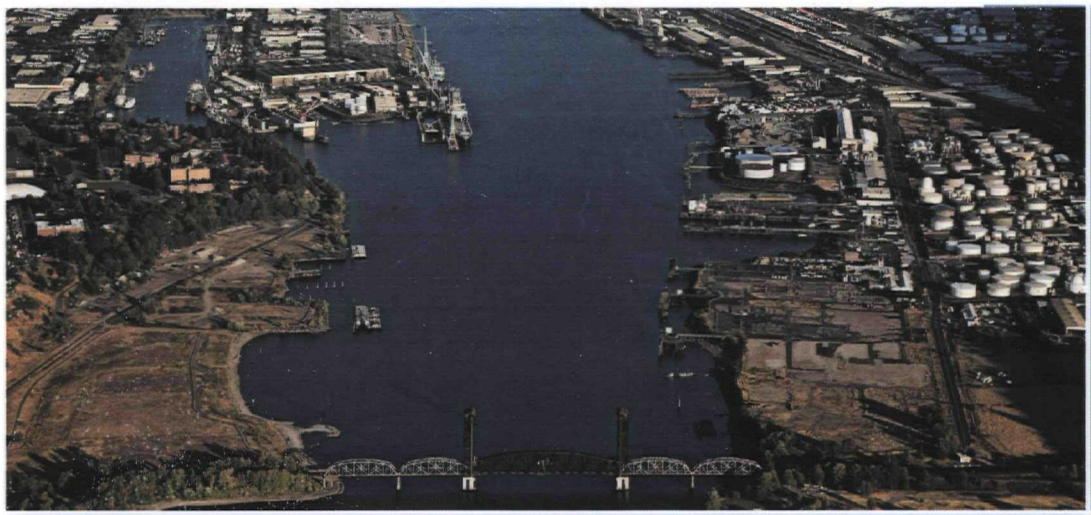

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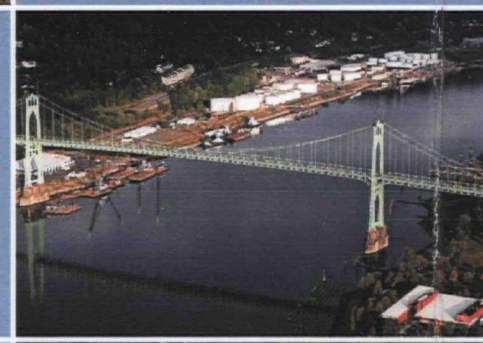

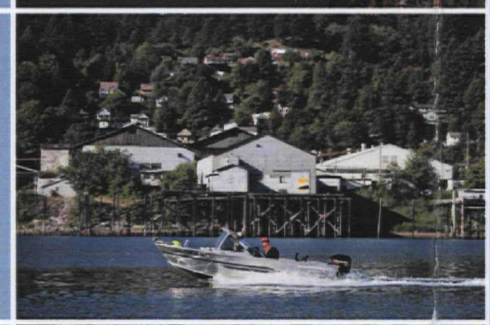

Prepared for

The Lower Willamette Group

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October 27, 2009

Prepared for
The Lower Willamette Group

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LIST OF ACRONYMS

2-D	two dimensional
95 UPL	95th percentile upper prediction limit
ADCP	acoustic doppler current profiler
AFSO	Amended Final Stipulated Order
AOC	Administrative Order on Consent
AOPC	area of potential concern
ARAR	Applicable or Relevant and Appropriate Requirement
ASFO	Amended Stipulation and Final Order
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BAP	benzo(a)pyrene
BaPEq	benzo(a)pyrene equivalent
BEHP	bis-2(ethylhexyl) phthalate
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
bml	below mudline
BMF	biomagnification factor
BMP	best management practice
BOD	biological oxygen demand
BSAF	biota-sediment accumulation factor
BSAR	biota-sediment accumulation regression
BTEX	benzene, toluene, ethylbenzene, and total xylene
BTV	background threshold values
CBWTP	Columbia Boulevard Wastewater Treatment Plant
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfs	cubic feet per second
CGF	coarse-grained flood deposits
COI	chemical of interest
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CRAG	Columbia Region Association of Governments
CRBG	Columbia River Basalt Group
CRD	Columbia River datum
CRITFC	Columbia River Inter-Tribal Fish Commission
C_s	concentration of the chemical associated with solids
CSM	conceptual site model
CSO	combined sewer overflow
CT	central tendency
CVOCs	chlorinated volatile organic compound
CWA	Clean Water Act
DCA	dichloroethane

DCB	dichlorobenzene
DCE	dichloroethene
DDD	dichloro-diphenyl-dichloroethane
DDE	dichloro-diphenyl-dichloroethene
DDT	dichloro-diphenyl-trichloroethane
DDx	2,4′ and 4,4′-DDD, -DDE, -DDT
DEA	David Evans and Associates, Inc.
decaCB	decachlorobiphenyl
DEQ	Oregon Department of Environmental Quality
diCB	dichlorobiphenyl
DMR	Discharge Monitoring Report t
DO	dissolved oxygen
DOC	dissolved organic carbon
DRH	diesel-range hydrocarbons
ECSI	Oregon Environmental Cleanup Site Inventory
EDI	equal discharge increment
EFDC	Environment Fluid Dynamics Code
EOSM	Evraz Oregon Steel Mills
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FFA	fill, fine-grained facies of flood deposits, and recent alluvium
FFS	focused feasibility study
f_{oc}	fraction of organic carbon
FOIA	Freedom of Information Act
FS	feasibility study
FSP	field sampling plan
FSR	field sampling report
GIS	geographic information systems
GLISP	Guild's Lake Industrial Sanctuary Plan
GPS	global positioning system
GRH	gasoline-range hydrocarbons
GWPA	groundwater pathway assessment
HCH	hexachlorocyclohexane
heptaCB	heptachlorobiphenyl
hexaCB	hexachlorobiphenyl
HI	hazard index
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran
HQ	hazard quotient
HRGC	high resolution gas chromatography
HRMS	high resolution mass spectrometry
HST	hydrodynamic and sediment transport
HxCDD	hexachlorodibenzo-p-dioxin

HxCDF	hexachlorodibenzofuran
IC	indicator chemical
ISA	initial study area
JSCS	joint source control strategy
K_d	solid/water partitioning coefficient
K_{oc}	organic carbon partitioning coefficient
K_{ow}	octanol-water partitioning coefficient
LISST	laser in situ scattering and transmissometer
LOAEL	lowest-observed-adverse-effect level
LOE	line of evidence
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
LRMS	low resolution mass spectrometry
LWG	Lower Willamette Group
LWR	lower Willamette River
M&B	McCormick & Baxter
MCB	monochlorobenzene
MDL	method detection limit
MFA	Maul Foster & Alongi, Inc.
MGP	manufactured gas production
MHWM	mean high water mark
MNR	monitored natural recovery
MOA	memorandum of agreement
monoCB	monochlorobiphenyl
MOU	memorandum of understanding
MRL	method reporting limit
MS4	municipal separated storm sewer system
MSL	mean sea level
mya	million years ago
N/m^2	Newton per square meter
NAPL	non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988
NB/NS	near bottom/near surface
NJADN	New Jersey Atmospheric Deposition Network
NGVD29/47	National Geodetic Vertical Datum of 1929 through the Pacific Northwest Supplemental Adjustment of 1947
NOAA	National Oceanic and Atmospheric Administration
nonaCB	nonachlorobiphenyl
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Response Center
NRIU	natural resource inventory update
OC normalized	organic carbon normalized
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
octaCB	octachlorinated biphenyl

ODFW	Oregon Department of Fish and Wildlife
ODHS	Oregon Department of Human Services
ODOT	Oregon Department of Transportation
OHWM	ordinary high water mark
ORP	oxidation-reduction potential
OSSA	Oregon State Sanitary Service Authority
OSWER	EPA Office of Solid Waste and Emergency Response
PAH	polycylic aromatic hydrocarbon
PBRA	potential benthic risk area
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDD/F	polychlorinated dibenzo-p-dioxin/furan
PCDF	polychlorinated dibenzofuran
PCP	pentachlorophenol
PD	percent difference
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
PEF	potency equivalency factor
pentaCB	pentachlorobiphenyl
PGE	Portland General Electric
POC	particulate organic carbon
POP	Port of Portland
POTW	publicly owned treatment works
PRD	Portland River Datum
PRE	preliminary risk evaluation
PRG	Preliminary Remediation Goal
PRP	potentially responsible party
PTRR	Portland Terminal Railroad
PVC	polyvinyl chloride
Q-Q	quantile-quantile
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RA	risk assessment
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RISG	Ross Island Sand and Gravel Company
RM	river mile
RME	reasonable maximum exposure
ROD	Record of Decision
RRH	residual-range hydrocarbons
RSL	regional screening levels
SAP	sampling and analysis plan
SCRA	site characterization and risk assessment
SCSR	site characterization summary report

SFO	Stipulation and Final Order
SHA	special habitat area
SLERA	screening-level ecological risk assessment
SLV	screening level value
SMA	sediment management area
SOW	statement of work
SPI	Sediment Profile Imagery
SQGs	sediment quality guidelines
SRM	Sandy River Mudstone
SSO	sanitary sewer overflow
SSR	stormwater sampling rationale
STA	Sediment Trend Analysis®
SVOC	semivolatile organic compound
SWAC	surface weighted average concentrations
TBT	tributyltin ion
TCA	trichloroethane
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofurans
TCE	trichloroethene
T_{cr}	critical shear stresses
TEF	toxicity equivalency factor
TEQ	toxic equivalent concentration
tetraCB	tetrachlorobiphenyl
TMDL	total maximum daily load
TOC	total organic carbon
TPH	total petroleum hydrocarbons
triCB	trichlorobiphenyl
TRV	toxicity reference value
TSS	total suspended solids
TZW	transition zone water
UCL	upper confidence limit
UPL	upper prediction limit
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
UTL	upper tolerance limit
VI	vertically integrated
VI-EMW	vertically integrated: east-middle-west
VOC	volatile organic compound
WHO	World Health Organization
WISCO	Willamette Iron and Steel Company
WOE	weight of evidence

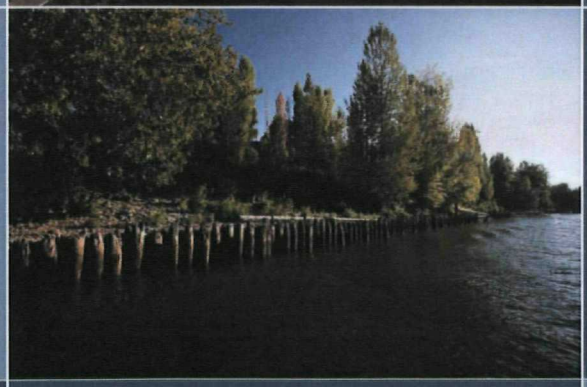
LWG
LOWER WILLAMETTE GROUP

Portland Harbor Superfund Site
Draft Remedial Investigation Report

October 2009

EXECUTIVE SUMMARY

Prepared for:
The Lower Willamette Group



Portland Harbor Superfund Site Draft Remedial Investigation Report

In December 2000, the U.S. Environmental Protection Agency (EPA) identified the Portland Harbor area of the lower Willamette River (LWR, just north of downtown Portland, OR) as a priority for cleanup and placed it on the National Priorities List as a Superfund site.

The Draft Remedial Investigation (RI) report is a major milestone of the Superfund process to address environmental contamination by hazardous chemicals. It presents the results of the last eight years of work to characterize the Portland Harbor Superfund Site (the Site), to assess risks to human health and the environment from the Site, and to lay the groundwork for a Feasibility Study (FS) to evaluate cleanup options.

The Draft RI report is the result of cooperative working relationships between the group of businesses and public entities funding the study - the Lower Willamette Group (LWG) - and the EPA; the Oregon Department of Environmental Quality (DEQ); and federal, state, and Tribal trustees; as well as ongoing public involvement and outreach to the Portland community.

The Superfund work in the Portland Harbor area is one of many efforts focused on the greater Willamette River watershed. Other initiatives that address water quality, public health advisories, and land use are being conducted under several other federal and state programs, such as the Clean Water Act.

This Executive Summary contains:

- An overview of the Remedial Investigation and the Superfund process
- A summary of the Remedial Investigation results, including:
  - The physical, chemical and biological systems of the LWR
  - The baseline assessments of human health and ecological risks associated with chemicals present at the site
- A summary of the next steps in the Superfund process

BRIEFLY

- The Portland Harbor Superfund Site is within a major urban and industrial area. EPA has identified the Site as a priority for cleanup of chemical contamination.
- The Superfund work in the Portland Harbor area is one of many efforts focused on the greater Willamette River watershed. Other initiatives that address water quality, public health advisories and land use are being conducted under several other federal and state programs, such as the Clean Water Act.
- The Draft Remedial Investigation (RI) report describes the nature and extent of contamination, characterizes physical conditions and the potential movement of contaminants, and assesses the risks contamination poses to human health and the environment.
- The Draft RI report is the result of cooperative working relationships between the Lower Willamette Group (LWG) and EPA, the Oregon Department of Environmental Quality (DEQ), and federal, state, and Tribal trustees, as well as ongoing public involvement and outreach to the Portland community.
- Four chemical groups (PCBs, chlorinated dioxins and furans, the pesticide DDT and related breakdown products, and PAHs) account for most of the estimated human health and ecological risks in Portland Harbor. These four chemicals tend to be located with other chemicals that may also pose risk.
- PCBs are by far the most significant and widespread chemicals posing risks to humans and wildlife.
- Ingestion of fish represents the primary exposure pathway for risk to humans and wildlife, especially aquatic mammals. Risks to people from other exposure pathways, such as direct contact with sediment or water, are much lower.
- The next major milestone of the Portland Harbor Superfund Program will be a Feasibility Study (FS) that evaluates remedial alternatives and approaches to sediment cleanup.

Overview of the Remedial Investigation

The RI was conducted by the LWG, which is composed of the 10 parties who signed an Administrative Settlement Agreement and Order on Consent (AOC) with EPA to conduct the RI and FS at the Site and four other parties who have contributed financially to the project. The LWG is a small subset of potentially responsible parties identified by EPA.

PORTLAND HARBOR REMEDIAL INVESTIGATION/ FEASIBILITY STUDY TIMELINE

1997 | EPA Preliminary Assessment/Site Investigation
2000 | Portland Harbor Superfund Site Placed on National Priority List
2001 | Lower Willamette Group Members Sign Administrative Order on Consent
2002 | Remedial Investigation Round 1 Sampling Performed
2004 | Remedial Investigation Round 2 Sampling Begins
2006 | Remedial Investigation Round 3 Sampling Begins, Administrative Order on Consent Amended
2007 | Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report Submitted to EPA
2009 | Draft Remedial Investigation Report Submitted to EPA for Review
2010 | Draft Feasibility Study Report Expected to be Submitted to EPA
TBD | EPA Record of Decision and Post-Record of Decision Cleanup and Monitoring Activities

From 2001 to 2008, the LWG conducted the sampling and analysis described in the Draft RI report under the formal oversight of EPA and its partners including DEQ and the site's Natural Resource Trustees (U.S. Department of the Interior, National Oceanic and Atmospheric Administration, State of Oregon, Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Grand Ronde Community of Oregon, Confederated Tribes of the Siletz Indians of Oregon, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, and the Nez Perce Tribe). EPA is the lead agency for the in-river site study and cleanup, and DEQ is the lead agency for investigating and controlling sources of contaminants entering the river.

STEPS IN THE SUPERFUND CLEANUP PROCESS

- Preliminary Assessment/Site Investigation
- Listing on the National Priority List
- Remedial Investigation/Feasibility Study
  - Scoping
  - Site Characterization (Remedial Investigation Report)
  - Development and Screening of Alternatives
  - Treatability Investigations
  - Detailed Analysis
- Record of Decision
- Remedial Design/Remedial Action
- Construction Completion
- Post Construction Completion
- Deletion of Site from National Priority List

The Draft RI report describes the nature and extent of contamination in the Study Area, characterizes sources of contaminants and the physical conditions that affect their movement, and assesses the risks contamination may pose to human health and the environment. A conceptual site model was developed to synthesize information gathered during the RI, including chemical sources and release mechanisms, pathways to the river, in-water transport and fate processes that affect the mobility of contaminants, and possible exposure and risks to ecological and human receptors.

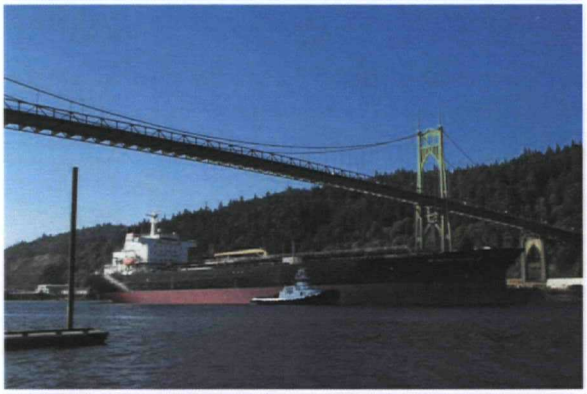
The RI required a significant commitment of time and resources by the LWG, EPA and its partners. All of the parties involved have placed a high priority on a cooperative process to identify and resolve issues that are typically encountered in a Superfund investigation. Throughout the RI sample collection and analysis process, the LWG has worked with EPA and its partners to provide information to many sectors of the community, such as the Portland Harbor Community Advisory Group, business, educational institutions, and the media.

Study Area

The Study Area for the RI is a 10-mile stretch of the LWR. It is located north of downtown Portland between Sauvie Island (river mile [RM] 1.9) and the Broadway Bridge (RM 11.8).

The Study Area includes Portland Harbor, an urban and industrial reach of the LWR located immediately downstream of downtown Portland and extending almost to the confluence with the Columbia River. What was once, more than 100 years ago, a shallow, meandering portion of the LWR has been redirected, filled, and dredged. A federally maintained navigation channel, extending nearly bank-to-bank in some areas, doubles the natural depth of the river and allows transit of large ships into the active harbor. Much of the riverbank contains overwater piers and berths, port terminals and slips, and other engineered features (e.g., armoring such as rip rap makes up approximately half of the harbor shoreline). These extensive physical alterations have resulted in a river reach that bears little resemblance to its pre-industrialized character in terms of hydrodynamics, sediment processes, ecological habitat, and human uses.

The Willamette River is the 13th largest river in the contiguous United States, with substantial flows, averaging 33,000 cubic feet per second. Flows vary considerably by season, with the lowest flows occurring during the late-summer dry season, typically increasing by 10 times through the winter rainy season. River flows in the LWR are regulated to some degree by a series of upstream dams, although major floods of 200,000 cubic feet per second or more still occur every few years during large storms. Despite periodic scouring of some locations by floods, the Study Area is situated in a relatively low energy, depositional reach of the LWR. Although the LWR is over 100 miles from the Pacific Ocean, it is influenced by tides. Tides cause the river stage to rise and fall up to several feet through a tidal cycle. During the dry season, when river discharge is low, rising tides can cause intermittent flow reversals throughout the harbor.



Current uses of the land and water in Portland Harbor include:

- Industrial and commercial operations
- Marine activities
- Surface transportation (railroads and roadways)
- Recreational use (including parks, boating and fishing)
- Cultural activities

Human activities contributed to chemical contamination of the Study Area via multiple pathways such as direct discharges, overwater releases and spills, stormwater and wastewater outfalls, overland flow, bank erosion and groundwater. Historical and current sources responsible for the existing contamination include, but are not limited to: 1) ship building, repair and dismantling; 2) wood treatment and lumber milling; 3) storage of bulk fuels and manufactured gas production; 4) chemical manufacturing and storage; 5) municipal combined sewer overflows (CSOs); and 6) stormwater from industrial, commercial, transportation, residential, and agricultural land uses. Various chemicals, including metals, polychlorinated biphenyls (PCBs), pesticides, polycyclic aromatic hydrocarbons (PAHs) from petroleum and other sources, and phthalates have been released to the river over many decades. More recently, cessation of operations, improved waste management practices, and source control activities have significantly reduced the amount of chemicals released to the Study Area.

Site Overview

LWG Lower Willamette Group

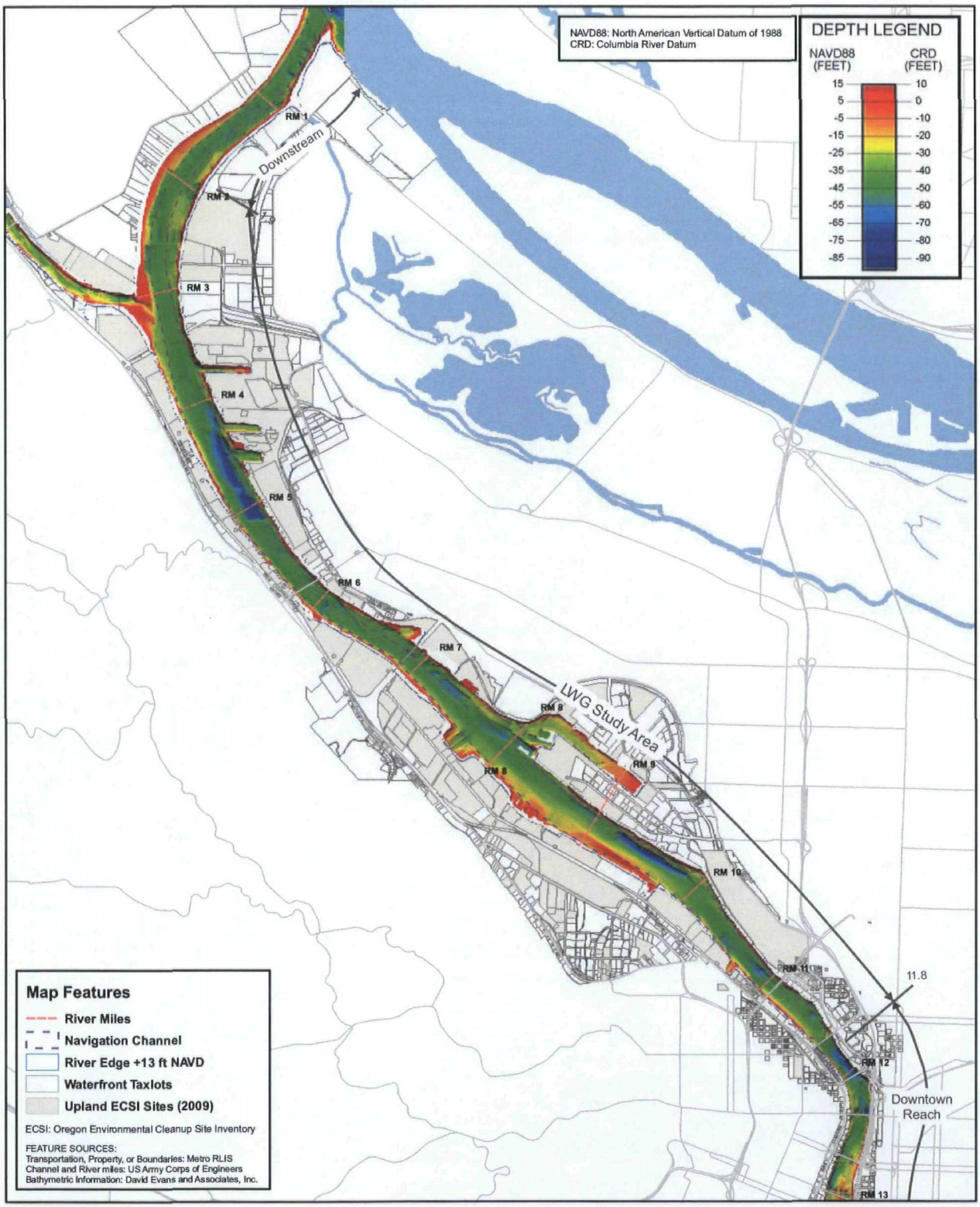
0 0.25 0.5 1 Miles

N

Map Features
River Miles
Navigation Channel
Bridges

FEATURE SOURCES:
Transportation, Property, or Boundaries: Metro RLIS.
Channel & River miles: US Army Corps of Engineers.
Aerial Photographs: ESRI.

2009 Bathymetric Hillshade



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Key Remedial Investigation Findings

The Draft RI report presents a detailed overview of the data gathering and analysis efforts performed at the Portland Harbor Superfund Site. Key findings of the RI include the following:

Extent of Contamination

- Higher concentrations of chemical contaminants in sediments occur in nearshore and off-channel areas.

- Chemical concentrations in sediment are generally higher in deeper sediments than in the surface layer, indicating that past chemical inputs were greater than current inputs, and that surface sediment quality has improved over time. The few exceptions include areas where higher surface sediment concentrations appear to be associated with ongoing local sources, low rates of sediment deposition, and physical disturbance of surface sediments, e.g., from boat scour.

- Chemical concentrations in surface sediments within the navigation channel and areas away from sources have relatively lower concentrations similar to levels measured in sediments upriver of the Study Area in areas unaffected by Portland Harbor sources.

Estimates of Risk

- Chemicals accounting for most of the estimated human health and ecological risks are primarily PCBs, and to a lesser extent dioxins/furans, PAHs, and the pesticide DDT and related breakdown products (collectively known as DDTs).

- PCBs are by far the most significant contributors to human health risk, with ingestion of fish representing the primary exposure pathway and the highest estimated risk.

- Consumption of fish and shellfish from the Study Area may pose human health risks that are greater than the EPA target risk range for human health (greater than one in a million [10^{-6}] to one in ten thousand [10^{-4}] excess risk of cancer).

- PCBs are also the most significant contributor to the estimated ecological risks, with the mink population being the receptor most at risk from PCB exposure. Along with total PCBs, total PAHs and total DDTs were associated with toxicity to benthic (i.e., bottom-dwelling) invertebrates in several localized areas constituting approximately five percent of the Study Area.

- Assessment of human health and ecological risks requires an understanding of chemical toxicity and estimates of exposures to these chemicals. The methods used to estimate risks within the Study Area are intended to be conservative and therefore may overestimate actual risks.

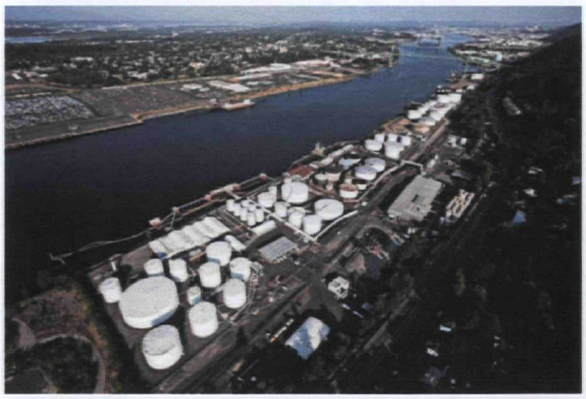
- Accumulation of PCBs in fish tissue is a regional (i.e., watershed-wide) and global problem that is not limited to fish within the Study Area. Consequently, fish in the Willamette and Columbia Rivers (outside of the Study Area) also contain PCBs that pose an increased cancer risk of greater than 10^{-4} based on a comparison with the EPA target fish tissue concentration. However, the concentrations of PCBs in fish tissue collected within the Study Area are generally higher than fish tissue concentrations at the regional level.

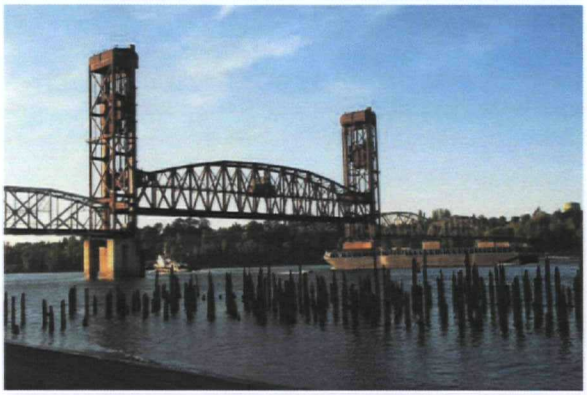
Sources of Contamination

- Much of the sediment contamination in the Study Area is associated with known or suspected historical sources and practices that have largely been discontinued or otherwise controlled. Industrial activities along the harbor included ship building, dismantling, and repair; gas and chemical manufacturing; steel production; wood treatment operations; metal recycling; fuel storage and transfer operations; electrical production and distribution; and rail yards. Other potential sources along the harbor included ship terminals, roads, numerous wastewater and stormwater outfalls and runoff, and overwater discharges. Agricultural activities, while present within the harbor in the early part of the last century, now occur primarily upriver.

- Chemicals still reach the Study Area through various pathways including stormwater, permitted industrial discharges, atmospheric deposition, bank erosion, groundwater, and incidental releases within the Study Area, and in surface water and sediment inflows from upstream.

- Upstream sources include or have included sewers, stormwater runoff, and direct discharge of industrial wastes; agricultural runoff; and aerial deposition of global or regional contaminants on the river water surface and drainage areas within the Willamette Valley.





- For most chemicals, the current mass of contaminants entering the Study Area from upstream river flows (in surface water and suspended sediments) per year exceeds the current mass from upland sources within the Study Area. This is due to the large volume of water and sediments that enters the Study Area from upstream.

- Stormwater input is likely the most important current source pathway within the Study Area (i.e., excluding upstream sources) for many chemicals. The issue of localized sources will be further evaluated in the recontamination analysis in the FS.

- Significant contributions of contaminants to the Study Area via groundwater are currently limited to only a few upland properties where there is known groundwater contamination.

- Although many specific sources of contamination have been identified, the RI report is not an exhaustive list of current or historical sources of contamination. Identification and evaluation of potential sources is ongoing.

Potential for Contaminant Transport Within and Downstream of the Study Area

- Most of the sediments with the highest chemical concentrations that pose potential risk are associated with relatively stable, nearshore areas.

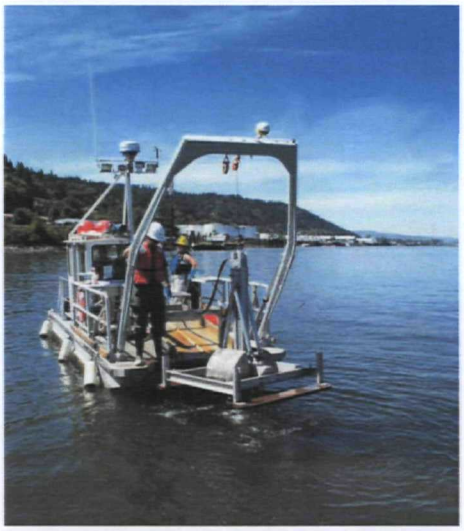
- Most nearshore areas and much of the navigation channel are stable, depositional environments. Two well-defined portions of the channel (i.e., RM 5 to 7 and upstream of RM 10) are more dynamic and potentially subject to erosion during flood events. Deep sediments (greater than 1-ft sediment depth) in these two channel areas are generally not highly contaminated so the risks of re-exposure of buried contaminants during a flood event and downstream dispersal of contaminants are low.

- Sediments immediately downstream of the Study Area in either the Willamette River main stem or Multnomah Channel show little evidence of chemical migration from the Study Area.

The results of the RI and risk assessments provide the information necessary to evaluate remedial alternatives to reduce risk to human health and the environment. This evaluation will occur during the FS.

Summary of Data Collected for the Portland Harbor Remedial Investigation

The investigations to support the site characterization were performed by the LWG between 2001 and 2008. Three major rounds of environmental sampling addressed different investigation needs, often timed around varying river stages, seasonal river flows, and storm events. Extensive physical studies (e.g., time-series bathymetric surveys) and sampling and chemical testing of sediment, surface water, transition zone water (TZW), and biota were conducted to support the RI, the risk assessments, and the FS.



Round 1 sampling, which focused on the collection of biota (tissue) samples, was conducted in 2002. Round 2 sampling began with multiple field efforts in 2004 and focused on the characterization of surface and subsurface sediment quality. In 2006, specialized sampling to support the hydrodynamic sediment transport model (e.g., surface sediment erosion rates) was conducted. Round 3 sampling between 2006 and early 2008 included collecting samples of surface water, biota, sediment upstream and downstream of the Study Area, suspended sediments (in-river sediment traps), and stormwater from selected outfalls. Round 3 sampling also filled data gaps related to site characterization, ecological and human health risks, upriver background, and the FS.

Data Collected for the Portland Harbor Remedial Investigation

NUMBER	COLLECTED SAMPLE TYPES AND INVESTIGATIONS
1,949	Surface sediment and beach composite samples
2,168	Subsurface samples from 860 core locations
460	Composite tissue samples
282	Surface sediment samples tested for toxicity to aquatic invertebrates
186	Surface water samples from 25 point and transect stations
420	Transition zone water samples from 9 sites
52	In-river sediment trap samples from 16 locations
501	Stormwater outfall composite water samples
44	Stormwater outfall sediment trap samples
281	Catch basin and in-line solids samples
6	Groundwater seep samples
500	Sediment profile images
800	Sediment trend analysis sample points
5	Major bathymetry surveys of 16 miles of the LWR
1	Time-series sediment stake nearshore bank elevation change measurements
3	Acoustic doppler current profiler surveys
1	Hydrodynamic and sediment transport model data collection effort
	In addition, the LWG conducted three wildlife habitat surveys and a cultural resource survey.

Note: Table includes data collected by LWG and other relevant studies.

Draft Remedial Investigation Findings
Physical, Chemical and Biological Systems

The results of RI studies performed to characterize the physical, chemical, and biological systems in the Study Area are described in the following sections.

Physical System

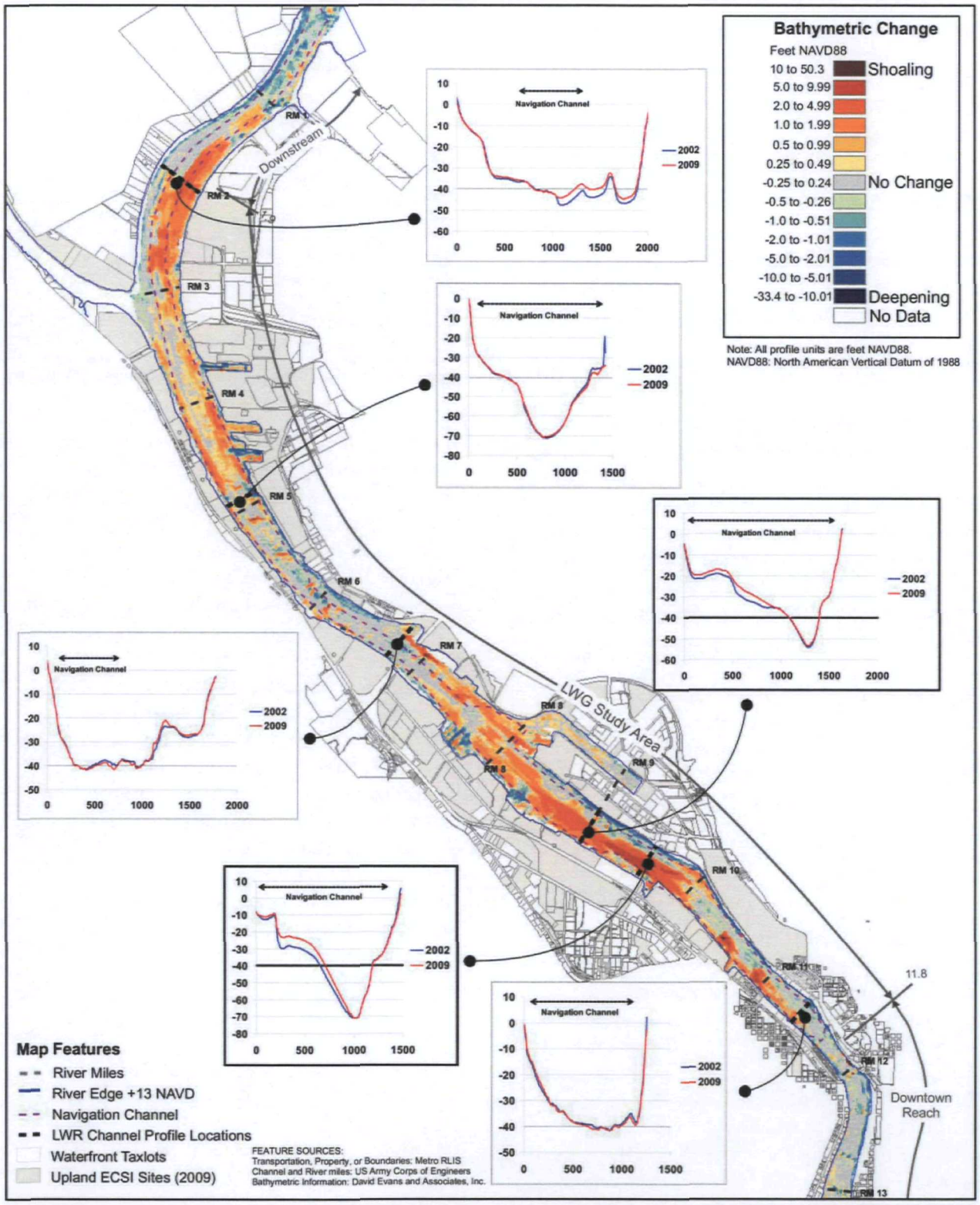
Portland Harbor occupies the last 12 miles of the Willamette River just above its confluence with the Columbia River. It is the widest portion of the LWR and overall acts as a depositional environment for sediments that enter the reach from upstream. Sediments need to be periodically dredged from portions of the navigation channel and berthing areas to allow marine operations. Sediments in some locations may also be resuspended and move downstream during periods of high flow such as flood events. Resuspension of sediments can also result from disturbances caused by ships operating within the harbor and other in-water activities.

The degree of deposition and movement of sediments is controlled largely by the texture (i.e., grain size and organic matter content) of the sediments, water velocity, and human activities. Once in suspension, finer-grained sediments including clay and silt are characteristically transported farther than larger sandy sediments under all flow conditions.

Bathymetric changes from 2002 to 2009 suggest the greatest net sediment accumulation from deposition on the river bottom occurs in the channel where the river is wide and where flow velocities are reduced. These shoaling areas show relatively high percentages of silt and clay sized particles. Long-term deposition rates are particularly high in some sections of the channel, exceeding 1 foot per year in the large shoal present from RM 7 to 10. Some natural scour areas and slip and berthing areas that have been dredged were also evident in the bathymetric change data. The RI sediment transport model predicts that intermittent periods of erosion (i.e., greater than 1 ft) during flood events are limited to relatively narrow portions of the channel (e.g., RM 5 to 7). In these areas, sediments are relatively stable during low flow conditions but may be eroded when exposed to unusually high flow velocities.

Nearshore areas between the channel edge and riverbank, and off-channel areas, such as Swan Island Lagoon, Willamette Cove, and port terminals, do not show much net sediment accumulation. Evidence of sediment scour in some of these locations appears to be due to bottom disturbance by ship traffic (wakes and prop wash) and possibly other human activities. These factors also appear to mix surface sediments without resulting in net erosion or deposition.

Lower Willamette River Channel Profiles and Bathymetric Change 2002 - 2009



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Chemical System

Various abiotic media (e.g., sediments, surface water) and biota from the Study Area have been analyzed for a wide range of chemicals of interest and physical parameters. Four chemical groups (total PCBs, total dioxins and furans, total DDTs, and total PAHs) are considered "bounding indicator chemicals" because their distribution is believed to encompass the spatial extent of chemicals posing potentially unacceptable risk identified in the baseline risk assessments. This is not intended to imply that other chemicals will not be evaluated in the FS.

The following focuses on important trends in distributions of these four bounding indicator chemicals. The Draft RI report contains a detailed evaluation of these four bounding indicator chemicals, as well as other indicator chemicals, in the Study Area.

SUMMARY STATISTICS FOR TOTAL PCBs, TOTAL DIOXINS/FURANS, TOTAL DDTs AND TOTAL PAHs IN SURFACE AND SUBSURFACE SEDIMENT, STUDY AREA (RM 1.9-11.8)

		CONCENTRATION			
Analyte	**Number Analyzed**	**Mean**	**Median**	**95th Percentile**	**Maximum**
Total PCBs (μg/kg) ppb					
Surface Sediment	1,191	176	19.5	553	35,400
Subsurface Sediment	1,326	265	27	486	150,000
Total Dioxins/Furans (pg/g) ppt					
Surface Sediment	216	2,480	391	5,620	264,000
Subsurface Sediment	241	2,550	279	4,150	218,000
Total DDTs (μg/kg) ppb					
Surface Sediment	1,210	249	6.5	376	84,900
Subsurface Sediment	1,291	7,360	9.01	743	3,640,000
Total PAHs (μg/kg) ppb					
Surface Sediment	1,603	28,100	1,120	65,600	7,260,000
Subsurface Sediment	1,545	219,000	1,130	266,000	53,300,000

ppb = parts per billion ppt = parts per trillion

Bottom Sediments

Elevated concentrations of chemicals in Study Area sediments are generally found in localized nearshore and off-channel areas (e.g., slips, embayments, and shallow areas) near some known or suspected sources. Concentrations of organic contaminants and metals tend to be higher in subsurface sediments than in surface sediments, particularly in depositional areas. The navigation channel, Multnomah Channel, and areas downstream and upstream of the Study Area generally have lower chemical concentrations in bottom sediment, especially for organic contaminants.

Well-defined areas of elevated PCB concentrations in bottom sediments were identified at locations throughout the Study Area. Elevated concentrations of total dioxins/furans are mostly concentrated in nearshore sediments at the center of the Study Area around RM 7. The area of highest total DDTs concentrations occurs along the western shoreline between RM 6 and 7.5. Total DDTs concentrations are generally higher in the subsurface than in the surface layer indicating predominantly historical point and nonpoint sources of DDTs. With few exceptions, total PAH concentrations are higher in subsurface than in surface sediments. Total PAH concentrations are highly variable across the Study Area, with peak concentrations around RM 6.

Upstream areas characterized during the RI for comparison with the Study Area included the downtown reach (RM 12 to 16), immediately above the Study Area, and upriver of Ross Island to Willamette Falls (RM 16 to 26). Excluding some known or suspected source areas and cleanup sites in the downtown reach, sediment chemical concentrations in these more physically dynamic reaches upstream of the Study Area are generally low and the sediments are sandier.

Most areas of highly elevated concentrations appear to be stable over time. However, migration of some chemicals within the Study Area is evident in limited areas consistent with source types and general sediment transport patterns. Sediments immediately downstream of the Study Area in either the Willamette River main stem or Multnomah Channel show little evidence of chemical migration from the Study Area.

Suspended Sediments

Elevated concentrations of chemicals in samples collected from sediment traps correspond with areas where chemical concentrations in surface sediments on the river bottom are very high, indicating the effect of resuspension of bottom sediment on water quality, the presence of current sources, or both. Sediment trap samples from the Study Area generally had higher concentrations of indicator chemicals than samples from upstream of the Study Area.

Surface Water

Concentrations of PCBs, pesticides, dioxins/furans, and PAHs in surface water were measured down to extremely low levels, parts per quadrillion in some cases, using specialized sampling techniques. Concentrations of these chemicals in surface water samples varied both spatially and with river flow.

Concentrations of total PCBs, total dioxins/furans, and total PAH in surface water within the Study Area were generally higher than those upstream of the Study Area under all flow conditions. Elevated concentrations were generally observed in both transect (i.e., cross-river composite samples) and single-point surface water samples at various locations throughout the Study Area. The highest concentrations of total DDTs and total PAHs in surface water during low-flow conditions were found adjacent to known sources of these chemicals. The highest total PCB concentrations are associated with single-point samples collected at RM 6.7 within Willamette Cove during low-flow conditions. At RM 2, at the downstream end of the Study Area, concentrations of total PCBs, total dioxins/furans, total DDTs, and total PAHs in surface water were generally lower than the rest of the Study Area.

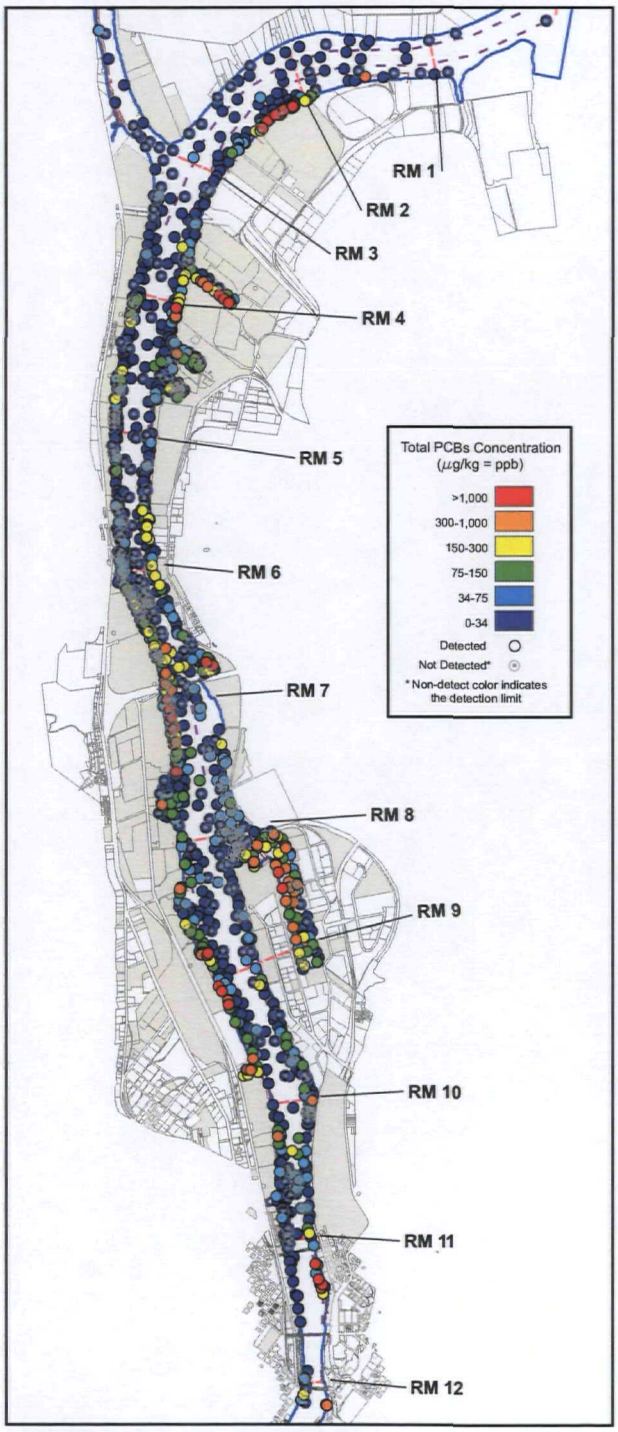
Concentrations of total PCBs and total PAHs in surface water tended to decrease with increasing flow rates due to the effect of dilution under higher flow conditions. No clear relationship was found between total dioxins/furans concentrations and river flow. Total DDT concentrations in surface water upstream of the Study Area were elevated in high-flow conditions, suggesting DDTs were mobilized from upstream sources during high-flow conditions.

Transition Zone Water

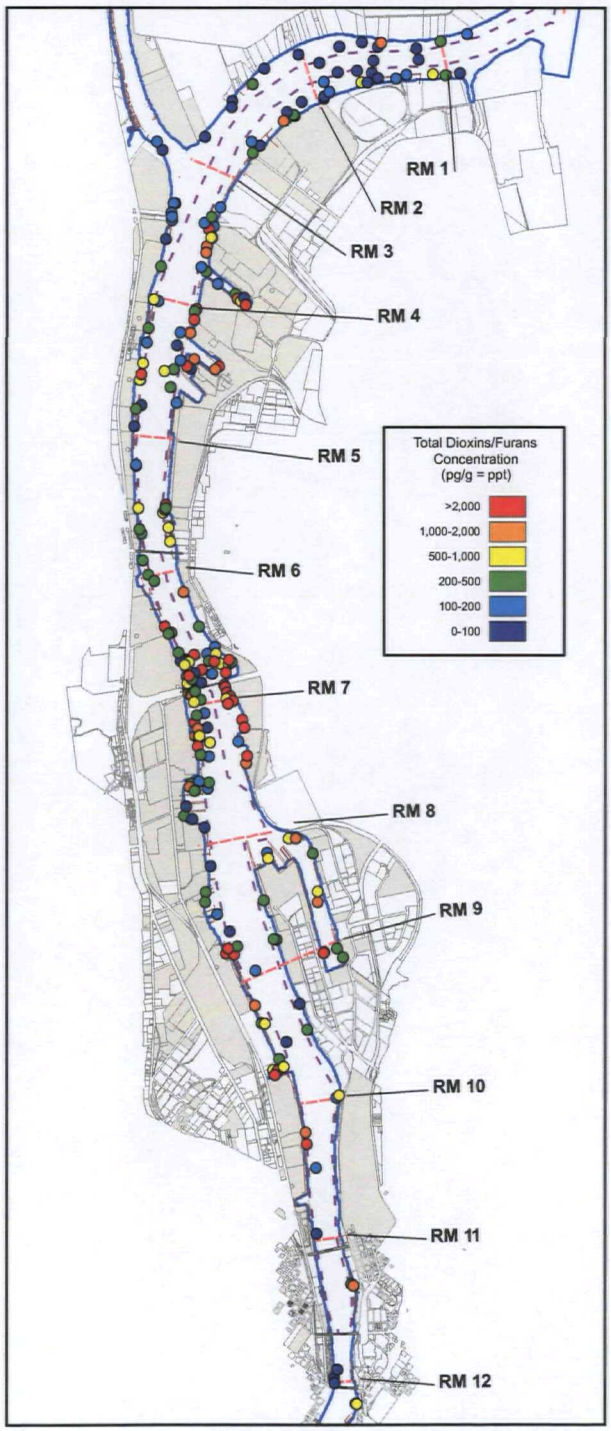
Samples of TZW (pore water) in surface and near surface sediments were collected offshore of nine upland sites where groundwater was suspected of potentially impacting sediment and/or pore water quality. The groundwater pathway was shown to potentially influence sediment/pore water quality at four of these sites.

Surface Sediment Samples (0 - 1ft)

Total PCBs Concentration



Total Dioxins/Furans Concentration



LWG Lower Willamette Group

0 0.25 0.5 1 Miles

N

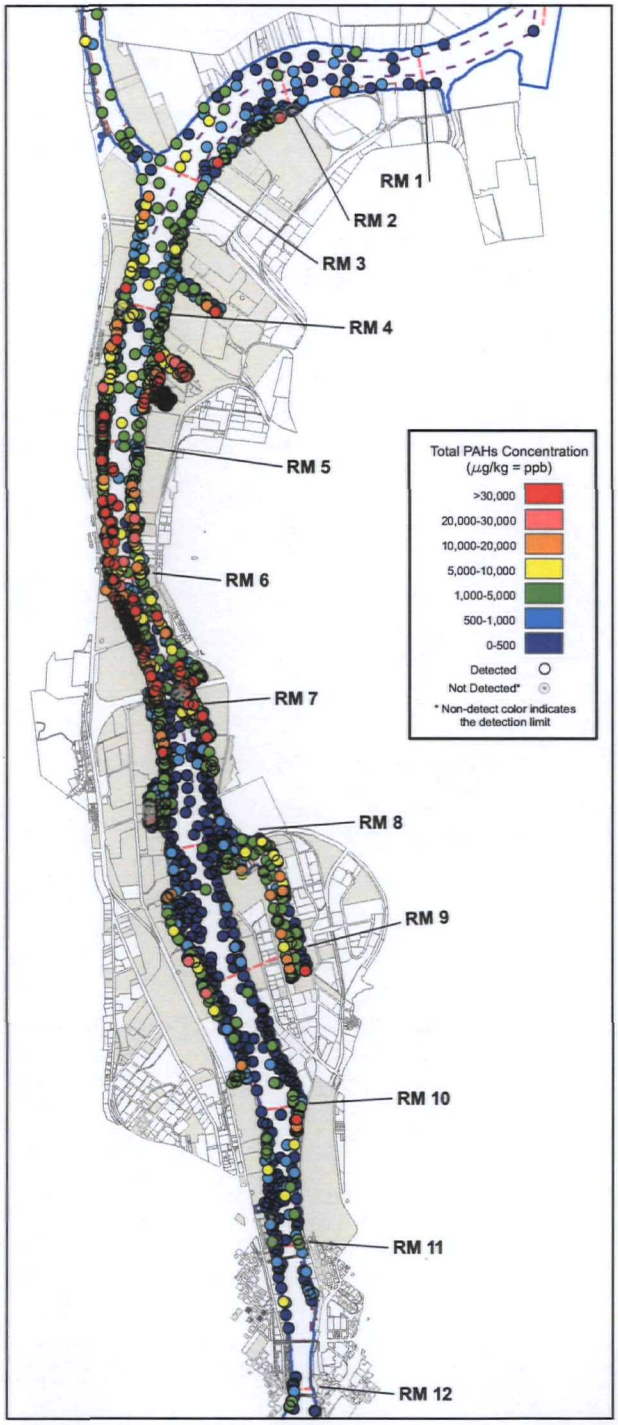
FEATURE SOURCES:
Transportation, Property, or Boundaries: Metro RLIS.
Channel & River miles: US Army Corps of Engineers.
Bathymetric Information: David Evans and Associates, Inc.

Map Features
- River Miles
- Navigation Channel
- River Edge +13 ft NAVD
- Bridges
- Waterfront Taxlots
- Upland ECSI Sites (2009)

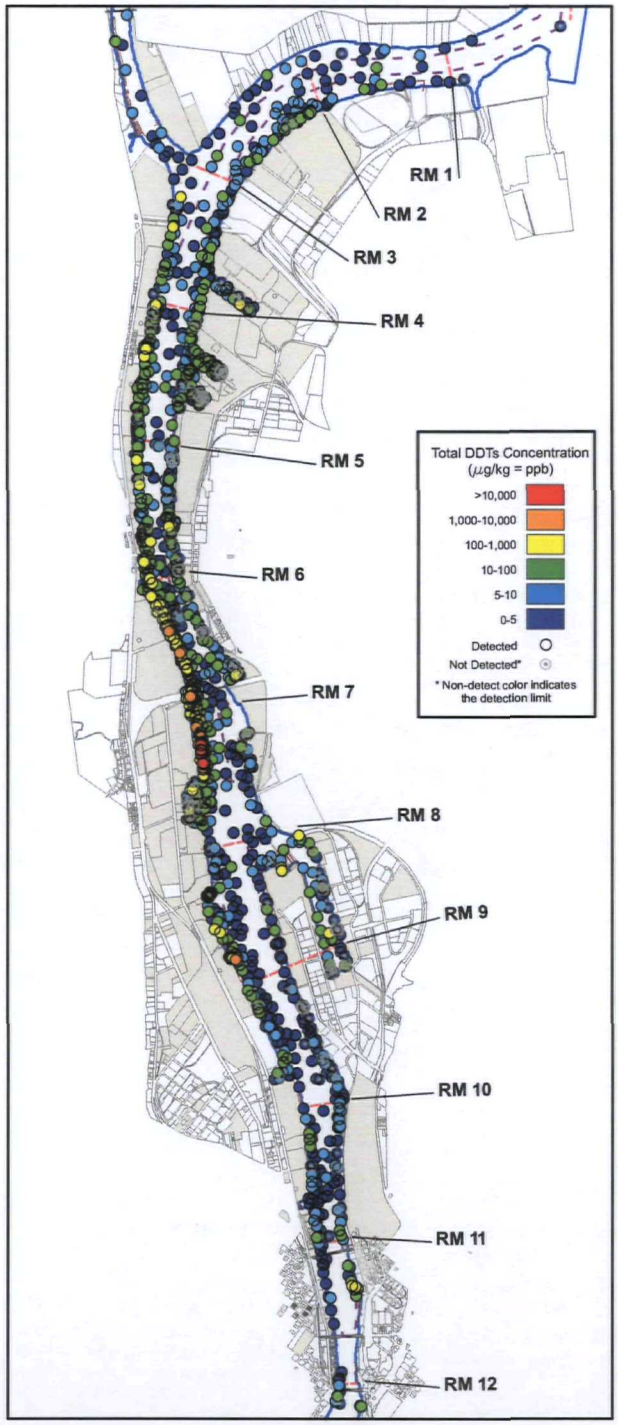
ECSI: Oregon Environmental Cleanup Site Inventory

Surface Sediment Samples (0 - 1ft)

Total PAHs Concentration



Total DDTs Concentration



LWG Lower Willamette Group

0 0.25 0.5 1
Miles

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Map Features
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ECSI: Oregon Environmental Cleanup Site Inventory

Fish and Invertebrate Tissue

PCBs, dioxins/furans, DDTs, and PAHs were detected in most samples of various fish and invertebrate species across the entire Study Area. Concentrations of these indicator chemicals varied greatly within and between species, with fish tissue concentrations generally greater than those in invertebrates. Concentrations of bioaccumulative compounds such as PCBs and DDTs were often found at greater concentrations in organisms higher on the food chain. On a site-wide scale, biological samples from within the Study Area exhibited greater concentrations of most indicator chemicals than those seen in samples from upriver reaches and above Willamette Falls. Localized areas of elevated concentrations of some indicator chemicals were found in resident species (e.g., sculpin), reflecting high concentrations in nearby surface sediment and biological uptake by species with small home ranges.

Sources of Chemical Contaminants

Chemicals from upland areas have entered the river system directly through outfalls, overwater releases and spills, and indirectly through overland flow, bank erosion, groundwater, and other nonpoint sources. In addition, contaminants from regional sources have reached the Study Area through inputs of surface water and sediment from upstream and through atmospheric deposition.

The main ongoing sources quantified in the Draft RI report are upstream surface water inputs (all upstream watershed sources), local stormwater in the Study Area, groundwater, and atmospheric deposition. Some unquantified sources such as bank erosion may also be important in localized areas.

Biological System

The Study Area is an active working harbor and supports invertebrate, fish, and wildlife communities as well as human recreation (e.g., boating, fishing, beach uses).

Ecosystem

Portland Harbor includes habitat for invertebrates, fishes, birds, mammals, amphibians, reptiles, and aquatic plants. Each group makes a contribution to the ecological function of the river, with its relative importance depending on its niche, its abundance, and its interaction with the physical environment.

The invertebrate community living in the sediments of Portland Harbor is dominated by worms, midge (fly) larvae, amphipods (small shrimp-like animals), mayfly larvae, caddisfly larvae, flatworms, crayfish, and the invasive Asiatic clam. Many of these benthic invertebrates provide important food for fish in the Study Area.

The diverse fish species that use Portland Harbor include migratory fish, such as salmon, lamprey, and sturgeon, and numerous resident fish, including recreational species such as smallmouth bass. Fish in the harbor provide an important food resource for birds, such as osprey and bald eagle, and some larger fish species like northern pikeminnow and smallmouth bass. Many aquatic mammals also feed on fish.

Birds that use the harbor include many migratory and resident species. Resident birds such as bald eagle, Canada goose, mallard, spotted sandpiper, great blue heron, and others are found in the Study Area. Spotted sandpiper, osprey, and bald eagle were selected for evaluating ecological risk to birds, the sandpiper because of its habit of probing mud for food, and osprey and bald eagle because they prey on fish and are high on the food chain.

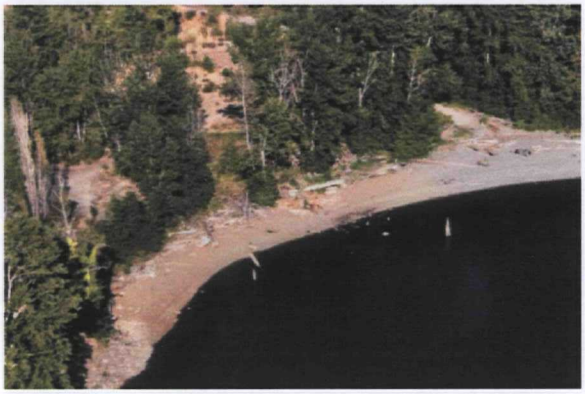
Mink and river otter were used for assessing ecological risks to mammals because they feed on fish and shellfish. Mink are rare in the Study Area due to limited habitat. Evidence and sightings of river otter are more common. Other mammals with habitat in the Study Area include beaver, muskrat, raccoon, and California sea lion.

Portland Harbor provides limited habitat for amphibians and reptiles. Most of the native amphibians that might be found in Portland Harbor prefer undisturbed areas that offer seasonal wetlands with emergent plants and shallow waters. Most local reptile species prefer wet vegetated upland habitats.

Aquatic plant communities are used by wildlife for refuge and for nesting and breeding habitat. The plants also provide food for herbivores and play a role in the cycling of nutrients. Current habitat constraints in Portland Harbor, including muddy water and overwater obstructions (e.g., docks) that prevent the sun from reaching the bottom plus extensive bank armoring, limit the development of dense submerged and emergent plant communities in the Study Area.

Human Use

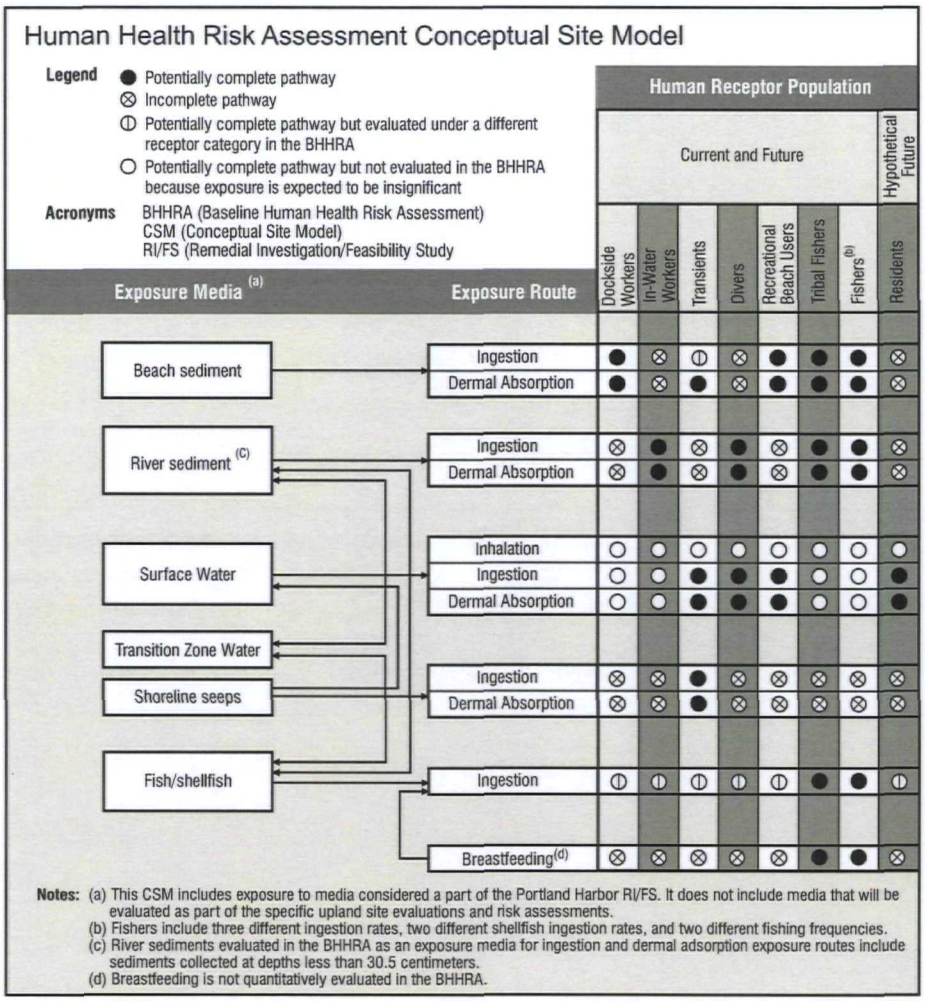
Industrial and urban development of Portland Harbor and adjacent areas has been extensive. The majority of the shoreline in the Study Area is currently zoned for industrial land use and is designated by the City of Portland as an "Industrial Sanctuary". Worker activities occur at the industrial and commercial facilities in the Study Area.



Portland Harbor also provides recreational opportunities both within the river itself and along the riverbanks. Additionally, there are residential areas located near the river and downstream of the Study Area. Recreational activities are associated with the public access areas, such as beaches and boat ramps, and may include water skiing, occasional swimming, and waterfront recreation. Fishing for salmon, sturgeon, and other species is conducted throughout the Study Area, both by boaters and from locations along the banks. The LWR also provides Native American ceremonial and subsistence fisheries for Pacific lamprey (particularly at Willamette Falls) and spring Chinook salmon. In addition, transients have been observed along the LWR, including some locations within the Study Area.

Baseline Human Health Risk Assessment

The Baseline Human Health Risk Assessment (BHHRA) evaluated the potential for adverse human health effects from exposure to hazardous chemicals within the Study Area. The general objective of the BHHRA was to assess the potential risks to human health from exposure to chemicals present in sediment, surface water, and groundwater seeps, or accumulating in fish and shellfish. The results of the BHHRA will be used to refine remedial action objectives and to inform decisions about cleanup of the Site.

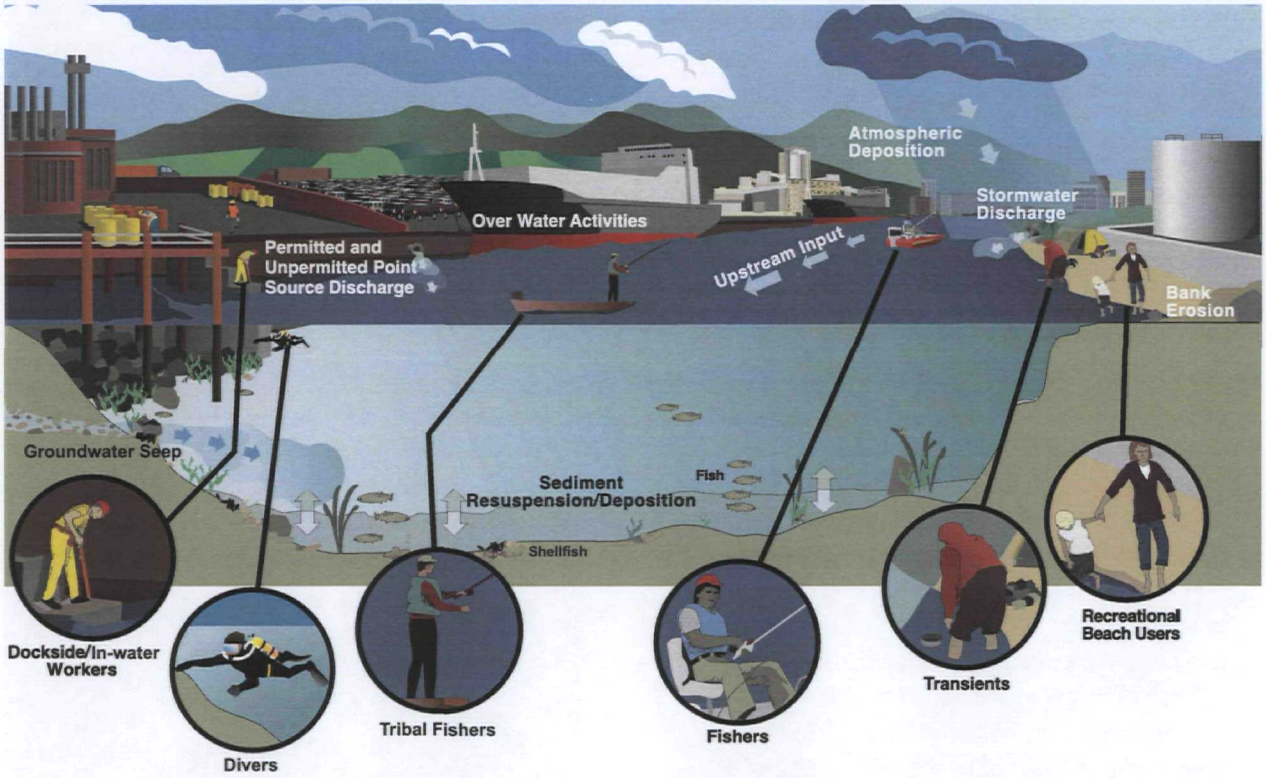


Approach to the Baseline Human Health Risk Assessment

The BHHRA evaluated the following exposure scenarios and receptors:

- **Dockside worker** — direct exposure to (i.e., ingestion of and dermal contact with) beach sediment
- **In-water worker** — direct exposure to in-water sediment
- **Transient** — direct exposure to beach sediment, surface water, and groundwater seeps
- **Adult and child recreational beach user** — direct exposure to beach sediment and surface water
- **Tribal fisher** — direct exposure to beach sediment or in-water sediment, and fish consumption
- **Fisher** — direct exposure to beach sediment or in-water sediment, fish consumption, and shellfish consumption
- **Diver** — direct exposure to in-water sediment and surface water.

Portland Harbor Superfund Site Illustration of Human Health Receptors and Exposure Pathways



A hypothetical future resident was also included as an exposure scenario to evaluate the domestic use of untreated surface water (ingestion and dermal contact). However, there are no known or anticipated future uses of the LWR within Portland Harbor as a domestic water source.

The BHHRA incorporated conservative, health protective assumptions in the development of exposure scenarios, the estimates of exposure, and the use of toxicity values, based on discussions with and direction from the EPA and its partners. The use of conservative exposure scenarios and toxicity values may overestimate risks, and this potential overestimation is considered when making decisions about Site cleanup.

Non-cancer and cancer effects were evaluated separately in the BHHRA. The potential for non-cancer effects was evaluated by comparing the estimated exposures to their toxicity values (i.e., threshold for adverse effects) using a ratio approach (i.e., Hazard Quotient HQ for single chemicals or Hazard Index HI for a chemical mixture where HI is the sum of HQs for chemicals in the mixture). When the HQ or HI is below 1, no hazard is expected. When the HQ or HI is above 1, a health hazard may be present. The potential for cancer was evaluated by comparing the estimated probability of cancer during an individual's lifetime to a target risk range of one in ten thousand (10^{-4}) to one in a million (10^{-6}), which is the "target range" within which the EPA strives to manage risk as a part of the Superfund program.

Results of the Baseline Human Health Risk Assessment

The major findings of the BHHRA include:

- Fish consumption is the exposure scenario accounting for the majority of risks to human health in the Study Area. Risks from fish and shellfish consumption exceed the target HI of 1 and the target cancer risk range of 10^{-6} to 10^{-4}.

- PCBs account for most of the risk from fish consumption, followed by dioxins/furans. Together, PCBs and dioxins/furans contribute approximately 98 percent of the cumulative excess cancer risk for fish ingestion.

- Risks resulting from the consumption of fish or shellfish are generally orders of magnitude higher than risk resulting from direct contact with sediment, surface water, or seeps. With the exception of two ½-river mile segments for the tribal fisher scenario, all of the direct contact scenarios result in risks within or below the EPA target cancer risk range of 10^{-6} to 10^{-4} and below the target HI of 1.

- The impact of uncertainties associated with risk estimates for the fish and shellfish consumption scenarios will be considered during the FS and taken into account for decisions about cleanup of the Site. Risk estimates in the BHHRA are based on multiple assumptions that may underestimate, or more likely over-estimate the actual risks.

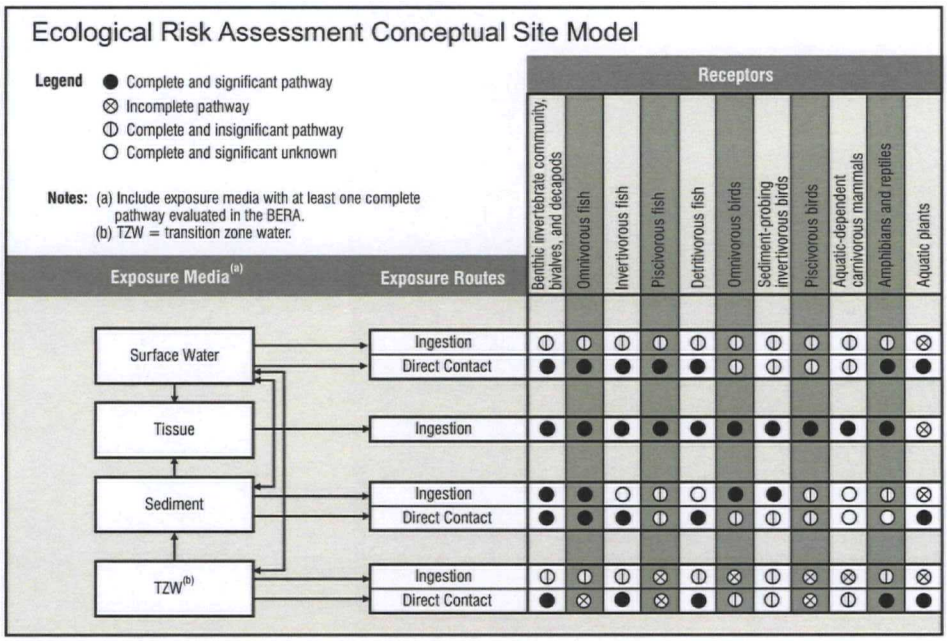
- The contribution of background sources of chemicals of concern (COCs) is an important consideration in decisions about site cleanup.

Two Examples of Human Health Risk Assessment Receptor Exposure Assumptions

	Fisher		Beach User	
	Fish	**Sediment**	**Sediment**	**Water**
Intake Rate	19 meals per month 10 meals per month 2 meals per month	Face, hands, forearms and lower legs (beach) Hands and forearms (in-water) Soil ingestion rates	Face, hands, forearms and lower legs (beach) Soil ingestion rates	Entire body Approx. 2 ounces per hour ingested
Exposure Duration and Frequency	365 days per year 30 years	2 or 3 days per week 30 years	5 days per week in summer, 1 day per week in spring/fall, 1 day per month in winter 30 years (adult) 6 years (child	2 days per week in summer (adult) 5 days per week in summer (child) 30 years (adult) 6 years (child)
Uncertainties	Preparation methods Maximum concentration Species consumed Site use Toxicity values	Beach use Site use Amount of contact Sediment adherence Toxicity values	Beach use Site use Amount of contact Sediment adherence Toxicity values	Swimming frequency Dermal absorption Toxicity values

Ecological Risk Assessment

The Baseline Ecological Risk Assessment (BERA) evaluated the potential for adverse effects on plants, invertebrates, amphibians, fish, and wildlife from hazardous chemicals within the Study Area. The primary objective of the BERA was to characterize the risks of chemical effects on these aquatic and aquatic-dependent ecological receptors in the Study Area.

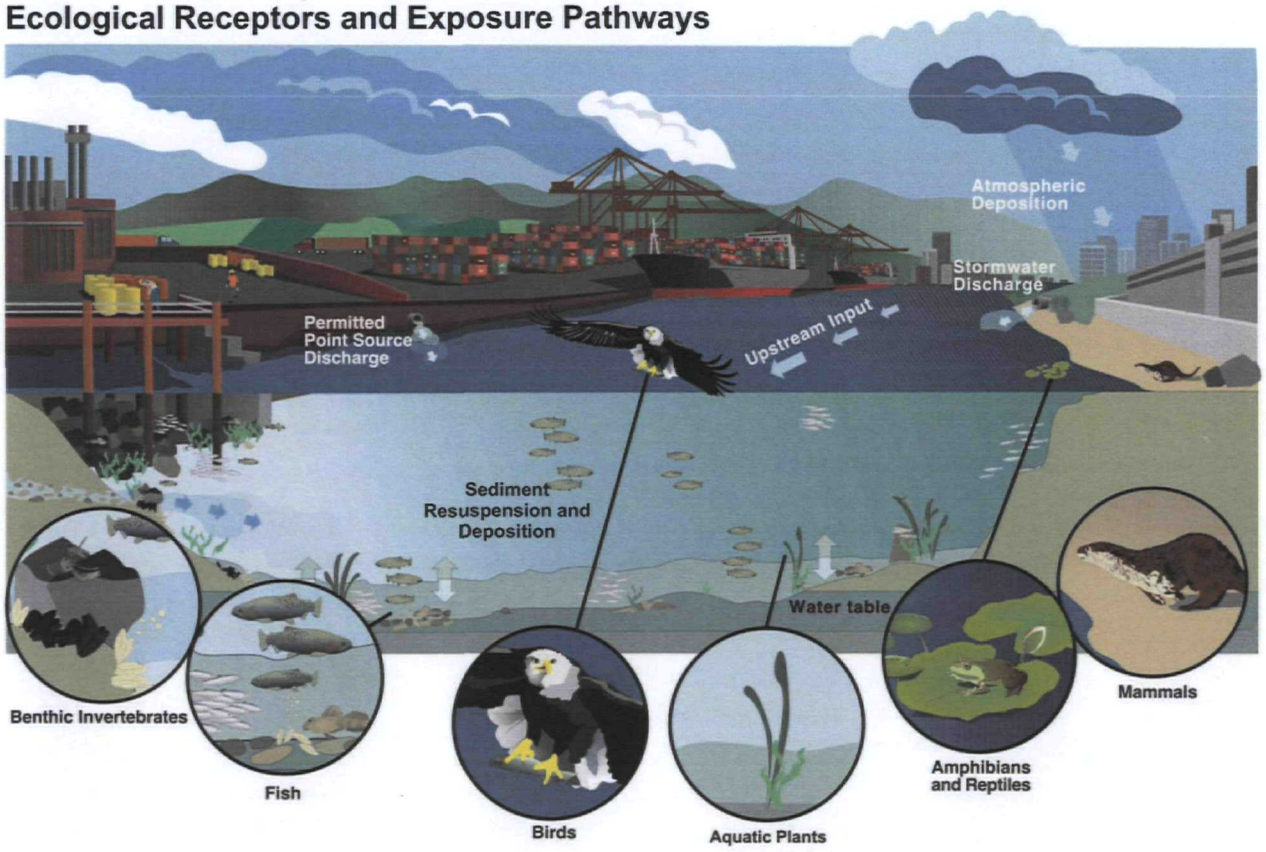


Approach to the Baseline Ecological Risk Assessment

The BERA was performed in accordance with EPA guidance and as otherwise directed by EPA. Ecological receptors were chosen for the assessment based on criteria consistent with EPA Superfund guidance. The receptors selected for assessment were:

- **Benthic invertebrate community** — benthic macroinvertebrate community, which includes clams, amphipods, crayfish, midge larvae and oligochaetes worms
- **Omnivorous fish populations** — largescale sucker, carp, and pre-breeding white sturgeon
- **Invertivorous fish populations** — sculpin, peamouth, and juvenile Chinook salmon
- **Piscivorous fish populations** — smallmouth bass and northern pikeminnow
- **Detritivorous fish individuals** — Pacific lamprey ammocoetes
- **Omnivorous bird populations** — hooded merganser
- **Sediment-probing invertivorous bird populations** — spotted sandpiper
- **Piscivorous bird populations/individuals** — osprey population and individual bald eagles
- **Aquatic-dependent carnivorous mammal populations** — river otter and mink
- **Amphibian and reptile populations** — amphibians (e.g., frog, salamander) and reptiles (turtle species)
- **Aquatic plant community** — phytoplankton, periphyton, macrophyte species

Portland Harbor Superfund Site Illustration of Ecological Receptors and Exposure Pathways



The assessment endpoints for all ecological receptors are based on the protection and maintenance of their populations and the communities in which they live, with the exception that survival, growth, and reproduction of organisms was designated by EPA as the assessment endpoint for juvenile Chinook salmon, Pacific lamprey ammocoetes, and bald eagle. For practical reasons and to be conservative, the organism-level measurement endpoints (survival, growth, and reproduction) were used for all receptors, requiring extrapolation to assess risks to populations and communities.

The BERA identified chemicals that might pose ecological risk (COCs). Throughout the process of assessing ecological risks and identifying COCs, a number of conservative assumptions were made. The most important conservative assumption in the process for initially identifying COCs was that effects on organism-level (i.e., individual-animal) endpoints translate into effects on ecological populations and communities. In reality, populations compensate for individual losses through a variety of ecological processes, so individual level risks do not necessarily imply population level risks. Therefore, the final list of COCs that have a plausible chance of causing adverse ecological effects was developed by considering the magnitude and spatial extent of risk estimates for organism-level endpoints.

Results of the Baseline Ecological Risk Assessment

The major findings of the BERA include:

- The majority of COCs identified in the Draft BERA were determined to pose no unacceptable risks to ecological populations or communities.
- Potentially unacceptable ecological risks are primarily from four chemical groups: PCBs, and to a lesser extent, dioxins/furans, DDTs, and PAHs. The BERA evaluates ecological risk to receptors from direct uptake and through the food chain (bioaccumulation). Bioaccumulation of PCBs by receptors and their prey poses the most significant ecological risks. PCBs were found to pose potentially unacceptable risk to populations of mink, river otter, osprey, hooded merganser, and spotted sandpiper throughout the Study Area; and to individual bald eagles and the benthic invertebrate community (in localized areas only).
- Mink and otter were identified as the ecological receptors at greatest risk. Most unacceptable ecological risks from other chemicals are spatially collocated with mink PCB risks. The potentially unacceptable ecological risks for other chemicals likely would be reduced or eliminated as a result of remedies in areas of elevated PCBs.
- Other areas of potentially unacceptable risk were identified for the benthic invertebrate community based on exceedances of sediment quality guidelines (SQGs) for PAHs and DDTs, primarily in portions of the middle reach of the Study Area (RM 5 to 8). Approximately five percent of the Study Area poses potentially unacceptable risk to the benthic community.
- Surface water and TZW results do not identify any additional ecological risk areas.
- Exposure to mercury concentrations in fish was found to potentially pose unacceptable risk to individual bald eagles; however, mercury contamination is a greater Willamette River issue requiring watershed-scale management action.
- Background levels of chemicals are an important factor, in addition to site-specific releases, contributing to potentially unacceptable ecological risks in the Study Area.

Next Steps

The Draft RI report provides extensive information, including Study Area physical, chemical, and biological characteristics; source identification; contaminant loading; a conceptual site model for the Study Area; and risk assessment results. Data collection for the RI is complete.

To support the FS, some tasks begun under the RI will be continued as part of the FS analysis, including:

Fate and transport modeling

Fate and transport models will support the evaluation of the effectiveness of remedial alternatives in the FS. They will also be used to assess the potential for recontamination of the Site from upland or upstream sources after implementation of potential remedies. The hydrodynamic and sediment transport model developed for the RI will be refined and coupled to chemical fate and transport models to achieve these objectives. In addition, the relative percentages of chemicals in fish and wildlife resulting from sediment versus surface water contamination will be evaluated using the fate and transport and bioaccumulation models developed for the RI/FS.

Ongoing source inventory update

Additional source information, including appropriate data collected by others, will be compiled in the FS to develop an updated inventory of ongoing sources for each potential in-water cleanup area. This information will be used to address the potential for unacceptable levels of recontamination or the need for DEQ to undertake upland source controls.

Refinement of the Conceptual Site Model

The Conceptual Site Model provided in the Draft RI will be refined as necessary and focused on individual sediment management areas identified in the FS.

To expedite development of the FS, EPA and the LWG have started to discuss Preliminary Remedial Goals and areas of potential concern. Early Preliminary Remedial Goals and areas of potential concern will be refined following EPA's review of the Draft BHHRA and Draft BERA. The refined Preliminary Remedial Goals and areas of potential concern will be incorporated into the FS. The LWG is currently proceeding with initial development and screening of remedial alternatives. Following EPA's review of the alternatives screening effort, the LWG will proceed with a detailed evaluation and comparative analysis of the remedial alternatives in accordance with EPA's evaluation criteria, culminating in development and submittal of the Draft FS report expected in late 2010.

List of Acronyms

AOC	Administrative Settlement Agreement and Order on Consent
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
COCs	chemicals of concern
DDD	dichlorodiphenyldichloroethane, a breakdown product of DDT
DDE	dichlorodiphenyltrichloroethylene, a breakdown product of DDT
DDT	the pesticide dichlorodiphenyltrichloroethane
DDTs	the pesticide DDT and its metabolites, DDD and DDE
DEQ	Oregon Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HI	hazard index
HQ	hazard quotient
LWG	Lower Willamette Group
LWR	lower Willamette River
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RI	remedial investigation
ROD	record of decision
RM	river mile
TZW	transition zone water

Glossary

10^{-6} to 10^{-4} risk: A range of cancer risk corresponding to a chance (probability) of excess cancer from one in a million to one in ten thousand. EPA considers this range when evaluating whether a risk estimate indicates an unacceptable risk to human health. Cancer probability is expressed in terms of risks in excess of those encountered over a life time in the general population.

Abiotic: Non-living. Typically refers to sediment, surface water, groundwater and other non-living environmental media.

Area of Potential Concern: An area of contaminated sediments that potentially contributes to unacceptable risks within the Site.

Background: Concentrations of chemicals, either naturally occurring or related to human activities that are not influenced by the releases from a site.

Benthic: Relating to or characteristic of the bottom of a water body or the organisms and plants that live there.

Bioaccumulative: Tending to accumulate in biota.

Biota: The animal and plant life of a given site or region.

Bounding Indicator Chemicals: In the RI, four chemical groups (total PCBs, total dioxins/furans, total DDTs, and total PAHs) are referred to as "bounding" indicator chemicals because their distribution is believed to encompass the spatial extent of potentially unacceptable risks associated with all COCs identified in the baseline risk assessments.

Chemicals of Concern: Chemicals identified through the baseline risk assessment that are associated with potentially unacceptable risk to human and/or ecological receptors.

Cleanup: Actions taken to remove contaminants from the environment and/or prevent excessive exposure of humans and ecological receptors. The term "cleanup" is sometimes used interchangeably with the terms remedial action, removal action, response action, natural attenuation, or corrective action.

Combined Sewer Overflow: Discharge of a mixture of stormwater and domestic wastewater when the flow capacity of a combined sewer system is exceeded during rainstorms.

Contaminant Loading: A rate of chemical input to a specified location within the river.

Dermal Contact: Contact between a chemical and the skin.

Ecological Risk Assessment: The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors, including chemicals.

Exposure Pathway: The path from sources of chemicals through environmental media to human or ecological receptors.

Groundwater: Water found beneath the ground surface in pore spaces between soil particles and in fractured rock. Groundwater provides drinking water from wells, and discharges to springs, rivers and wetlands.

Hazard Index: An indicator of the potential for cumulative noncancer effects that is derived by summing individual hazard quotients for two or more chemicals. HI values below 1 indicate a negligible hazard. HI values above 1 indicate a potentially unacceptable hazard.

Hazard Quotient: An indicator of the potential for adverse effects other than cancer from a given chemical calculated by dividing an estimated exposure (dose or concentration) by a toxicity reference value or reference dose. HQ values below 1 indicate a negligible hazard. HQ values above 1 indicate a potentially unacceptable hazard.

Human Health Risk Assessment: The process that evaluates the likelihood that adverse human health effects may occur or are occurring as a result of exposure to one or more stressors, including chemicals.

Lower Willamette River: The stretch of the Willamette River from the confluence with the Columbia River (river mile 0) to Willamette Falls (approximately river mile 26).

Media: Specific environmental materials such as air, water, soil and biological tissue.

Pathway: The physical course a chemical takes from its source to the exposed organism.

Preliminary Remediation Goal: A chemical concentration in a specific medium (e.g., sediments and water) that should meet acceptable risk levels.

Receptor: Human, fish, wildlife, or other species to be evaluated in a risk assessment.

Remedial Action: The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.

Risk Assessment: Qualitative and quantitative evaluation of the risk posed to human health or the environment by the actual or threatened release of specific chemical(s).

Risk Estimate: A quantitative value indicating the likelihood of an adverse effect (e.g., a cancer risk for humans). Although hazard quotients (e.g., for assessing non-cancer effects in either humans or ecological receptors) are typically referred to as risk estimates, they are not quantitative indicators of likelihood and should be interpreted mainly as indicating thresholds for hazard.

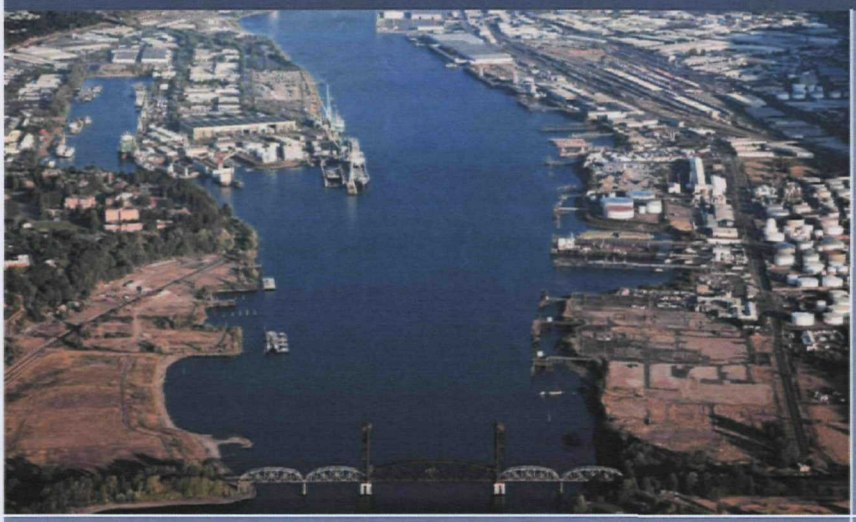
Study Area: The 10-mile stretch of the lower Willamette River (LWR) from river mile 1.9 to river mile 11.8, roughly between Sauvie Island and the Broadway Bridge north of downtown Portland.

Superfund: The EPA program that addresses both emergency removal and long-term remedial activities for contamination by hazardous chemicals. The Superfund program includes investigating sites for inclusion and ranking on the National Priorities List, and conducting and/or supervising cleanup and other remedial actions.

Transition Zone Water: The groundwater/surface water transition zone (also known as the hyporheic zone) is the interval where a mixture of groundwater and surface water compose some percentage of the water occupying interstitial space in the sediments.

Toxicity: The capacity for a substance or mixture of substances to cause adverse effects in humans or other organisms.

LWG
LOWER WILLAMETTE GROUP



For More Information on the Draft Remedial Investigation Report go to:

www.epa.gov/region10/portlandharbor

Section 1

1.0 INTRODUCTION

This remedial investigation report evaluates the environmental data collected and compiled by the Lower Willamette Group (LWG) since the inception of the Portland Harbor Remedial Investigation and Feasibility Study (RI/FS) in 2001. Portland Harbor, which encompasses the downstream portion of the Willamette River in Portland, Oregon, was designated as a Superfund site in 2000 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The LWG is performing the RI/FS for the Portland Harbor Superfund Site (Site) pursuant to a U.S. Environmental Protection Agency (EPA) Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (AOC; EPA 2001a, 2003b, 2006a). As provided in the Statement of Work (SOW) to the AOC, the objectives of the Portland Harbor RI/FS are as follows:

- Investigate the nature and extent of contamination for the Study Area[1]
- Identify sources of contamination that contribute, or have contributed, to unacceptable risk in Study Area[2]
- Assess potential risk to human health and the environment
- Develop and evaluate potential remedial alternatives to reduce risks to acceptable levels
- Recommend a preferred alternative for cleanup.

This RI Report addresses the first three objectives and includes the human health and ecological baseline risk assessments as appendices. The final two objectives will be addressed in the FS. The Final RI Report will capture any preliminary or incomplete information from the risk assessments that has changed pursuant to finalization of these documents.

Portland Harbor has been the focus of numerous environmental investigations completed by the LWG and various other governmental and private entities. Major LWG data collection efforts occurred during three sampling rounds to characterize the physical system of the lower Willamette River (LWR) and to assess the nature and extent of contamination in sediment, surface water, transition zone water (TZW)[3], stormwater, and biota. Media-specific investigations performed in Round 1 (summer 2002 to spring 2004) and Round 2 (fall 2004 to spring 2006) were previously documented in the *Comprehensive Round 2 Site Characterization Summary and Data*

[1] Defined as the in-water portion below or equal to +13 ft North American Vertical Datum (NAVD) from river mile 1.9 to 11.8.

[2] Upland source control efforts, including site-specific upland source control studies and implementation of source control measures, are performed under the oversight of the Oregon Department of Environmental Quality and are not within the scope of the AOC and SOW for the in-water portion of the Site.

[3] Transition zone water is the interval where both groundwater and surface water comprise some percentage of the water occupying pore space in the sediments.

Gaps Analysis Report (Round 2 Report; Integral et al. 2007), which was submitted to the EPA on February 21, 2007. Round 3 sampling activities took place during multiple field efforts in the winter of 2006, the summer/fall/winter of 2007, and February 2008. Data collected during these efforts supplemented the data collected in previous sampling rounds and closed data gaps identified by EPA and LWG.

The content and organization of this RI report adhere to CERCLA's *Guidance Document for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (EPA 1988). The required content of this RI Report is specified in Section 7.8.2 of the SOW:

> This report shall summarize results of field activities to characterize the Site, sources of contamination, nature and extent of contamination, and the fate and transport of contaminants. Respondents will refer to the RI/FS Guidance for an outline of the report format and contents. Following comment by EPA, Respondents will prepare a final RI Report that satisfactorily addresses EPA comments.

In accordance with these requirements, this report assembles data collected by the LWG and others, characterizes the physical characteristics and nature and extent of contamination in the Study Area (described below in Section 1.2) based on those data, identifies sources of contaminants to the Study Area, provides an analysis of the fate and transport of contaminants, discusses background contaminant concentrations, presents the baseline human health and ecological risk assessments, and provides a revised conceptual site model (CSM). The identification of areas of potential concern (AOPCs) and preliminary remediation goals (PRGs) for those AOPCs will be addressed during the FS process, and are not discussed in this RI Report.

The revised CSM expands upon the preliminary CSM previously presented in the Programmatic Work Plan (Integral et al. 2004), and updated in the CSM Update (Integral and GSI 2005a,b,c) and the Round 2 Report. Unlike the AOPC-specific CSMs presented in Section 11 of the Round 2 Report, the scope of the revised CSM presented in this RI Report is site-wide and includes a cross-media conceptual understanding of sources, chemical distribution, loading, fate and transport, and exposure pathways for human and ecological receptors for select chemicals of concern (COCs).

1.1 RI/FS OVERVIEW AND OBJECTIVES

The Programmatic Work Plan presented a generalized road map of the RI/FS process for the Portland Harbor Superfund Site. The process is multifaceted and iterative, with specific sampling events, technical memoranda, and decision points made during various phases that inform the RI and direct future FS work. The RI and FS are conducted concurrently, and data collected during the RI phase are used to develop and evaluate remedial alternatives in the FS phase. The ultimate goal of the RI is to collect sufficient data to adequately characterize the Site so that EPA can select a remedy that is protective of human and ecological receptors. The ultimate goal of the FS is to ensure that appropriate remedial alternatives are developed and evaluated in accordance

with CERCLA guidance to allow the selection of the most efficient remedies for cleanup that balance effectiveness, protectiveness, cost, compliance with Applicable or Relevant and Appropriate Requirements (ARARs), and public acceptance.

The RI was conducted consistent with EPA (1988) guidance (page 1-3, 2nd paragraph):

> The objective of the RI/FS process is not the unobtainable goal of removing *all* uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site. The appropriate level of analysis to meet this objective can only be reached through constant strategic thinking and careful planning concerning the essential data needed to reach a remedy selection decision. As hypotheses are tested and either rejected or confirmed, adjustments or choices as to the appropriate course for further investigations and analyses are required. These choices, like the remedy selection itself, involve the balancing of a wide variety of factors and the exercise of best professional judgment.

Specific objectives of the RI, which conform to the CERCLA RI/FS guidance document (EPA 1988) and the SOW, include the following:

- Investigate and describe the Site's physical setting, including land use, hydrology, hydrogeology, river and sediment dynamics, aquatic and wildlife habitat, and human use
- Identify major sources of historical and ongoing chemical contamination and the status of source control activities
- Describe the nature and extent of indicator chemicals (ICs), vertically and laterally, that may pose risk for both harbor-wide and localized areas of contamination
- Evaluate the loading, fate, and transport of ICs using available empirical information and model results
- Define the concentrations and statistical characteristics of ICs in appropriate upstream reference locations (i.e., background) for use in risk characterization, PRG development, and remedial alternatives evaluation during the FS
- Assess human and ecological risk under baseline conditions and identify COCs that may pose unacceptable risk
- Develop a revised site-wide CSM for select ICs that describes the cross-media understanding of chemical distribution, sources, loading, fate, transport, and exposure pathways for human and ecological receptors at the Site.

Ultimately, the primary information needed to make risk management decisions includes the following:

1. Identification of the receptors, exposure scenarios, and chemicals that are associated with potentially unacceptable risk from exposure to in-water media

2. For the above, identification of the exposure pathways (including media) and, to the extent practicable, locations that contribute most to a finding of unacceptable risk
3. For the receptors/pathways/chemicals identified in items "1" and "2" above, determination of whether the most important sources of contaminants to the river are ongoing or historical (not current releases), so that risk management actions can be taken to reduce exposures.

For in-water sources, actions may include active cleanup, natural recovery, or other management options for contaminated sediments in the river. The RI/FS must also identify potential sources that are not in the river, or are in the river upstream of the Study Area, but that are important ongoing sources of contamination to sediments and surface water, and therefore, may require management to address unacceptable risks to humans and biota associated with the Study Area. Management of these sources will be overseen by the Oregon Department of Environmental Quality (DEQ).

1.2 AREA OF STUDY

In accordance with the AOC, the RI/FS initially focused on the stretch of the LWR from river mile (RM) 3.5 to 9.2 and adjacent areas logically associated with an evaluation of the in-water portion of this stretch of the river. The SOW and the Programmatic Work Plan refer to that initial study area as the "ISA." During development of the Programmatic Work Plan, EPA required the LWG to broaden the investigation to include areas of the river extending from approximately RM 1.9 to 11; this expanded area was termed the "Study Area." Based upon its review of the Round 2 Report, EPA further expanded the Study Area to include RM 1.9 to 11.8[4] (Map 1.2-1). The ISA and the subsequent Study Areas do not define the Portland Harbor Superfund Site, the boundaries of which will be determined by EPA upon issuance of a Record of Decision (ROD).

1.3 SITE BACKGROUND

Portland Harbor is a heavily industrialized reach of the LWR located immediately downstream of downtown Portland, Oregon and extending almost to the confluence with the Columbia River. The harbor has been the site of numerous manufacturing, shipbuilding, petroleum storage and distribution, metals salvaging, and electrical power generation activities for over a century. Since the late 1800s, the harbor has been extensively modified by wetland draining, channelization, and dredging for creation and maintenance of the navigation channel and ship berthing areas. A large portion of the upland area adjacent to the Study Area is zoned industrial within the River Industrial

[4] As part of the RI, the LWG also sampled contiguous areas adjacent to the Study Area downstream to RM 0.8, in the upstream portion of the Multnomah Channel, and upstream to RM 12.2. This sampling was conducted to support the Site boundary definition and assess potential contaminant migration in these adjacent areas.

Greenway overlay. Little, if any, original shoreline or river bottom exists that has not been modified by the above actions, or as a result of them. Some riverbank areas and adjacent parcels have been abandoned and allowed to revegetate, and beaches have formed along some modified shorelines due to relatively natural processes.

Public and private outfalls are located on both shores of the river. These outfalls have historically discharged stormwater, municipal waste, and industrial wastewater to the harbor from numerous drainage basins that have a variety of land uses and facilities. In addition to areas adjacent to the harbor, agricultural, industrial, transportation, and residential land uses in the Willamette Basin upstream of the harbor historically and currently discharge municipal, agricultural, and industrial wastewater and stormwater directly to the Willamette River and indirectly discharge through overland, overwater, and groundwater pathways, thereby contributing to chemical contamination of sediments in the Study Area. Although private industries and municipalities within the river watershed began installing waste control systems beginning in the 1950s, the legacy of past waste management practices remains in the river bottom sediments.

In March 1997, DEQ and EPA initiated a joint study of shallow, nearshore river sediment contamination in the LWR from approximately RM 3.5 to 9.5. Sediments containing metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated pesticides, and dioxins were found throughout the harbor area (Weston 1998). Based on the concentrations of these contaminants, EPA determined in December 2000 that Portland Harbor qualified for placement on the National Priorities List (NPL) under CERCLA. In the listing, EPA and DEQ are the lead agencies for the in-water and upland portions, respectively, of the Portland Harbor Superfund Site. Both agencies coordinate their efforts through a Memorandum of Understanding (MOU) that was signed in 2001 by government stakeholders, including six tribal governments (the Confederated Tribes and Bands of the Yakama Indian Nation, the Confederated Tribes of Grande Ronde, the Confederated Tribes of Siletz Indians of Oregon, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce tribes) and several state and federal natural resource trustees (National Oceanic and Atmospheric Administration [NOAA], Oregon Department of Fish and Wildlife [ODFW], U.S. Fish and Wildlife, and U.S. Department of Interior).

In September 2001, EPA and the LWG entered into the AOC to complete an RI/FS of the Portland Harbor Superfund Site. The LWG includes private property owners along the Willamette River, the Port of Portland, and the City of Portland and represents a small subset of the potentially responsible parties (PRPs) identified by EPA. The final Programmatic Work Plan was approved by EPA in June 2004. The Programmatic Work Plan provides an outline and schedule for the sampling activities performed to support the RI/FS. All field sampling activities are documented in a series of field sampling plans (FSPs), quality assurance project plans (QAPPs), health and safety plans, field sampling reports (FSRs or cruise reports), and site characterization summary reports (SCSRs).

DEQ is working with upland property owners to identify and control upland sources of contamination that may be affecting river sediments through such pathways as overland runoff, bank erosion, stormwater discharge, or groundwater seepage. A total of 82 upland sites are in various phases of cleanup, ranging from agreement negotiation to source control evaluation and implementation (DEQ 2009). Cleanup at two upland NPL sites within or adjacent to Portland Harbor (Gould and McCormick & Baxter Creosote Co. [M&B]) has been implemented, including some in-water work at M&B.

Early in-water removal actions have been or are being performed by three upland property owners under separate EPA orders: Port of Portland at Terminal 4 (RM 4.5), NW Natural adjacent to the former Gasco site (RM 6.2), and Arkema adjacent to its former plant (RM 7.2). These actions will probably precede any remediation that occurs as a result of the Portland Harbor RI/FS and will be coordinated with cleanup actions ordered by EPA in the Portland Harbor ROD(s).

EPA is also working with the University of Portland to conduct cleanup activities on the Triangle Park property (RM 7.4). EPA is overseeing the investigation and eventual upland cleanup.

1.4 REPORT ORGANIZATION

The remaining sections of this report include the following information:

- **Section 2. Environmental Data Sets.** This section focuses on data quality reviews that were performed to evaluate the quality of LWG and non-LWG data and to determine their usability for various purposes in the RI/FS, Baseline Human Health Risk Assessment (BHHRA), and Baseline Ecological Risk Assessment (BERA). It summarizes the LWG investigative activities that have occurred since the Portland Harbor RI/FS began in 2001, including sediment, surface water, TZW, sediment trap, stormwater, and biota sampling, as well as physical characterizations. Historical and concurrent investigations performed by others and used in the risk evaluations are also described.
- **Section 3. Current Environmental Setting.** This section reviews the physical characteristics of the Study Area, including land use, geology, hydrogeology, bathymetry, sediment physical properties, habitat, and public access. Results from the application of the hydrodynamic sedimentation model are also discussed.
- **Section 4. Identification of Sources.** This section describes general land use changes to give a historical context to the Study Area. A history of the municipal sanitary and stormwater conveyance system is also provided. The types of known and potential chemical sources that affect the Study Area are identified. This section augments general information on sources provided in the Programmatic Work Plan and the Round 2 Report.

- **Section 5. In-river Distribution of Indicator Chemicals.** This section describes the nature and extent of ICs in surface and subsurface sediment, in-river sediment traps, surface water, TZW, and biota.
- **Section 6. Loading, Fate, and Transport for Select Indicator Chemicals.** This section presents an overview of the primary known sources of chemicals to the river; describes the processes affecting the release, transport, and fate of ICs within the Study Area; and presents estimates of current pathway-specific mass-loading rates of select ICs. Historical loading to the Study Area is discussed qualitatively in this section.
- **Section 7. Determination of Background Concentrations for Indicator Chemicals.** This section evaluates the concentrations and statistical characteristics of ICs in surface water and sediment samples collected from upstream reference locations (i.e., background) for use in risk characterization, PRG development, and remedial alternatives evaluation during the FS. Sediment trap data, surface water suspended solids, and subsurface sediment data collected from dredge borrow pits near the upstream end of the Study Area are also discussed as supporting lines of evidence for background.
- **Section 8. Baseline Human Health Risk Assessment Summary.** This section provides a summary of the BHHRA included in Appendix F.
- **Section 9. Baseline Ecological Risk Assessment Summary.** This section provides a summary of the BERA included in Appendix G.
- **Section 10. RI Conceptual Site Model for Select Indicator Chemicals.** This section presents a site-wide overview of the physical setting; chemical distribution in sediments; contamination sources; external loading and internal fate and transport mechanisms; human health risk drivers and potentially complete exposure pathways/scenarios; and ecological risk drivers and ecological receptors/exposure pathways. For selected ICs, this section also presents integrated, chemical-specific evaluations of nature and extent in abiotic and biotic media in the Study Area, and the relationships between the observed distribution in the system and known or likely historical and current sources of contamination.
- **Section 11. Summary and Conclusions.** This section provides an overview of Sections 1 through 10 of the RI report, lists the major findings of the RI, and the next steps in the RI/FS process. The objective of the section-by-section summaries is to note the content and key elements of each section.
- **Section 12. References.** Citations noted in the RI are found in this section.
- **Section 13. Glossary.** This section contains definitions of technical terms found in the RI.

Seven appendices are included with this document:

- **Appendix A. Data Sources and Site Characterization/Risk Assessment Database.** This appendix briefly summarizes the studies from which data in this RI report were obtained and includes the complete database in Access® files on compact disc. Data rules for reducing the site characterization/risk assessment (SCRA) database into the RI data set are provided. Further, this appendix includes the process for calculating chemical concentrations from whole-body bass and carp samples. Finally, an administrative appendix that documents the decision-making process between EPA and the LWG for the RI is included.
- **Appendix B. DEQ April 2009 Milestone Report Table 1.** This appendix presents Table 1 from DEQ's Joint Source Control Strategy (JSCS) Milestone Report (DEQ 2009).
- **Appendix C. Stormwater Statistics and Groundwater Characterization.** Summary statistics for stormwater collected by the LWG and other parties are included in this appendix. Details of LWG's groundwater pathway assessment work, including identification of potential upland groundwater source areas and TZW investigation results, are also provided.
- **Appendix D. Nature and Extent of Chemicals in Biotic and Abiotic Media.** Summary statistics of the chemical and physical data for all media are provided. The appendix includes constituent concentrations used in each summed analyte group for all media. Scatter plots, histograms, and maps of chemical distribution of ICs not included in the main report are also included in this appendix. Two technical memos are included in this appendix: 1) Comparison of PCB Aroclor and Congener Data, and 2) Monitored Natural Recovery Area Radioisotope Evaluation.
- **Appendix E. Loading, Fate, and Transport Supporting Information and Calculations.** This appendix provides the analyses used to develop loading estimates for upstream surface water, stormwater, permitted point source discharges, atmospheric deposition, groundwater plumes, and advection through sediments.
- **Appendix F. Baseline Human Health Risk Assessment.** This appendix provides the complete BHHRA.
- **Appendix G. Baseline Ecological Risk Assessment.** This appendix provides the complete BERA.

Section 2

2.0 ENVIRONMENTAL DATA SETS

Environmental data have been collected within the Portland Harbor Study Area during numerous LWG sampling events since the inception of the Portland Harbor RI/FS in 2001. These data, along with data from historical and concurrent studies by other parties in the LWR constitute the Portland Harbor SCRA database. The Portland Harbor SCRA database consists of over one million analytical results representing a variety of sample matrices dating back to 1969. The most recent data are from June 2008.

Environmental data sets in the SCRA database have undergone rigorous data quality review and meet the data quality objectives established for the project in the Programmatic Work Plan (Integral et al. 2004; see Section 2.1.1). The SCRA database is the basis for defining the nature and extent of the contaminants and provides foundational information from which decisions are made regarding human health and ecological risk within the Study Area, as well as the development of remedial alternatives for the FS.

The Portland Harbor SCRA database was transmitted to members of the LWG risk assessment teams on June 2, 2008. The RI, BERA, and BHHRA database managers separately queried the Portland Harbor SCRA database to derive subsets of data to support their respective efforts. For the RI, the BERA, and the BHHRA, a date of May 1, 1997 was used to define the initiation of the sediment data set to follow the last major flood of the Willamette River in the winter of 1996. Additional selections and data reduction steps were applied to the RI, BHHRA, and BERA data sets to satisfy specific data evaluation and presentation needs. Each data set is briefly described below:

- **RI Data Set** – The RI data set includes data from those matrices relevant to discussions of chemical distributions, chemical loading, background, and potential sources, including sediment/sediment trap, riparian sediment and soil, surface water, TZW, seep, tissue, and stormwater data. Selected data collected by other parties are presented in Table 2.0-1 and are described in Section 2.1.4 and Appendix A1. Exclusions from the RI data set are presented in Appendix A2. A flat file of the RI data set is provided in Appendix A3.
- **BHHRA Data Set** – The BHHRA data set includes only those matrices relevant for direct human health exposure pathways, including surface sediment, clam and crayfish tissue, fish tissue, surface water, seep water, and shallow TZW. Data sources and selection criteria for the BHHRA data set are summarized in Section 2.1.4 and are described in detail in Appendix F.
- **BERA Data Set** – The BERA data set includes matrices relevant to ecological exposure pathways, including surface sediment, benthic invertebrate and fish tissue, surface water, and shallow TZW. Data sources and selection criteria for

the BERA data set are summarized in Section 2.1.4 and are described in detail in Appendix G.

The remainder of Section 2 presents the data management and reduction process used in the RI and risk assessments (RAs; Section 2.1) and the environmental data collected by media (Section 2.2).

2.1 DATA EVALUATION PROCESS

This section focuses on data quality reviews that were performed to evaluate the quality of LWG and non-LWG data and determine their usability for various purposes in the RI/FS, BHHRA, and BERA. The principal issues related to the usability of historical and current data include data quality, sediment stability over time, and the intended use of the data. All of these factors must be acceptable for data to be considered usable.

2.1.1 Data Quality

Methods for performing data quality reviews for data generated by the LWG are described in the project-specific QAPP. In addition, a detailed review of the quality of each non-LWG chemical and biological data set was performed prior to entering those data sets into the project database. Methods for reviewing non-LWG data are described in the Programmatic Work Plan (Section 4 and Appendix F; see Integral et al. 2004).

Two overall data quality categories were established in the Programmatic Work Plan, as follows:

- **Category 1.** Category 1 data are of known quality and are considered acceptable for use in decision making for the Site. There is sufficient information on these data sets to confidently verify that the data, along with associated data qualifiers, accurately represent chemical concentrations present at the time of sampling.
- **Category 2.** Category 2 data are of generally unknown or suspect quality. The quality assurance and quality control (QA/QC) information shows that data quality is poor or suspect, or essential QA/QC data (e.g., surrogate recoveries, matrix spike/matrix spike duplicates) are either incomplete or lacking.

The evaluation of data quality was conducted at the finest level of detail available for each data set. This evaluation focused on individual analyte groups within each survey when possible, and so any given survey may contain all Category 1 data, all Category 2 data, or a combination of Category 1 and 2 data. In addition, data that received a QA1 or QA2 level of validation were flagged as such, providing a combined data quality category (e.g., Category 1 QA2). For chemistry data, Category 1 and 2 designations were entered into the project database for each sample and analyte. Sample counts of Category 1 and Category 2 data are summarized in Table 2.1-1.

Project decisions will be based on analyses using Category 1 data. Category 1 data that have had an EPA-approved level of data validation, comparable to Washington State Department of Ecology's "QA2" evaluation, are designated as "Category 1 QA2" data sets. All data generated by the LWG hold the Category 1 QA2 designation. Some data generated by other parties are also designated Category 1 QA2. Non-LWG Category 1 data that received an abbreviated level of review are termed "Category 1 QA1." Only Category 1, QA2 data are used in the BHHRA, the BERA, and the determination of background chemical concentrations (Section 7). Both Category 1, QA1 and QA2 data are used to describe the nature and extent of contamination (Section 5) and to evaluate contaminant loading, fate, and transport (Section 6). Category 2 data were generally used for project scoping. For example, Category 2 tissue data were used to help identify chemical of interest (COIs), and Category 2 sediment data were used in the initial assessment of trends in chemical concentrations, which was useful for developing sampling programs. No Category 2 data for environmental media other than sediment are included in the RI data set provided in Appendix A3.

2.1.1.1 Chemical Data Review Criteria

Criteria for placing data sets into categories were developed during the compilation of existing information to identify basic data qualities and not to limit data to specific program uses. Chemical data quality was assessed by evaluating the following factors:

- Traceability
- Comparability
- Sample integrity
- Potential measurement bias
  - Accuracy
  - Precision.

All of these factors were known or supported by existing QA/QC information (analytical methods, chain-of-custody, sample holding time, method blanks, matrix spike/matrix spike duplicates, laboratory control samples, replicates, surrogates) for Category 1 data. If supporting documentation for each factor was not available or was not reinforced by the availability of other high-quality QA/QC information, data were assigned a Category 2 designation. If the acceptance criteria for any of the above factors were not satisfied for either the entire data set or a specific analyte group, data for that data set or group were generally qualified and were determined to have limited usefulness. The chemical data were reviewed by analyte group (e.g., metals, semivolatile organic compounds [SVOCs]). As a result, a data set may contain all Category 1 data, all Category 2 data, or both Category 1 and Category 2.

2.1.1.2 Biological Data Review Criteria

Bioassay data quality was evaluated based on validation guidelines and performance criteria from the Puget Sound Estuary Program (PTI 1989). Bioassay validation guidelines include checks of completeness, holding conditions, standard reporting methods, and QA/QC results for negative control, reference sediment, positive control (reference toxicant), and measured water quality parameters according to standard testing methods and established performance criteria.

2.1.2 Sediment Stability and Temporal Integrity

The observed and modeled hydrodynamic and sediment transport patterns in the LWR, particularly in the Study Area, are detailed in Section 3. Early RI investigations—Sediment Trend Analysis® (STA), Sediment Profile Imagery (SPI), and time-series bathymetry studies—have been described previously (Integral et al. 2004, 2007), and these initial lines of evidence suggested the potential for widespread, small-scale (≤30 cm) surface sediment disturbance or movement during winter (rainy season) flow regimes. The measured, maximum net bathymetric change over the 25-month period between the January 2002 and February 2004 surveys was less than 30 cm (1 ft) over 90 percent of the ISA (see Section 3.4.2). While river bed elevations during flooding events were not measured, the 30-cm depth appears to represent an interval below which sediment erodibility decreases markedly (or conversely sediment column stability increases). While this characteristic is heterogeneous across the site (e.g., erodibility of sandy sediments being different than mud), a 30-cm surface sediment layer definition for the RI was designed to capture that portion of the sediment column that has the potential to be disturbed or transported under typical annual conditions.

Empirical surface sediment erodibility measurements (Sedflume) associated with the hydrodynamic and sediment transport (HST) modeling, as well as measured surface-to-subsurface gradients in chemical contamination, also indicate that significant river-wide sediment bed movement or resuspension does not occur under typical flow conditions in the Study Area. There is potential, however, for significant sediment bed movement in the high-energy portions of the LWR during rare high-flow events. Modeling simulations of extreme hydrological events (e.g., the 100-year flood) on the LWR indicate the potential for significant sediment bed erosion up to one meter (m) or more in the more dynamic portions of the Study Area (see Section 3.4.3; WEST and Tetra Tech 2009). The February 1996 flood is the most recent hydrologic event on the LWR that approaches a 100-year flood level. The following winter (1997) had the second highest flow levels observed in the past 30+ years.

In consideration of these factors, the RI data set only includes data that were collected after the winter of 1996/1997 and that meet the other usability criteria described above; the earliest data included in the database were collected in May 1997. The presumption is that while near-surface changes in chemical concentrations due to sediment scour or accretion certainly have occurred in places, no natural large-scale erosion events or re-exposure of buried deep sediments has occurred since that time.

2.1.3 Data Usability

A final component of the data evaluation process is to consider the intended use of the data throughout the complete RI/FS process. This is an important component because, although the same database may be used, various treatments and interpretations of the data may be necessary depending on the objectives of the specific evaluations. This section describes some of the more commonly encountered, and perhaps most consequential, data usability issues for the Portland Harbor RI/FS—elevated detection limits for undetected chemical concentration data and N-qualified chemical concentration data.

2.1.3.1 Elevated Detection Limits

The historical database for Portland Harbor contains some samples with undetected concentrations of constituents at high detection limits. From a purely analytical perspective, EPA categorizes all data meeting proper QA/QC procedures, regardless of detection limit level, as Category 1 (i.e., data of known quality and considered acceptable for use). However, the acceptability of these data is dependent on their specific use. For example, in the absence of other data, elevated detections limits may provide insight on the need for additional analyses for which lower detection limits are achievable. From a data-needs standpoint, however, these same data may not be useful because if inappropriately compared to some concentration benchmark, they could unnecessarily result in the perceived need for additional sampling and analysis (despite their attendant uncertainty in actual concentration). From a predictive risk assessment perspective, these data are recommended by EPA to be excluded from formal risk quantification because of their uncertainty in concentration (EPA 1989). From an applied engineering and feasibility standpoint, elevated detections limits are also not useful because they are not capable of defining with precision actual chemical concentration data that can be used to set boundaries for remedy considerations.

2.1.3.2 N-qualifiers

N-qualified data present another situation that requires evaluation in the context of data use. N-qualified data in the RI data set are identified and used in the RI and RAs with recognition of the potential limitations associated with using this data noted below.[1] The N-qualifier denotes that the identity of the analyte is presumptive and not definitive, generally as a result of the presence in the sample of an analytical interference, such as hydrocarbons or, in the case of pesticides, PCBs. Data that are N-qualified meet the primary identification criteria of the method; however, the confirmation criteria are not met and the identification is potentially a false positive. In addition to uncertainty regarding chemical identification, N-qualified data also indicate some uncertainty in the reported concentration level (EPA 1989). The degree of attendant uncertainty in both identification and concentration is commonly assessed on a sample-by-sample basis.

[1] Consistent with Risk Assessment Guidance for Superfund Part A (EPA 1989), N-qualified data were included in the data set used for use in risk assessment, as documented here.

Given the uncertainty associated with N-qualified data, as well as the varying extent of this uncertainty, users must carefully weigh the impacts of its use throughout the RI/FS process. This careful attention is fully consistent with EPA guidance and other data-use guidance documents recommending the use of N-qualified data only on a case-by-case basis. The rationale for this is that data are evaluated and used in different ways throughout the RI/FS process. Provided below are some examples of how intended use of N-qualified data could vary:

- **Nature and Extent.** In nature and extent determinations, evaluations of data are generally predicated on individual, point-by-point analytical results (e.g., determining the individual chemical concentration results at various sample locations as opposed to calculating a mean across those samples). In instances when N-qualified data are spatially accompanied by data of more certain chemical identification and concentration, the role of N-qualified data is likely limited. This is often the case for Portland Harbor, where there exists an abundance and wide distribution of data for sediment, surface water, and biota that are not N-qualified. The number and percentage of N-qualified data for the nature and extent ICs (see Section 5.0) for all media are summarized in Table 2.1-2 and details are provided in data reports and SCSRs for the various sampling tasks.

- **Risk Assessment.** N-qualified data are present in the database, and EPA requested that these data be included in the risk assessments (EPA 2006). EPA (1989) recognizes that while uncertainty in both chemical identity and chemical concentration exists for N-qualified data, their use in risk assessment is judged on a case-by-case basis. N qualification indicates "the presence of an analyte that has been 'tentatively identified,' and the associated numerical value represents its approximate concentration" (EPA 1999). The qualification indicates that the analyst believed that the result was the result of analytical interference from a chemical other than the target analyte. All N-qualified results are therefore biased high for organochlorine pesticides and may result in an overestimation of risk.

- **Feasibility Study.** As the RI process proceeds towards conclusion, the LWG will continue to engage EPA on the need and importance of utilizing N-qualified data. Because the FS stage relies on both elements of nature and extent and risk assessment, the LWG will continue to examine carefully to what degree, if any, N-qualified data impact the FS work and its findings.

2.1.4 SCRA Database

The LWG project database contains all of the data reported by the analytical laboratories. This includes field and lab replicates, lab dilutions, results for the same analyte from multiple analytical methods (SW8270 and SW8270-SIM, for example), and laboratory QA samples such as matrix spikes, surrogates, and method blanks. The

data handling rules described in *Guidelines for Data Averaging and Treatment of Non-detected Values for the Round 1 Database* (Kennedy/Jenks et al. 2004) were used to create a simplified data set for the SCRA data users. This involved creating a SCRA database that excludes laboratory QA results, contains only the most appropriate dilution result and analytical method for each analyte, and averages laboratory replicates and splits. The resulting data set contains only one result per analyte per sample.

2.1.4.1 Quality Assurance/Quality Control

QA/QC checks were made throughout the data management process, but those specific to SCRA data reduction steps focused on the following checks:

- **Completeness** – Chain-of-custody forms submitted to the laboratory listing samples, methods, and analyses were compared to samples, methods, and analytes loaded into the SCRA for each sampling event. These checks were made for all samples. For data sets prepared by other parties, the source document was typically used to check sample/method/analyte completeness in the SCRA.
- **Averaging** – Laboratory duplicates and field splits were averaged. Because averaging required significant data manipulation, a series of additional checks was performed on the SCRA database before distribution. Data were divided into subgroups, and approximately 40 percent of the data in each subgroup were verified. If any problems were found with the averaging, then 100 percent of the data in the subgroup were verified and problems were corrected.
- **Database Codes** – Project database codes were checked for sample type, matrix type, basis, and units. Unusually high and low values for a given method were checked to confirm potential unit or analytical errors.
- **Qualifiers** – Checks were made for unusual data qualifier codes. Qualifier codes for calculated averages followed guidelines provided in Kennedy/Jenks et al. (2004).

In addition to the standard checks above, Integral's senior chemists reviewed all final SCRA files prior to distribution.

2.1.4.2 Calculated Totals

This section presents the summation rules for the RI data set and baseline RA data sets and highlights where they deviate. Data management rules for all three data sets are summarized in Table 2.1-3.

2.1.4.2.1 General Summation Rules

RI data set summation rules are as follows:

- Calculated totals are the sum of all detected concentrations; non-detected concentrations are treated as zero
- If all analytes for a total are not detected, then the highest detection limit is used for the summation.

Baseline RAs and the background data set summation rules are as follows:

- Calculated totals are the sum of all detected concentrations, and non-detected results for analytes detected at least once in the RA data set within the Study Area for a given medium are included in the summation at one-half the detection limit
- If none of the analytes are detected for a given sample, but are determined to be present within the Study Area, then the highest detection limit is used for the summation
- Non-detects for analytes never detected within a data set for a given medium are excluded (i.e., treated as zero).

The determination of medium-specific data sets differs between the BHHRA and the BERA based on relevant exposure scenarios. Medium-specific data sets are described in Appendix F (BHHRA) and Appendix G (BERA).

2.1.4.2.2 Individual Analytes in Calculated Totals

Data sets for the RI and baseline RAs included calculated totals for the chemical groups listed in Table 2.1-4.

Individual analytes included in totals are as follows:

- **Total PCBs**—Sum of PCB Aroclors or PCB congeners. Total PCB Aroclors represent the sum of all reported Aroclors. Total PCB congeners represent the sum of all reported (up to 209) individual congeners. For the RI and BHHRA data sets, total PCB congeners were selected to represent total PCBs when available. If not available, total PCB Aroclors were selected. Total PCB selection in the BERA varied depending on the medium:
  - For all BERA surface sediment samples, the total PCB concentration is represented by total PCB Aroclors.
  - For the BERA tissue data set, the total PCB concentration is represented by total PCB Aroclors for Round 1 samples and total PCB congeners for Round 2 and Round 3 samples. Aroclors were selected over congeners for Round 1 because PCB congener analysis was performed on only a limited number of samples.
  - For the BERA surface water data set, the total PCB concentration is represented by total PCB congeners for all XAD samples and by total PCB Aroclors for locations where only peristaltic samples were collected.

- **Total PCDD/Fs**—Total polychlorinated dibenzo-p-dioxin/furan (PCDD/Fs) reported in the RI are the sum of tetra and higher polychlorinated dioxin and furan homologs: tetrachlorodibenzo-p-dioxins (TCDDs), pentachlorodibenzo-p-dioxins (PeCDDs), hexachlorodibenzo-p-dioxins (HxCDDs), heptachlorodibenzo-p-dioxins (HpCDDs), octachlorodibenzo-p-dioxin (OCDD), tetrachlorodibenzofurans (TCDFs), pentachlorodibenzofurans (PeCDFs), hexachlorodibenzofurans (HxCDFs), heptachlorodibenzofurans (HpCDFs), and octachlorodibenzofuran (OCDF). Total PCDD/Fs for the BERA were calculated from the sum of individual PCDD/F compounds. The BHHRA relies solely on the 2,3,7,8-TCDD TEQ.
- **PCB and Dioxin TEQs**—Toxic equivalency factors (TEFs) were used to calculate PCB and dioxin toxic equivalent concentrations (TEQs). Concentrations of congeners are multiplied by their TEFs to estimate toxicity of the congeners relative to 2,3,7,8-TCDD. Resulting concentrations are summed. TEFs are published by the World Health Organization (WHO) for fish and birds (Van den Berg et al. 1998) and for mammals (Van den Berg et al. 2006).
- **Total DDx**—Total DDx was calculated from the six DDx compounds: 2,4′-dichloro-diphenyl-dichloroethane (DDD); 4,4′-DDD; 2,4′-dichloro-diphenyl-dichloroethene (DDE); 4,4′-DDE; 2,4′-dichloro-diphenyl-trichloroethane (DDT); and 4,4′-DDT. Total DDD were calculated with 2,4′-DDD and 4,4′-DDD; total DDE were calculated with 2,4′-DDE and 4,4′-DDE; and total DDT were calculated with 2,4′-DDT and 4,4′-DDT.
- **Total LPAHs**—Total low molecular weight PAHs (LPAHs) are the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
- **Total HPAHs**—Total high molecular weight PAHs (HPAHs) are the sum of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
- **Total PAHs**—Sum of the individual LPAHs and HPAHs.
- **Total cPAHs**—A benzo(a)pyrene (BAP) equivalent (BaPEq) concentration was calculated by multiplying the carcinogenic PAHs (cPAHs) by their respective potency equivalent factors (PEFs), and summing the resulting concentrations. PAHs classified as carcinogenic are benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, and dibenzo(a,h)anthracene. PEFs were assigned according to EPA (1993) and are shown in Appendix A3.
- **Total Chlordanes**—Sum of cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.
- **Total Endosulfan**—Sum of alpha-endosulfan, beta-endosulfan, and endosulfan sulfate.

- **Total Xylene**—Sum of m,p-xylene, o-xylene, and xylene.
- **BTEX**—Sum of benzene, toluene, ethylbenzene, and total xylene.
- **Total Fines**—Sum of all silt and clay grain-size fractions passing U.S. standard sieve #230 (0.0625-mm openings).
- **TPH**—Total petroleum hydrocarbons (TPH) are the sum of diesel-range hydrocarbons, residual-range hydrocarbons, gasoline-range hydrocarbons, lube oil, and motor oil.

For both the RI and baseline RA data sets, a minimum number of individual analytes for a given sample was required to be analyzed in order to complete the totals. These rules are provided in Table 2.1-5. Totals with less than the expected number of analytes but above the minimum number of analytes were qualified with an "A." For PCB and dioxin TEQs, all analytes with TEFs were required in order to calculate a total.

2.1.4.3 Field Replicates

For the RI, the BHHRA, and the BERA data sets, field replicates were generally retained as individual sample results. For spatial analyses requiring the calculation of spatially weighted average concentrations, only one sample result was used for those results with identical sampling coordinates. In those cases, data associated with the first sample were used in the analysis. Field replicates in the background data set were averaged to avoid bias by overweighing a single sample location. The potential for bias is greater in the background data set due to the small number of samples. Otherwise, data presentations and analyses included field replicates as discrete samples.

2.1.4.4 Organic Carbon Normalization

Organic chemical results were organic carbon normalized (OC normalized) for subsequent evaluation in the BERA and background data sets. Dry-weight concentrations in mg/kg were divided by the decimal percent total organic carbon (TOC) value. For TOC less than 0.2 percent, a value of 0.2 percent was substituted. For samples without associated TOC data, a value of 1 percent was assigned.

2.1.5 RI Data Set

The data set used for each RI data type is summarized in Table 2.1-6. The first column of the table lists the various data types. The second column lists the data sources and the general data quality selection criteria (e.g., Category 1 versus Category 2 and QA1 versus QA2). Additional data inclusion or exclusion criteria used for subsequent data analyses and presentations in the RI Report are listed in the third column. Further data evaluation steps, such as the outlier analysis, that are specific to a particular data set, are not included here but are discussed in the appropriate RI report sections. A complete list of data exclusions for each data type is provided in Appendix A2. The RI data set is provided electronically in Appendix A3.

2.1.6 BHHRA Data Set

The data set used for each BHHRA data type is summarized in Table 2.1-7. The first column of the table lists the various data types. The second column lists the data sources and the general data quality selection criteria (e.g., Category 1 vs. Category 2 and QA1 vs. QA2). Additional data inclusion or exclusion criteria used to develop the BHRRA data set are listed in the third column. Specific data management procedures and rules and additional data reduction steps for the BHHRA are provided in Appendix F.

2.1.7 BERA Data Set

The data set used for each BERA data type is summarized in Table 2.1-8. Taken together, the inclusion and exclusion criteria listed below were used to develop the BERA data set. Specific data management procedures and rules and additional data reduction steps for the BERA are provided in Appendix G.

2.1.8 Query Manager™ Database

EPA and its government partners, as well as members of the general public, use the Query Manager™ database-mapping application developed by NOAA's National Ocean Service Office of Response and Restoration.[2] Sediment and biota chemistry data contained in the SCRA database were translated into Query Manager-compatible format files and uploaded to NOAA's Portland Harbor Watershed Database. Currently, water data are not stored in Query Manager. NOAA has integrated the Portland Harbor Watershed Database with data query software (MARPLOT®) and ArcView® GIS on a web-based portal (http://mapping2.orr.noaa.gov/website/portal/portland/). Users may analyze and display the data contained in Query Manager along with spatial information, such as aerial photos, bathymetry, shoreline types, and outfalls.

Summing methods used in Query Manager for the various compound groups discussed above depart slightly from the LWG's summing methods. In all cases, non-detects for individual substances in a compound group are treated as zero values, and if the sum of detected results for individual substances in a sample is less than the maximum undetected result, then the sum is reported at the higher detection limit with a U-qualifier. Specific summing rules are provided below:

- **Total PCBs**—Aroclor and congener data are summed separately (PCB SUM A [total Aroclors] and PCB SUM P [total congeners]). In Query Manager, the preferred PCB sum is reported for the Aroclor data since those data are reported for the majority of studies. In the LWG database, the preferred PCB sum is reported for the congener data.

[2] The LWG relies on the Portland Harbor SCRA database for decision-making purposes and reporting.

- **Total DDx**—Calculated using six isomers where available. If three or fewer isomers are reported, the sums are not derived (routine assumes that only p,p'-isomers were reported). Also, the sum of isomer pairs of DDT and its derivatives were calculated. The following pairs were summed when both isomers were provided for samples in the data set: 2,4'-DDT and 4,4'-DDT; 2,4'-DDD and 4,4'-DDD; 2,4'-DDE and 4,4'-DDE.
- **Total LPAHs**—Sum of acenaphthene, anthracene, biphenyl, 2,6-dimethylnaphthalene, fluorene, 1-methylnaphthene, 2-methylnapthene, 1-methylphenanthrene, phenanthrene, naphthalene, where two or more are measured.
- **Total HPAHs**—Sum of benzo(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, perylene, and pyrene, where two or more are measured.
- **Total PAHs**—Calculated as the sum of the LPAH and HPAH chemicals. Only those samples with more than one chemical in the group (LPAH and HPAH) are summed.
- **Total Chlordanes**—Sum of alpha-chlordane, gamma-chlordane, beta-chlordane, cis- and trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.

All field duplicates and splits are retained in the Query Manager database and are recorded as separate samples reported from the same location and similar species/tissue type (if applicable) or depths. No data within the Query Manager database is an average. For some queries run with the Query Manager interface, if there are two results with the same StationID/SampleID (lab replicates), the result that has been designated as the preferred result (the "normal" sample) is reported in the queries. "Multi-chem" queries show both the main sample results and lab replicate results.

To illustrate the outcome of a query first performed on the RI data set and then performed in Query Manager, the following example is provided. Table column headings below are those provided in the respective data sets and offer corresponding information. In this example, total LPAHs were queried for samples collected from a surface sediment location (DG-11) collected in Round 3. Field splits (DG11-2 and DG11-3) were also collected from this location.

From Query Manager:

Stationid	exsampid	chemcode	conc	qualcode	units
DG11-1	LW3-DG11	LPAH	30.1	CALC	PPB
DG11-2	LW3-DG11-2	LPAH	142.9	CALC	PPB
DG11-2	LW3-DG11-3	LPAH	155.7	CALC	PPB

From RI Data Set:

LocationName	SampleID	cas_rn	ValueNum	Qualifiers	Units
DG11-1	LW3-DG11	LPAH	32	JT	ug/kg
DG11-2	LW3-DG11-2	LPAH	160	JT	ug/kg

Because no field splits are averaged in Query Manager, three separate total LPAH results were reported. Further, because total LPAHs are calculated using an analyte list that differs from the RI data set, and because splits are averaged in the RI data set, the calculated totals are different. In this case, the results reported in the RI data set are slightly higher than the results reported in Query Manager.

2.2 SUMMARY OF ENVIRONMENTAL DATA BY MEDIA

Between 2002 and 2008, the LWG collected the following data in the LWR:

- Surface and subsurface sediment and tissue chemistry
- Sediment toxicity data
- Physical sediment characteristics
- Sediment trap chemistry
- Surface water chemistry
- TZW chemistry
- Stormwater chemistry
- Habitat type and distribution
- Species occurrence
- Hydrodynamic/sediment transport processes data
- Upland sources and pathways information
- Cultural resources information.

The characterization process was multifaceted and iterative, involving three rounds of sampling for different data needs, often timed around varying river stages, river flows, and storm events. Table 2.2-1 provides an overview of the LWG sampling dates for each major round of sampling. Each sampling event followed an approved FSP and QAPP. Field results were documented in an FSR. Analytical results were documented in a data report and/or a SCSR.

Chemical and biological data from other parties were obtained primarily from individual LWG members, EPA, DEQ, the U.S. Geological Survey (USGS), and the U.S. Army Corps of Engineers (USACE). These investigations are summarized in Table 2.0-1. Data types included sediment, TZW, surface water, tissue, and seep chemistry and were compiled from both hard copy and digital sources. Appendix A1

provides additional information on the project objectives, sampling dates, sampling methods, sample types, and analyses for data collected by other parties listed in Table 2.0-1. USACE information related to recent Portland Harbor dredging projects, requested via the Freedom of Information Act (FOIA) in spring 2008, had not yet been received prior to the June 2, 2008 lockdown date and is not included in the Portland Harbor SCRA database.

Environmental data collected during LWG Round 1 and 2 investigations, as well as studies by other parties during that same period, were summarized in the Round 2 Report (Integral et al. 2007). The Round 2 Report evaluated the physical, chemical, and biological information collected through the Round 2 (2006) sampling effort in order to focus the Round 3 data collection effort and, to the extent practicable, determine the final data needs for the RI/FS. Table 2.2-2 summarizes, by media, all data that are included in the RI data set. A subset of these data for matrices relevant to ecological and human health exposure are included in the BERA and BHHRA data set, and are discussed further in the sections below. Numbers of samples and analyses performed on each sample are summarized in Tables 2.2-3 (sediment), 2.2-4 (sediment trap), 2.2-5 (surface water), 2.2-6 (stormwater), 2.2-7 (TZW), and Tables 2.2-8, Table 2.2-9, and Table 2.2-10 (biota).

2.2.1 Physical System

Many RI investigative activities were designed to develop a greater understanding of the Portland Harbor physical system. These included time-series bathymetric surveys, nearshore bank elevation change monitoring, and river flow measurements during high- and low-flow events. Additional time-critical data collection activities included a SPI field study, baseline bathymetric survey from RM 0 to Ross Island, juvenile salmon residence time field study, and STA. Other field efforts involved the collection of water current direction and velocity profiles at several transects across the Study Area.

Along with existing information about the LWR, the physical data from the above studies were used to develop the physical CSM and to scope, develop, and calibrate a numerical HST model for the site (WEST 2004), which is described further in Section 3.4. The following physical system studies were conducted, and the following data types were collected for the RI:

- STA survey to document major trends in sediment transport
- SPI field study to provide reconnaissance information on physical and biological features of surface sediments in the LWR from Ross Island to the Columbia River
- Five precision multibeam bathymetric surveys to document riverbed elevation changes over time
- Time-series sediment stake measurements to document nearshore bank elevation changes

- Three acoustic doppler current profiler (ADCP) surveys to provide flow measurements during specific hydrological conditions, including a high-flow event and across tidal cycles
- Physical system data to calibrate the HST model, including TSS concentrations, cohesive suspended sediment settling velocities, erosion rates, and critical erosion velocities.

Physical system data are presented and described in detail in Section 3.0 of this RI Report.

2.2.2 Sediment

Sediment chemistry data in the RI data set include LWG data collected from Rounds 1, 2, and 3 and data collected by other parties according to the criteria presented in Table 2.1-6. Only Category 1 QA2 surface sediment data that were not subsequently dredged or capped were used in the BHHRA and BERA.

The LWG data set is composed of samples collected from shorebird and human-use beaches (surface transect composites), riverbed samples (surface and subsurface), samples from biota sampling locations (collocated surface sediment), sediment toxicity samples (surface), samples from TZW sampling locations (collocated surface sediment), and physical sediment characteristic samples (surface and subsurface). Data collected by other parties consist primarily of surface and subsurface riverbed samples. The majority of LWG surface and subsurface riverbed sediment samples were collected during Rounds 2 and 3 (some collocated surface sediment was collected in Round 1 from benthic invertebrate stations in the ISA). Surface and subsurface sediment data were collected from the Study Area (RM 1.9–11.8), Multnomah Channel, downstream (RM 0–1.9), downtown Portland (RM 11.8–15.3), and upriver (RM 15.3–28.4). Surface and subsurface sediment sampling locations for all three LWG rounds, as well as studies conducted by other parties, are shown in Maps 2.2-1a–y and 2.2-2a–t, respectively. Numbers of samples and analyses performed on each sample are summarized in Table 2.2-3. Results for Rounds 1 and 2 were presented in detail in the Round 2 Report.

2.2.3 In-River Sediment Traps

The RI data set includes in-river sediment trap data collected by the LWG during Round 3. Data collected by the Port of Portland at Terminal 4 were excluded from the RI data set. Sediment trap data were not used in the BHHRA or BERA.

The LWG traps were deployed and maintained for one year at 12 locations within the Study Area, one location just downstream of the Study Area at RM 1.8, two upstream locations near RM 16, and at one location in Multnomah Channel (Map 2.2-3). Samples were collected quarterly. The number of sediment traps and the frequency of recovery and redeployment were designed to capture anticipated spatial and temporal

variability of suspended sediment mass and to investigate the potential contributions of chemicals via waterborne sediment for various regions of the Study Area. The LWG sediment trap sampling program was not designed to support estimation of chemical mass loading within or throughout the system (Anchor 2006b). Table 2.2-4 lists the sample counts and analyses performed on each sample.

2.2.4 Bank Sediment and Soil

The RI data set includes bank (also referred to as the riparian zone; see EPA 2005b) sediment and soil data largely collected by other parties as part of bank and upland investigations. The LWG did not conduct bank/riparian zone investigations because the upper Study Area boundary is drawn at +13 ft NAVD88 elevation.[3] This elevation is based on a DEQ memorandum dated July 9, 2003 to EPA regarding the upland/in-water boundary for the Superfund Site (DEQ 2003b). Figure 2.2-1 depicts the shoreline boundary graphically. As noted in Table 2.1-6, surface sediment/soil data of any quality collected between +13 ft NAVD88 and +20 ft NAVD88 are included in the RI data set. The bank sediment data are presented and discussed only in Sections 6 and 10 of the RI Report as part of the evaluation of potential sources of contamination to the Study Area. Bank sediment and soil data were not used in the BHHRA or BERA.

2.2.5 Surface Water

The RI data set includes LWG-collected data and data collected by other parties. The characterization of surface water in the following sections of the RI Report includes the LWG-collected data and TSS data collected by the City of Portland. All other surface water data collected by other parties were excluded from the presentation of surface water data. Only LWG data were included in the BHHRA and BERA.

Surface water chemistry and conventional water quality parameter (i.e., temperature, pH, dissolved oxygen, and conductivity) data in the RI data set include samples collected during three surface water sampling events that took place during Round 2A and four events during Round 3A. Sampling events were executed at certain times of the year to determine if various river stages, river flows, and storm events have a measurable effect on the nature or concentration of surface water chemical constituents. Sampling stations included both river-wide transects and single-point sampling stations at specific locations. River-wide transect sampling was designed to estimate integrated water concentration through a cross section of the river, or fraction of a cross section, at a point in time. Round 2A transect samples involved a single vertically and horizontally integrated sample composite collected from multiple lateral substations across the width of the river channel. Round 3A transects at RM 2 and RM 11 were subdivided into three segments: east shoreline to navigational channel, navigational channel, and navigational channel to west shoreline. At each segment mid-point

[3] LWG Round 1 beach samples were composite samples from multiple grabs collected based on random-sampling scheme from the water line to the vegetation line, some individual grab subsamples from this sampling program were collected in the riparian zone (above +13 NAVD88, see Figure 2.2-1).

location, a vertically integrated (VI) water column sample was collected. For the other four transects (i.e., RM 4, 6.3, 16, and Multnomah Channel), separate near-bottom and near-surface (NB/NS) laterally integrated transect samples were collected. Single-point samples were stationary samples or sample pairs located adjacent to amphibian habitats to support the BERA, in generally quiescent areas adjacent to beaches that are used by swimmers to support the BHHRA, and near known or suspected sources.

Round 2A data were collected at three transect stations (RM 4, 6.3, and 11) and at 20 single-point stations. Round 3A surface water samples were collected at six transect stations (RM 2, 2.9 [Multnomah Channel], 4, 6.3, 11, and 16) and 12 single-point stations. Map 2.2-4 shows the surface water sampling locations, and Table 2.2-5 lists the sample counts and analyses performed on each sample.

2.2.6 Stormwater

The RI data set includes LWG-collected data and stormwater grab, sediment trap, and catch basin solids sample data collected by other parties. Only Category 1 data collected since June 1, 2004 are presented in Section 4 of the RI Report. Stormwater data were not used in the BHHRA or BERA.

The LWG performed stormwater sampling during Round 3, which consisted of flow-weighted composite samples, grab stormwater samples, continuous stormwater monitoring, and sediment trap deployment at selected stormwater outfalls within the Study Area. Samples were collected during eight separate storm events during the spring of 2007. An additional mobilization consisting of stormwater composite and sediment trap samples was conducted in the fall of 2007. Sampling locations are shown on Map 2.2-5, and sample counts and analyses performed on each sample are summarized in Table 2.2-6.

2.2.7 Groundwater/Transition Zone Water

The RI data set includes all TZW chemistry data collected by the LWG during Round 2, as well as groundwater, seep, and TZW data collected by other parties. The transition zone is defined as the interval where both groundwater and surface water comprise some percentage of the water occupying pore space in the sediments (EPA 2008a). The primary focus of the transition zone analyses presented in Section 5.4 and Appendix C2 of this report is the surface sediment layer, which is considered to be the upper 30 cm of the sediment. For RI sampling purposes, the surface or shallow TZW samples were collected at depths up to 38 cm below mudline (bml). Deeper (90 to 150 cm bml) TZW samples are also discussed in some cases to lend insight into observed chemical distribution patterns. TZW data were evaluated in the BHHRA and BERA. Seep data collected from Outfall 22B were also evaluated in the BHHRA. Seeps are defined as locations where water discharges from the ground either above or below the river surface (GSI 2003b). Additional upland and baseline groundwater data, which are not included in the Portland Harbor SCRA database, were reviewed for use in the

Groundwater Pathway Assessment Appendix for selected sites (Appendix C2). These data are described in detail in Appendix C2.

TZW data were collected by the LWG at nine sites located within the Study Area (see Section 4), selected in agreement with EPA as sites with a confirmed or reasonable likelihood for discharge of upland groundwater COIs to Portland Harbor. These sites are adjacent to the Kinder Morgan Linnton Terminal, ARCO Terminal 22T, ExxonMobil Oil Terminal, Gasco, Siltronic, Rhone Poulenc, Arkema, Willbridge Terminal, and Gunderson (Map 2.2-6). Additional stratigraphic characterization of a riverbed area offshore of the Gunderson site was conducted during Round 3, but it was determined that sampling of TZW at this site would not be necessary because the stratigraphic data did not provide physical evidence of a potentially complete flow pathway.

The LWG TZW samples were collected with either a Trident push probe at depths ranging from 30 to 150 cm or with a small-volume peeper deployed at sediment depths of 0 to 38 cm. The TZW data set also includes samples collected by other parties offshore of the Gasco and Siltronic sites with Geoprobe©. Table 2.2-7 lists the numbers of samples and analyses performed on each sample.

2.2.8 Biota

The RI data set includes LWG-collected biota tissue data and adult Chinook, adult lamprey, and adult sturgeon fish tissue data from the Oregon Department of Human Services (ODHS)/EPA/Agency for Toxic Substances and Disease Registry (ATSDR) Fish Contaminant Study (ODHS et al. 2003). Biota tissue types included in the BHHRA or BERA are provided in Appendix F and Appendix G, respectively. Data collected as part of the ODHS study were the only non-LWG fish tissue data of acceptable quality utilized for BHHRA evaluation.

Fish and invertebrate tissue chemistry data were collected from the Study Area by the LWG and other parties to estimate exposure concentrations (as tissue residues or diet) for appropriate species or groups of ecological receptors (i.e., benthic invertebrates and fish). Biota tissue data were also collected upriver of the Study Area. Results of the LWG's laboratory bioaccumulation bioassays were also included in the RI data set. The bioassays were performed using commercially supplied clams (*Corbicula fluminea*) and laboratory-cultured worms (*Lumbriculus variegatus*) exposed to surface sediments collected at the same locations where field clams and worms were collected within the Study Area (Map 2.2-7).

Sampling locations for field-collected biota during all three sampling rounds are shown on Maps 2.2-8 through 2.2-12. Sampling locations specific to small-home-range species of fish and invertebrates are shown on Maps 2.2-8 and 2.2-9; large-home-range fish species are shown on Maps 2.2-10 through 2.2-12. Table 2.2-8 summarizes the biota samples and analyses. Table 2.2-9 lists the LWG and non-LWG sample counts

and analyses performed on each sample. Table 2.2-10 provides the number of fish and invertebrates in each sample composite.

2.2.8.1 Bioassay

In Rounds 2 and 3, 293 surface sediment samples from the Study Area and upriver were submitted to a bioassay testing laboratory for toxicity testing. Toxicity testing was performed to support the development of one or more predictive models characterizing the relationship between sediment chemistry and benthic invertebrate toxicity in the Study Area. Two whole-sediment toxicity testing protocols were employed. The 10-day *Chironomus tentans* and the 28-day *Hyallela azteca* sediment toxicity tests measuring survival and growth were conducted. Bioassay reference stations were also collected upriver of the Study Area. Sediment bioassay sampling locations are shown on Map 2.2-1a–y. Bioassay data are included in the BERA data set only (Appendix G).

2.2.8.2 Invertebrates

Invertebrate tissue in the RI data set included LWG field-collected tissue samples for crayfish (*Pacifasticus leniusculus)*, clam (*Corbicula fluminea*), mussels (tentatively identified as *Margaritifera falcata* and *Anodonta nuttalliana*), which were incidental by-catch during clam sampling, and epibenthic invertebrates and zooplankton collected with multiplate samplers. Invertebrate sampling locations for these small-home-range species are shown on Map 2.2-8. For clams, mussels, and crayfish, the map locations are shown as centroids of the specific sampling areas for each species (i.e., crayfish sampled in an area of 100-ft shoreline contour by 100-ft extension into the river channel, and for clams and mussels sampled in variable benthic sledge tow areas). Table 2.2-8 provides the total number and type of invertebrate tissue data and the analyses performed on each sample. Invertebrate samples were analyzed for the same suite of chemicals as fish. Collocated surface sediment samples were also collected at clam and crayfish tissue sampling locations (or as close as possible) and analyzed for a similar suite of chemicals (Map 2.2-8).

2.2.8.3 Fish

The following fish species were selected as ecological receptors for the various feeding guilds in the LWR:

- **Omnivorous and herbivorous fish**—Largescale sucker (*Catostomus macrocheilus*), carp (*Cyprinus carpio carpio*), and pre-breeding white sturgeon (*Acipenser transmontanus*)
- **Invertivorous fish**—Sculpin (*Cottus asper*, *C. perplexus*, and *C.* spp.), peamouth (*Mylocheilus caurinus*), and juvenile Chinook salmon (*Oncorhynchus tshawytscha*)

- **Piscivorous fish**—Smallmouth bass (*Micropterus dolomieui*) and northern pikeminnow (*Ptychocheilus oregonensis*)
- **Detritivorous fish**—Larval stages of (ammocoetes and macropthalmia) Pacific lamprey (*Lampetra* sp.).

LWG-collected fish tissue data are included in the RI, BHHRA, and BERA data sets. In addition, data for adult Chinook salmon, adult sturgeon, and adult lamprey collected by other parties were included in the RI and BHHRA data sets.

Table 2.2-10 provides the number of fish and invertebrates in each sample composite. Fish species composites were based on individual fish collected over various reaches of the river. Sculpin were composited from areas similar to where crayfish were collected. The map locations are shown as centroids of the sampled area of 100-ft shoreline contour by 100-ft extension into the river channel (Map 2.2-8). Largescale sucker, peamouth, and northern pikeminnow were composited over 1-mile stretches (Map 2.2-9); smallmouth bass were composited over 1-mile reaches for Round 1 and composited from either side of the river over 1-mile reaches for Round 3 (Maps 2.2-10a–d); and black crappie, brown bullhead, and carp were composited over 3-mile reaches (Maps 2.2-11 and 2.2-12a–c). Map 2.2-13 shows sturgeon and juvenile Chinook samples collected within discrete set line areas (for sturgeon) or beach seine areas (for juvenile Chinook). Juvenile sturgeon samples were not composited. Three juvenile sturgeon were collected and individually analyzed for each of five reaches that ranged from 1 to 2 miles long. The 15 points on Map 2.2-13 show the individual location of all sturgeon collected (three at each reach). Pacific lamprey ammocoetes and micropthalmia were collected wherever suitable habitat was encountered (Map 2.2-14). For lamprey ammocoetes and macropthalmia samples, composites were made up of samples collected at several different areas within the Study Area and the map locations are shown as each successful sampling site of the sampling areas for each composite. Three ammocoetes collected during Round 1 were not analyzed. Note that collected lamprey ammocoetes and micropthalmia specimens were not positively identified to species because as larvae they are difficult to distinguish from other lampreys.

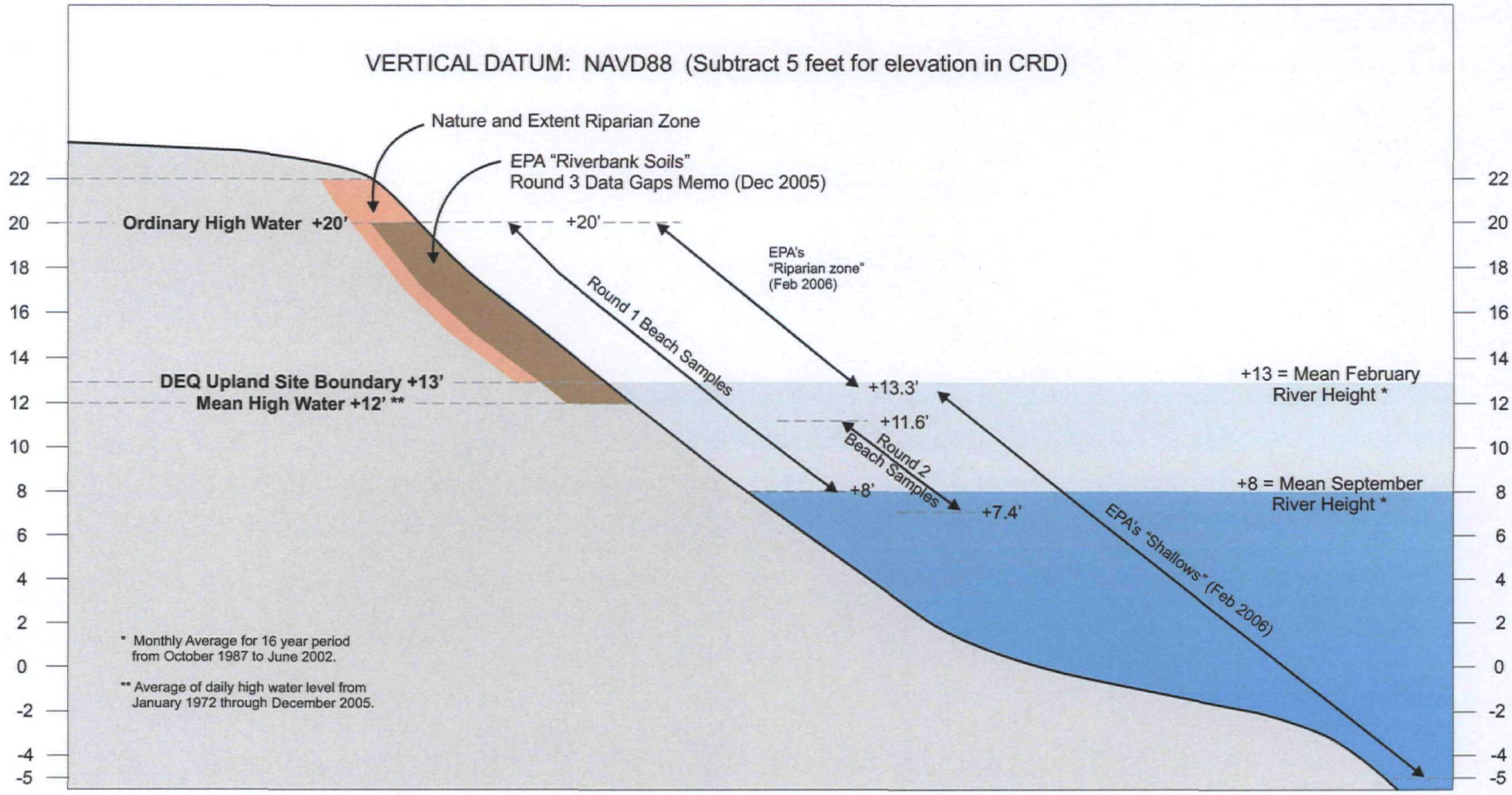
Whole-body and fillet tissue types were composited separately for carp, black crappie, smallmouth bass, and brown bullhead. During Round 1, fillets were collected from different fish than were used for whole-body samples, including black crappie, brown bullhead, carp, and smallmouth bass. During Round 3B, however, fillet and whole-body data were obtained using the same fish. Fillets were removed from Round 3B carp and smallmouth bass, and fillets and bodies without fillets (i.e., remaining bodies) were composited and analyzed separately. Methods for calculating whole-body concentration for smallmouth bass and carp are provided in Appendix A4.

Stomach contents were also examined, and prey species were enumerated for juvenile Chinook salmon and juvenile sturgeon; stomach contents were analyzed for the same

select chemicals relative to fish dietary risks. Collocated surface sediment samples were also collected at sculpin tissue sampling locations (or as close as possible) and analyzed for a similar suite of chemicals (Map 2.2-8).

2.2.9 Cultural Resources Survey

According to CERCLA and its implementing regulations, EPA is required to comply with federal statutes that provide protection of archaeological and historical resources, including Native American burials and places of traditional religious and cultural significance. In 2001, EPA and DEQ signed an MOU with six tribal governments and three federal and state agencies that identified cultural resources as an area of special concern to the signatory tribes. The AOC requires a cultural resources survey as part of the RI/FS. The survey included the LWR from the confluence of the Willamette and Columbia rivers to Willamette Falls, including upland areas adjacent to this stretch of the river. Results of the survey are documented in *Cultural Resource Analysis Report for the Portland Harbor Superfund Site, Portland, Oregon* (AINW 2005).



integral consulting inc. LWG LOWER WILLAMETTE GROUP

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This document is currently under review by US EPA
and its federal, state, and tribal partners,
and is subject to change in whole or in part.

Figure 2.2-1
Portland Harbor RI/FS
Draft Remedial Investigation Report
Schematic Willamette Riverbank
Cross Section, RM 2-11

Table 2.0-1. Summary of Investigations Performed by Other Parties Included in the RI Data Set.

Survey Name	Used for Risk Evaluation (Y/N)	Survey ID	Study Objective	River Mile(s)	Begin Date	End Date	Number of Samples	Sample Intervals (cm)	Composite (Y/N)	Dredged (Y/N)	Capped (Y/N)	QA Category
Sediments												
Downtown Portland Sediment Characterization	N	WLLASE08	Sediment characterization	12 - 16	5/12/2008	6/10/2008	81 surface sediment, 36 subsurface	surface 0 - 40 cm, subsurface to 378 cm	N	N	N	Category 1 QA2
Gasco EE/CA	Y [a]	WLCGSG04	Early action characterization	6.5	7/19/2004	9/9/2005	16 subsurface sediment	up to 610 cm	N	N	Y - RAA-02-20	Category 1 QA2
2005 Portland District O&M Sediment Characterization	Y	WLCDRD05	Dredged material characterization	2 - 11.7	4/28/2005	5/27/2005	82 surface, 72 subsurface	surface 0-30 cm, subsurface to 421 cm	N	N	Y - WR-PG-50, WR-VC-50	Category 1 QA2
ExxonMobil Beach Sediment Sheen Samples	N	WLCEMH04	Oily sheen investigation	5.16	10/6/2003	8/13/2004	4 surface sediment	0-15 cm	N	N	N	Category 1 QA1
Terminal 4 Early Action EE/CA Report	Y	WLCT4C04	Early action characterization	4.5	3/3/2003	5/20/2004	5 sediment trap, 43 subsurface sediment	up to 671 cm	Y	N	N	Category 1 QA2
Corps Dredged Material O&M Characterization	Y [a]	WLCDRI03	Dredged material characterization	3, 8-10, 15, 23	9/18/2003	9/25/2003	19 subsurface composites, 2 surface reference	up to 305 cm	Y	N	N	Category 1 QA2
Gunderson Area 2 Sandy Beach	N	WLCGNG03	Gunderson, Inc. Area 2 - sandy beach area upland source evaluation	9	7/8/2003	7/8/2003	4 surface sediment	0-15 cm	N	N	N	Category 1 QA1
International Terminal Sediment Data Report	N	WLCITC03	Dredged material characterization	4, 5	3/11/2003	3/13/2003	20 subsurface sediment	up to 518 cm	N	Y	N	Category 1 QA1
ATOFINA Phase 2 Stage 1/2 In-River Investigation	Y [a]	WLCEAF02	Phase 2 Stage 1 & 2 in-river groundwater and sediment investigation	8	6/3/2002	3/10/2003	211 subsurface sediment	up to 1,305 cm	N	N	N	Category 1 QA2
City Outfall Source Control Investigation	Y	WLCOFJ02	Source control investigation	5-10	10/14/2002	10/23/2002	84 surface sediment	0-15 cm	N	N	Y - Station 4	Category 1 QA2
Surface Water, Sediment, and Groundwater Sampling Report	N	WLCMBI02	Surface water, sediment, and groundwater sampling, McCormick & Baxter	7, 8	9/5/2002	9/26/2002	41 water grabs, 19 water SPMD, 11 subsurface sediment	30-35 cm	N	N	Y - 14 samples	Category 1 QA2, petroleum Category 2
US Moorings RI Sediment Investigation	Y	WLCMRI02	US Moorings remedial investigation	6, 7	9/10/2002	9/11/2002	2 surface, 3 subsurface sediment	0-30, 0-90 cm	Y	N	N	Category 1 QA2
City Outfall Pilot Project	Y	WLCOFH02	Sediment quality study off Outfalls M1 and 18 (9 sediment grabs taken at each outfall)	9	8/21/2002	8/23/2002	18 surface sediment	0-15 cm	N	N	N	Category 1 QA2
MarCom Expanded Preliminary Assessment	N	WLCMCB02	Expanded preliminary assessment of MarCom property	6	2/8/2002	2/8/2002	3 surface sediment	0-15 cm	N	N	N	Category 1 QA1
GATX Linnton Terminal RI	N	WLCGXB02	Kinder Morgan Linnton facility remedial investigation	5	2/5/2002	2/7/2002	2 surface sediment	0-15 cm	N	N	N	Category 1 QA1
T4 Slip 3, Berth 410 Dredge Material	N	WLCT4L01	Marine Terminal 4 Slip 3 dredge material characterization study	5	12/11/2001	12/13/2001	9 subsurface sediment	up to 213 cm	Y	Y	N	Category 1 QA1
Willamette Reference Area Phase 2	N	WLLRSI01	Phase II reference area reconnaissance study	16, 19, 23, 24	9/17/2001	9/17/2001	8 surface sediment	0-10 cm or 0-30 cm	N	N	N	Category 1 QA1
Willamette Reference Area Phase 1	N	WLLRSH01	Phase I reference area reconnaissance study	16, 17, 18, 19, 24	8/29/2001	8/29/2001	9 surface sediment	0-10 cm	N	N	N	Category 1 QA1, grain size Category 2
Cargill Irving Elevator Permit Applications	N	WLCCIF01	Dredged material characterization	12	6/29/2001	6/29/2001	5 subsurface, 1 subsurface pore water	up to 109 cm	Y - 1 sample	Y	N	Category 1 QA1
T2/T5 2001 Dredge Characterization Study	N	WLCT0F01	Dredged material characterization	2, 10	6/27/2001	6/29/2001	4 subsurface pore water, 7 subsurface sediment	up to 182 cm	Y	Y	N	Category 1 QA1
Chevron Dredging Permit Application	N	WLCCPF01	Dredged material characterization	8	6/6/2001	6/7/2001	15 subsurface sediment	up to 244 cm	N	Y	N	Category 1 QA1
Gasco Source Control Evaluation	Y	WLCGSD01	Characterization of nearshore conditions to validate groundwater modeling predictions	7	4/10/2001	4/11/2001	18 subsurface sediment, 9 surface sediment	surface 0-10 cm, subsurface to 40 cm	N	Y	Y - AN-2-1 to 2 4	Category 1 QA2
McCormick & Baxter RI Phase 4	N	WLCMBA01	Phase IV remedial investigation of McCormick & Baxter Creosoting Co.	8	1/5/2001	2/5/2001	32 subsurface sediment, 1 upriver reference surface sediment	0-38 cm	N	N	Y - 13 samples	Category 1 QA1
Goldendale Aluminum Phase 2	N	WLCGAL00	Post-dredge residual check	11	12/21/2000	12/21/2000	4 surface sediment	0-30 cm	N	N	N	Category 1 QA1

Table 2.0-1. Summary of Investigations Performed by Other Parties Included in the RI Data Set.

Survey Name	Used for Risk Evaluation (Y/N)	Survey ID	Study Objective	River Mile(s)	Begin Date	End Date	Number of Samples	Sample Intervals (cm)	Composite (Y/N)	Dredged (Y/N)	Capped (Y/N)	QA Category
Oregon Steel Mills Pre-Remedial Investigation Field Activities Data Report	N	WLCOSJ00	Pre-remedial investigation; sediments collected off outfalls to investigate storm water as potential pathway	2, 3	10/10/2000	10/11/2000	1 subsurface sediment, 15 surface sediment	surface 0-10 or 0-30 cm, subsurface 0-60	N	N	N	Category 1 QA1
Willbridge 60-in Outfall	N	WLCWTI00	Remedial investigation of sediments at 60-inch outfall location, Willbridge Terminal	8	9/21/2000	9/22/2000	13 subsurface sediment	up to 229 cm	N	N	N	Category 1 QA1
UP RR Albina Yard Expanded Preliminary Assessment Data Report	N	WLCAYH00	Expanded preliminary assessment of UPRR's Albina Yard	11, 12	8/9/2000	8/17/2000	3 subsurface sediment, 6 surface sediment	surface 0-20 cm, subsurface to 69 cm	N	N	N	Category 1 QA1
Marine Finance Expanded Preliminary Assessment Data Report	N	WLCMFH00	Expanded preliminary assessment of Marine Finance Site	6	8/8/2000	8/9/2000	3 subsurface sediment, 6 surface sediment	surface 0-20 cm; subsurface to 66 cm	N	N	N	Category 1 QA1
T1 South Sediment Study	N	WLCT1F00	Baseline sediment investigation associated with potential lease arrangement	11, 12	6/22/2000	6/22/2000	9 surface pore water, 9 surface sediment	0-10 cm	N	N	N	Category 1 QA1
Goldendale Aluminum Phase 1	N	WLCGAF00	Dredged material characterization	11	6/12/2000	6/12/2000	5 surface sediment, 1 reference surface sediment	0-30 cm	N	Y	N	Category 1 QA1
Ross Island Phase I (Port)	N	WLCRIL99	Phase I remedial investigation of Ross Island Lagoon	15, 16	11/2/1999	4/28/2000	6 subsurface pore water, 20 subsurface sediment, 38 surface pore water, 41 surface sediment, 4 surface reference sediment	surface 0-10 cm, subsurface up to 1,798 cm	Y - 1 sample	N	N	Category 1 QA1
Willamette November Sediment Quality Evaluation	N	WLR1199	Dredged material characterization	9, 10, 12	11/29/1999	11/29/1999	9 subsurface sediment, 7 subsurface pore water, 1 surface sediment	surface 0-15 cm, subsurface up to 386 cm	N	N	N	Category 1 QA1, metals & conventionals Category 2
T5 1999 Berths 501-503 Sediment Characterization Study	N	WLCT5K99	Dredged material characterization	1, 2	11/22/1999	11/22/1999	5 subsurface sediment, 5 subsurface pore water	up to 182 cm	Y - 2 samples	Y	N	Category 1 QA1, grain size Category 2
Ross Island Lagoon Baseline	N	WLCRIJ99	Baseline sediments investigation of Ross Island Lagoon	16	10/26/1999	10/28/1999	4 surface pore water, 12 surface sediment	0-10 cm	Y - 1 sample	N	N	Category 1 QA1
Ross Island Phase 1 (Ross Island Sand & Gravel)	N	WLCRIV99	Phase I remedial investigation of Ross Island Lagoon	15, 16	10/7/1999	10/28/1999	4 surface sediment, 41 subsurface sediment	surface 0-10cm, subsurface up to 79 cm	N	N	N	Category 1 QA2
GATX Linnton Terminal ESA	N	WLCGXV99	Environmental site assessment	5	10/8/1999	10/8/1999	4 surface sediment, 4 subsurface sediment	surface 0-10 cm, subsurface to 40 cm	N	N	N	Category 1 QA1
McCormick & Baxter RI Phase 3	Y	WLCMBJ99	Phase III remedial investigation of McCormick & Baxter Creosoting Co.	8	10/1/1999	10/1/1999	44 site and 4 upriver reference surface sediment	0-15 cm	N	N	Y - 30 samples	Category 1 QA2
Willamette April Sediment Quality Evaluation	N	WLR0499	Dredged material characterization	3, 9, 10	4/29/1999	4/29/1999	11 subsurface sediment, 3 pore water	up to 434 cm	N	N	N	Category 1 QA1, metals & conventionals Category 2
Portland Harbor Sediment Investigation	Y	WR-WSI98	EPA's sediment inspection	4 - 10	9/17/1997	2/2/1999	158 surface sediment, 28 surface pore water, 39 subsurface sediment	surface 0-10 cm, subsurface 0-90 cm	Y - 12 samples	Y - SD029, SD032	Y - SD76, 79, 82, 64, 65	Category 1 QA2
TOSCO 1999 Sediment Sampling Results	Y [a]	TOSCO99	Dredged material characterization	8	1/20/1999	1/22/1999	4 subsurface sediment, 1 surface reference	up to 304 cm	Y	N	N	Category 1 QA2
Elf Atochem 1999 Willamette River	N	WLRELF99	Sediment investigation of Atofina shoreline	8	11/23/1998	1/20/1999	15 subsurface sediment, 13 surface sediment	surface 0-10 cm, up to 90 cm	N	N	N	Category 1 QA1
Willbridge Terminal Facility RI	N	WLRWTF98	Remedial investigation of Willbridge Terminal	8	12/17/1998	12/18/1998	15 surface sediment	0-12.7 cm	N	N	N	Category 1 QA1
T2/T4 Sediment Study	N	PPTLDT24	Dredged material characterization	6, 10	9/15/1998	10/15/1998	3 subsurface pore water, 3 subsurface sediment	0-91 cm	Y	Y	N	Category 1 QA1, grain size Category 2
Port of Portland T4 RI	N	WLCT4J98	Remedial investigation of Terminal 4	5	10/12/1998	10/15/1998	18 subsurface sediment, 44 surface sediment, 2 surface reference sediment	surface 0-10 cm, subsurface up to 128 cm	N	N	N	Category 1 QA1

Table 2.0-1. Summary of Investigations Performed by Other Parties Included in the RI Data Set.

Survey Name	Used for Risk Evaluation (Y/N)	Survey ID	Study Objective	River Mile(s)	Begin Date	End Date	Number of Samples	Sample Intervals (cm)	Composite (Y/N)	Dredged (Y/N)	Capped (Y/N)	QA Category
Sediment Characterization Local Sponsors' Berths (conducted with Corps)	N	WLCT0I98	Dredged material characterization of Port of Portland berths	2, 5-8, 10-12	9/14/1998	9/14/1998	7 subsurface pore water, 7 subsurface sediment, 12 surface pore water, 12 surface sediment	surface 0-10 cm, subsurface up to 152 cm	Y - 6 subsurface	N	N	Category 1 QA1
International Terminals Sediment Sampling Event	N	WLCITH98	International Terminals sediment sampling event	4	8/18/1998	8/18/1998	5 surface sediment	0-15 cm	N	N	N	Category 1 QA1
Portland Shipyard Sediment Investigation	Y	PSYSEA98	Sediment investigation to characterize distribution of chemicals in surface and subsurface sediments, supporting property transfer	8, 9, 10, 11	3/31/1998	4/16/1998	65 subsurface sediment, 60 surface sediment, 61 surface pore water, 3 surface reference	surface 0-10 cm, subsurface to 490 cm	N	N	N	Category 1 QA2, conventionals QA1
Portland Shipyard Environmental Audit	Y	PSYD&M97	Sediment investigation to identify chemicals in the vicinity of the shipyard and their distribution	9	11/26/1997	1/22/1998	4 subsurface sediment, 8 surface	surface 0-10 cm, subsurface up to 304 cm	N	N	N	Category 1 QA2
Willamette River 1998 Data	Y	WRD&M98	Sediment investigation to identify chemicals in the vicinity of the shipyard and their distribution	7, 8, 9, 10, 11	1/19/1998	1/21/1998	12 surface sediment	0-10 cm	N	N	N	Category 1 QA2
T4 Berth 416 1997 Sediment Characterization Study	N	WLCT4J97	Dredged material characterization	5, 6	10/23/1997	10/24/1997	4 subsurface sediment, 4 subsurface pore water	up to 182 cm	Y - 1 sample	Y	N	Category 1 QA1
Baseline Sediment Riedel	N	RIEDEL97	Baseline sediment assessment off Riedel's Portland Yard Site	8	8/12/1997	8/13/1997	19 subsurface sediment, 8 surface sediment	surface 0-15 cm, subsurface to 460 cm	N	N	N	Category 1 QA1
CRCD - Willamette River Channel Deepening	N	WLR0797	Dredged material characterization supporting proposed channel deepening project	1-9, 11, 12	7/22/1997	7/25/1997	18 surface sediment, 17 surface pore water, 50 subsurface sediment, 1 subsurface pore water	surface up to 25 cm, subsurface up to 609 cm	Y- 3 samples	Y - WRGC30, WRGC31	N	Category 1 QA1, grain size & conventionals Category 2
PAH in surface sediments	Y	WLCASF97	Assessment of the nature of PAH in surface sediments along the southwestern shore of Portland Harbor Superfund Site	5, 6, 7, 8, 9	6/10/1997	6/12/1997	37 surface sediment	0-10 cm	N	N	Y - Sta 1	Category 1 QA2
T4 Berths 410,411 Maintenance Dredging	N	WLCT4E97	Marine Terminal 4 Berths 410, 411 maintenance dredging	5	5/6/1997	5/6/1997	3 subsurface sediment	up to 152 cm	N	Y	N	Category 1 QA1
BP Bulk Terminal 22T Supplemental Sediment and Revetment Investigation	N	WLCBPE06	BP Bulk Terminal 22T basis of design report Revetment SCM	4.8 - 4.9	9/9/2003	6/20/2006	48 surface sediment, 66 subsuface sediment	surface up to 30 cm, subsurface up to 1,036 cm	N	Y	N	Mixture of Category 1 QA1 and Category 2
Gasco Phase 2 Offshore Investigation	N	WLCGSG07	Gasco Phase 2 offshore investigation	6.1 - 6.4	8/30/2007	10/11/2007	24 suburface sediment	up to 457 cm	N	N	N	Category 1 QA1
Gasco Phase 1 Offshore Investigation	N	WLCGSJ06	Gasco Siltronic groundwater source evaluation Phase 1 Report & P2 FSA	6.1 - 6.5	10/5/2006	6/4/2007	186 suburface sediment	up to 582 cm	N	N	N	Category 1 QA1
RI/RA Ross Island Phase 2 (Landau)	N	WLCRIF01	Substantive Response Document, RI/RA Ross Island Sand & Gravel	13.9 - 14.6	6/1/2001	6/1/2001	5 surface sediment, 5 surface pore water	0-10 cm	N	N	Y	Category 2
Sulzer Pump, 16 riparian samples	N	WLCSPL03	Sulzer Pump, 16 riparian samples	10.2 - 10.3	12/22/2003	12/22/2003	16 surface sediment	0-15 cm	N	N	N	Category 1 NA
T4 Anchor Appendix G sediment data	N	WLCT4G06	T4 Anchor Appendix G sediment data	4.4 - 4.7	7/18/2006	12/14/2007	76 surface sediment, 68 subsurface sediment	surface up to 30 cm, subsurface up to 305 cm	N	Y - 17 samples	N	Category 1 QA1
Organochlorine and PAH by SPMD	N	WLCWQH99	Investigation of the distribution of organochlorine and PAH compounds using SPMD	12.6	9/10/1997	9/10/1997	1 surface sediment	0-3 cm	N	N	N	Category 2
Willbridge Terminal 2002 Post-Dredging Sediment Characterization	N	WLCWTG02	Post-dredging sediment characterization	7.6 - 7.7	7/16/2002	7/16/2002	17 surface sediment	up to 15 cm	N	N	N	Category 1 QA1
Zidell Waterfront Property RI: Riverbank Characterization	N	WLCZDH04	Zidell Waterfront property remedial investigation: riverbank characterization	13.5 - 14	8/9/2004	8/13/2004	50 surface sediment	0-15 cm	N	N	N	Category 1 QA1
Zidell Waterfront Property RI	N	WLCZDI00	Zidell Waterfront property remedial investigation	13.4 - 14.1	10/28/1997	12/10/2003	46 surface sediment, 46 suburface sediment, 19 surface pore water	surface up to 30 cm, subsurface up to 320 cm	N	N	N	Category 1 QA1

Table 2.0-1. Summary of Investigations Performed by Other Parties Included in the RI Data Set.

Survey Name	Used for Risk Evaluation (Y/N)	Survey ID	Study Objective	River Mile(s)	Begin Date	End Date	Number of Samples	Sample Intervals (cm)	Composite (Y/N)	Dredged (Y/N)	Capped (Y/N)	QA Category
Blue Heron & West Linn	N	WLFLH07	Site investigation	21.5 - 28.5	8/28/2007	8/31/2007	19 surface sediment	0-10 cm	N	N	N	Category 1 QA2
Tissue												
ATSDR/EPA/ODHS Fish Contaminant Study	Y [b]	WLTASE03	Fish tissue investigation	lamprey - RM26, sturgeon - RM3.5-9.2, chinook - Clackamas Hatchery	lamprey - 5/22/2003, chinook - 6/20/2003, sturgeon - 8/11/2003	lamprey - 5/22/2003, chinook - 6/20/2003, sturgeon - 8/25/2003	4 lamprey, up to 6 chinook fillet - skin on, up to 5 chinook whole body, up to 6 sturgeon fillet - skin off	--	Y - lamprey	--	--	Category 1 QA2
Transition Zone Water												
Siltronic Supplemental In-River Transition Zone Water	Y	WLCSLH01	Transition zone water study	6.4 - 6.8	8/2/2001	6/1/2005	76 TZW samples	up to 87 ft below mudline	N	--	--	Category 1 QA2
Gasco Phase 2 Offshore Investigation	N	WLCGSG07	Gasco Phase 2 offshore investigation	6.4	10/4/2007	10/6/2007	18 TZW samples	Unknown	N	--	--	Category 1 QA1
Surface Water												
City of Portland TSS Data	N	WLC1200Z	Surface water monitoring	1.1 - 20	2/1992	3/2006	2,520 composited surface water grabs	10 ft from surface	Y	--	--	none
Stormwater/Seeps												
Rhone-Poulenc Outfalls 22B and 22C Stormwater	Y [b]	WLCRPI04	Outfall monitoring	6.8, 6.9	10/1/1993	9/23/2004	9 samples on 7 dates	--	N	N	N	Category 1 QA2
GE Spring/Summer 2007 Stormwater Outfall Monitoring	N	WLCGED07	GE spring/summer 2007 stormwater outfall monitoring	9.6	4/18/2007	6/10/2007	4 outfall water	--	N	--	--	Category 1 QA2 Conventionals Category 2
T4 Spring 2007 Stormwater Outfall Monitoring	N	WLCT4C07	T4 spring 2007 stormwater outfall monitoring	4.2 - 5.1	3/24/2007	5/20/2007	24 outfall water	--	N	--	--	Category 1 QA1 PCB Congeners QA2

Table 2.0-1. Summary of Non-LWG Investigations Included in the RI Data Set.

Survey Name	Conventionals	Metals	Butyltins	SVOCs	PCBs	Pesticides	PCB Congeners	PCDD/Fs	VOCs	Other	Comment	Reference (See Appendix A1)
Sediments												
Downtown Portland Sediment Characterization	X	X	X	X	X	X		X	X	X	Petroleum analyzed	GSI Water Solutions, Inc. 2008
Gasco EE/CA	X	X		X		X			X	X	TPH - diesel, residual range; cyanide	Anchor 2006
2005 Portland District O&M Sediment Characterization	X	X	X	X	X	X				X	TPH - gasoline, #2 diesel, motor oil	Tetra Tech 2006
ExxonMobil Beach Sediment Sheen Samples										X	Petroleum analyzed	Kleinfelder 2004a
Terminal 4 Early Action EE/CA Report	X	X		X	X	X				X	TPH - gasoline, diesel, residual range	BBL 2005
Corps Dredged Material O&M Characterization	X	X	X	X	X	X						Hart Crowser 2004
Gunderson Area 2 Sandy Beach	X	X	X	X	X				X	X	Petroleum analyzed	Kleinfelder 2004c
International Terminal Sediment Data Report	X	X	X	X	X	X						Floyd Snider McCarthy 2003
ATOFINA Phase 2 Stage 1/2 In-River Investigation	X					X					174 samples field screened for 4,4'-DDT, 40 samples lab tested for pesticides	Integral Consulting 2003
City Outfall Source Control Investigation	X	X		X		X	X			X	Diesel, lube oil	City of Portland 2004
Surface Water, Sediment, and Groundwater Sampling Report		X		X								Ecology & Environment 2003
US Moorings RI Sediment Investigation	X	X	X	X	X	X					TPH - diesel, motor oil	URS 2003a
City Outfall Pilot Project	X	X		X	X	X				X	Herbicides and petroleum also analyzed	CH2M Hill 2002
MarCom Expanded Preliminary Assessment		X	X	X							SVOCs limited to PAHs	Parametrix 2002
GATX Linnton Terminal RI	X			X					X	X	Petroleum analyzed	KHM Environmental Management 2002a
T4 Slip 3, Berth 410 Dredge Material	X	X		X	X	X						Hart Crowser 2002a
Willamette Reference Area Phase 2	X	X	X	X	X	X					5 samples analyzed for conventionals only; pore water analyzed for butyltins	Hart Crowser 2002c
Willamette Reference Area Phase 1	X				X	X				X	Petroleum also analyzed	Hart Crowser 2001a
Cargill Irving Elevator Permit Applications	X	X	X	X	X	X					Pore water analyzed for butyltins	Harding ESE 2001
T2/T5 2001 Dredge Characterization Study	X	X	X	X	X	X					Pore water analyzed for butyltins	Hart Crowser 2001b
Chevron Dredging Permit Application	X	X	X	X	X	X			X	X	Petroleum analyzed	PNG Environmental 2001
Gasco Source Control Evaluation	X	X		X					X		SVOCs limited to PAHs	Anchor 2001
McCormick & Baxter RI Phase 4	X			X							SVOCs limited to PAHs and phenols	Ecology & Environment 2001
Goldendale Aluminum Phase 2	X			X								CH2M Hill 2001a

Table 2.0-1. Summary of Non-LWG Investigations Included in the RI Data Set.

Survey Name	Conventionals	Metals	Butyltins	SVOCs	PCBs	Pesticides	PCB Congeners	PCDD/Fs	VOCs	Other	Comment	Reference (See Appendix A1)
Oregon Steel Mills Pre-Remedial Investigation Field Activities Data Report	X	X		X	X					X	Petroleum analyzed	Exponent 2001
Willbridge 60-in Outfall	X	X		X					X	X	Only one sample analyzed for metals; SVOCs, VOCs, and petroleum analyzed	KHM Environmental Management 2002b
UP RR Albina Yard Expanded Preliminary Assessment Data Report	X	X	X	X	X					X	Petroleum analyzed	Jacobs Engineering 2000a
Marine Finance Expanded Preliminary Assessment Data Report	X	X	X	X	X					X	Petroleum analyzed	Jacobs Engineering 2000b
T1 South Sediment Study	X	X	X	X	X	X			X		Pore water analyzed for butyltins	SEA 2000
Goldendale Aluminum Phase 1	X	X	X	X	X	X			X			CH2M Hill 2001b
Ross Island Phase I (Port)	X	X	X	X	X	X			X	X	Pore water analyzed for butyltins, petroleum analyzed	Hart Crowser 2000a
Willamette November Sediment Quality Evaluation	X	X	X	X	X	X					Pore water analyzed for butyltins	USACE 2000
T5 1999 Berths 501-503 Sediment Characterization Study	X	X	X	X	X	X					Pore water analyzed for butyltins	Hart Crowser 1999a
Ross Island Lagoon Baseline	X	X	X	X	X	X					Pore water analyzed for butyltins	Landau Associates 2000a
Ross Island Phase 1 (Ross Island Sand & Gravel)	X	X	X	X	X	X			X	X	Petroleum analyzed in subsurface only	Landau Associates 2000b
GATX Linnton Terminal ESA	X	X		X	X	X			X		VOCs not analyzed in all samples	KHM Environmental Management 1999
McCormick & Baxter RI Phase 3	X	X		X				X			SVOCs limited to PAHs and phenols; PCDD/Fs not analyzed in all samples	Ecology & Environment 2001
Willamette April Sediment Quality Evaluation	X	X	X	X	X	X		X		X	All samples also analyzed for herbicides; 2 samples analyzed for PCDD/Fs; porewater analyzed for butyltins	USACE 1999a
Portland Harbor Sediment Investigation	X	X	X	X	X	X	X	X		X	Some samples analyzed for herbicides, PCDD/Fs, PCB congeners, and butyltins; pore water analyzed for butyltins and metals	Roy F. Weston 1998
TOSCO 1999 Sediment Sampling Results	X	X		X	X	X						Exponent 1999a
Elf Atochem 1999 Willamette River	X			X		X			X			Exponent 1999b
Willbridge Terminal Facility RI	X	X		X		X			X		SVOCs sometimes limited to PAHs	KHM Environmental Management 2000
T2/T4 Sediment Study	X	X	X	X	X	X						Hart Crowser 1999c
Port of Portland T4 RI	X	X		X		X			X	X	Not all samples analyzed for metals or VOCs; petroleum analyzed	Hart Crowser 2000c

Table 2.0-1. Summary of Non-LWG Investigations Included in the RI Data Set.

Survey Name	Conventionals	Metals	Butyltins	SVOCs	PCBs	Pesticides	PCB Congeners	PCDD/Fs	VOCs	Other	Comment	Reference (See Appendix A1)
Sediment Characterization Local Sponsors' Berths (conducted with Corps)	X	X	X	X	X	X					Pore water analyzed for butyltins	Hart Crowser 1999b
International Terminals Sediment Sampling Event	X	X	X	X		X						Schnitzer Steel Industries 1998
Portland Shipyard Sed. Inv.	X	X	X	X	X	X			X		Butyltins, pesticides, and VOCs not analyzed in all samples; pore water analyzed for butyltins	SEA 1998
Portland Shipyard Env. Audit	X	X	X	X	X				X		Butyltins and VOCs not analyzed in all samples; SVOCs sometimes limited to PAHs and phthalates	Dames & Moore 1998
Willamette River 1998 Data	X	X	X	X	X						SVOCs limited to PAHs and phthalates; butyltins analyzed in 7 samples	Dames & Moore 1998
T4 Berth 416 1997 Sediment Characterization Study	X	X	X	X	X	X					Porewater analyzed for butyltins	Hart Crowser 1998
Baseline Sediment Riedel	X	X	X	X							Limited SVOCs analyses	MFA 1997
CRCD - Willamette River Channel Deepening	X	X	X	X	X	X					Pore water analyzed for butyltins	USACE 1999b
PAH in surface sediments	X			X								Battelle 2002
T4 Berths 410,411 Maintenance Dredging	X	X	X	X	X	X					Pore water analyzed for butyltins	Hart Crowser 1997
BP Bulk Terminal 22T Supplemental Sediment and Revetment Investigation	X	X		X	X	X				X	Herbicides	URS Corporation 2007
Gasco Phase 2 Offshore Investigation	X	X		X				X	X	X	Herbicides	Anchor 2008
Gasco Phase 1 Offshore Investigation	X	X		X					X		Grain size, atterburg limits	Anchor 2007
RI/RA Ross Island Phase 2 (Landau)		X	X	X	X	X				X	TPH - diesel, heavy oil; pore waters analyzed for butyltins	Landau Associates 2002
Sulzer Pump, 16 riparian samples	X	X		X						X	TPH - diesel, heavy oil; SVOCs limited to PAH	GeoDesign 2004
T4 Anchor Appendix G sediment data	X	X		X	X	X				X	TPH - diesel, heavy oil	Anchor 2008
Organochlorine and PAH by SPMD	X			X		X	X	X				USGS 1999
Willbridge Terminal 2002 Post-Dredging Sediment Characterization	X	X	X	X	X	X			X			Anchor 2002
Zidell Waterfront Property RI: Riverbank Characterization		X	X	X	X						SVOCs limited to PAH	MFA 2004
Zidell Waterfront Property RI	X	X	X	X	X				X	X	TPH - diesel, heavy oil, lube oil, mineral spirits, Jet A, JP-4, kerosene, total petroleum hydrocarbons, and non-petroleum hydrocarbons	MFA 2003

Table 2.0-1. Summary of Non-LWG Investigations Included in the RI Data Set.

Survey Name	Conventionals	Metals	Butyltins	SVOCs	PCBs	Pesticides	PCB Congeners	PCDD/Fs	VOCs	Other	Comment	Reference (See Appendix A1)
Blue Heron & West Linn	X	X		X	X	X	X	X	X			Ecology and Environment, Inc. 2007
Tissue												
ATSDR/EPA/ODHS Fish Contaminant Study		X		X	X	X	X	X		X	PBDEs	ODHS, USEPA and ASTDR 2003
Transition Zone Water												
Siltronic Supplemental In-River Transition Zone Water	X	X		X					X	X	Herbicides, field measurements, lube oil, and diesel range hydrocarbons	MFA 2005
Gasco Phase 2 Offshore Investigation	X	X		X					X			Anchor 2008
Surface Water												
City of Portland TSS Data	X										TSS	City of Portland 2008
Stormwater/Seeps												
Rhone-Poulenc Outfalls 22B and 22C Stormwater	X	X		X	X	X		X	X	X	Herbicides, TPH - gas, diesel, and motor oi	AMEC Earth & Environmental, Inc. 2003, 2004, 2005
GE Spring/Summer 2007 Stormwater Outfall Monitoring	X	X		X	X		X			X	TPH - diesel; SVOCs limited to PAH and phthalates	AMEC Earth & Environmental, Inc. 2007
T4 Spring 2007 Stormwater Outfall Monitoring	X	X		X	X	X	X			X	Total petroleum hydrocarbons	Ash Creek Assoc. 2008

Notes:

For risk evaluation and nature and extent discussions, only data collected since May 1997 are used. Sediment samples collected from dredged or capped areas are removed for risk evaluations.
Risk evaluations use data with a Category 1 QA2 level of validation, and sediment samples must be collected from within the top 30.5 cm of the sediment horizon.
Nature and extent discussions use data with a Category 1 QA1 or QA2 level of validation. Surface sediments represent those collected from the top 40 cm.

[a] Included in the BERA but not the BHHRA.
[b] Included in the BHHRA but not in the BERA.

BERA - baseline ecological risk assessment
BHHRA - baseline human health risk assessment
EE/CA - engineering evaluation/cost analysis
EPA - U.S. Environmental Protection Agency
ESA - environmental site assessment
PAH - polycyclic aromatic hydrocarbons
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
RI - remedial investigation
RM - river mile
SCM - source control monitoring
SPMD - semipermeable membrane device
SVOC - semivolatile organic compound
TPH - total petroleum hydrocarbons
TSS - total suspended solids
TZW - transition zone water
VOC - volatile organic compound

Table 2.1-1. Summary of All Category 1 and Category 2 Results in the RI Data Set.

Analyte Group	Category 1	Category 2	Uncategorized	Grand Total
Grain Size	40,160	1,783		41,943
Atterberg Limits	427	21		448
Conventionals	22,249	1,628	297	24,174
Metals	77,089	4,604	328	82,021
Butyltins	6,194	377		6,571
PCB Aroclors	35,476	2,525	320	38,321
PCB Congeners	211,714	7,574		219,288
PBDE Congeners	748			748
PCB Homologs	11,185	374		11,559
PCDD/Fs	20,381	507	17	20,905
PCDD/F Homologs	12,330	234	11	12,575
Pesticides	125,112	4,928	1,121	131,161
Herbicides	7,923	192	20	8,135
PAHs	141,169	8,344	1,120	150,633
Phthalates	27,196	790	6	27,992
SVOCs	112,833	2,263	29	115,125
Phenols	55,502	1,050	67	56,619
VOCs	93,559	6,349	95	100,003
Petroleum	12,406	882	32	13,320
Radioisotopes	444			444
Grand Total	1,014,097	44,425	3,463	1,061,985

Notes:

PAH - polycyclic aromatic hydrocarbon
PBDE - polybrominated diphenyl
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
SVOC - semivolatile organic compound
VOC - volatile organic compound

Table 2.1-2. Summary of N-Qualified Data in RI Data Set.

	Surface Sediment			Subsurface Sediment			In-River Sediment Trap			Outfall Water Sediment Trap			Catch Basin Solids			In-Line Solids		
Analyte	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified
Butyltins																		
Tributyltin ion	497	2	0.4%	398	0	0.0%	48	0	0.0%	NAF	NAF	NAF	30	0	0.0%	NAF	NAF	NAF
PCBs																		
Total PCBs (Aroclors)	1514	27	1.8%	1539	38	2.5%	56	1	1.8%	4	0	0.0%	221	0	0.0%	2	0	0.0%
Total PCBs (congeners)	293	0	0.0%	151	0	0.0%	52	0	0.0%	41	0	0.0%	NAF	NAF	NAF	NAF	NAF	NAF
Total PCBs (TEQ) - mammalian WHO 2005 TEFs	293	0	0.0%	151	0	0.0%	52	0	0.0%	41	0	0.0%	NAF	NAF	NAF	NAF	NAF	NAF
PCDD/Fs																		
Total PCDD/Fs	355	10	2.8%	291	0	0.0%	48	0	0.0%	NAF	NAF	NAF	NAF	NAF	NAF	NAF	NAF	NAF
TCDD TEQ - mammalian WHO 2005 TEFs	348	10	2.9%	295	0	0.0%	48	0	0.0%	NAF	NAF	NAF	NAF	NAF	NAF	NAF	NAF	NAF
Herbicides																		
Silvex®	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Organochlorine Pesticides																		
4,4'-DDD	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total of 2,4' and 4,4'-DDD (Sum DDD)	1459	378	25.9%	1497	386	25.8%	58	6	10.3%	33	8	24.2%	32	0	0.0%	2	0	0.0%
Total of 2,4' and 4,4'-DDE (Sum DDE)	1457	230	15.8%	1497	279	18.6%	58	3	5.2%	33	8	24.2%	32	0	0.0%	2	0	0.0%
Total of 2,4' and 4,4'-DDT (Sum DDT)	1459	224	15.4%	1496	211	14.1%	58	17	29.3%	33	6	18.2%	32	0	0.0%	2	0	0.0%
Total of 2,4' and 4,4'-DDD, -DDE, -DDT (Total DDx)	1459	504	34.5%	1496	561	37.5%	58	23	39.7%	33	17	51.5%	32	0	0.0%	2	0	0.0%
Aldrin	1387	66	4.8%	1267	56	4.4%	50	2	4.0%	33	2	6.1%	32	0	0.0%	2	0	0.0%
gamma-Hexachlorocyclohexane	1387	98	7.1%	1267	58	4.6%	50	0	0.0%	33	2	6.1%	32	0	0.0%	2	0	0.0%
Total Chlordanes	1385	349	25.2%	1247	355	28.5%	50	15	30.0%	33	4	12.1%	32	0	0.0%	2	0	0.0%
Dieldrin	1387	63	4.5%	1267	28	2.2%	50	2	4.0%	33	1	3.0%	32	0	0.0%	2	0	0.0%
Polycyclic Aromatic Hydrocarbons[a]																		
LPAHs																		
Naphthalene	2010	0	0.0%	1857	0	0.0%	59	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Phenanthrene	2004	0	0.0%	1818	0	0.0%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Total LPAHs	2005	2	0.1%	1818	3	0.2%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
HPAHs																		
Benzo(a)pyrene	2005	0	0.0%	1818	0	0.0%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Total HPAHs	2005	0	0.0%	1818	4	0.2%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Total PAHs	2005	2	0.1%	1818	5	0.3%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Total Carcinogenic PAHs	2005	0	0.0%	1818	4	0.2%	57	0	0.0%	27	0	0.0%	166	0	0.0%	2	0	0.0%
Phthalates																		
Bis(2-ethylhexyl) phthalate	1729	0	0.0%	1629	0	0.0%	57	0	0.0%	27	0	0.0%	154	0	0.0%	2	0	0.0%
Butylbenzyl phthalate	1720	0	0.0%	1629	0	0.0%	57	0	0.0%	27	0	0.0%	152	0	0.0%	2	0	0.0%
Semivolatile Organic Compounds																		
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	1597	6	0.4%	1330	7	0.5%	50	0	0.0%	33	0	0.0%	13	0	0.0%	2	0	0.0%

Table 2.1-2. Summary of N-Qualified Data in RI Data Set.

	Surface Sediment			Subsurface Sediment			In-River Sediment Trap			Outfall Water Sediment Trap			Catch Basin Solids			In-Line Solids		
Analyte	**# Analyzed**	**# N-Qualified**	**% N-Qualified**	**# Analyzed**	**# N-Qualified**	**% N-Qualified**	**# Analyzed**	**# N-Qualified**	**% N-Qualified**	**# Analyzed**	**# N-Qualified**	**% N-Qualified**	**# Analyzed**	**# N-Qualified**	**% N-Qualified**	**# Analyzed**	**# N-Qualified**	**% N-Qualified**
Phenols																		
Pentachlorophenol	1714	62	3.6%	1339	30	2.2%	44	3	6.8%	NAF	NAF	NAF	18	0	0.0%	2	0	0.0%
Benzyl Alcohol	1574	0	0.0%	--	--	--	49	0	0.0%	NAF	NAF	NAF	12	0	0.0%	NAF	NAF	NAF
Volatile Organic Compounds																		
1,1,2-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total xylenes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Petroleum (TPH)																		
Diesel-Range Hydrocarbons	1288	0	0.0%	1527	0	0.0%	55	0	0.0%	NAF	NAF	NAF	156	0	0.0%	2	0	0.0%
Gasoline-Range Hydrocarbons	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Residual-Range Hydrocarbons	1048	0	0.0%	1370	0	0.0%	55	0	0.0%	NAF	NAF	NAF	16	0	0.0%	NAF	NAF	NAF
Total Petroleum Hydrocarbons	955	0	0.0%	1222	0	0.0%	55	0	0.0%	NAF	NAF	NAF	155	0	0.0%	2	0	0.0%

Table 2.1-2. Summary of N-Qualified Data in RI Data Set.

Analyte	Surface Water			Biota			TZW			Loading / Stormwater			Riparian Surface Soils/Sediments			Riparian Subsurface Soils/Sediments		
	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified
Butyltins																		
Tributyltin ion	177	0	0.0%	287	1	0.3%	--	--	--	7	0	0.0%	7	0	0.0%	2	0	0.0%
PCBs																		
Total PCBs (Aroclors)	61	0	0.0%	183	0	0.0%	--	--	--	140	0	0.0%	28	0	0.0%	27	0	0.0%
Total PCBs (congeners)	245	0	0.0%	387	25	6.5%	--	--	--	166	14	8.4%	1	0	0.0%	NAF	NAF	NAF
Total PCBs (TEQ) - mammalian WHO 2005 TEFs	245	0	0.0%	379	11	2.9%	--	--	--	166	8	4.8%	1	0	0.0%	NAF	NAF	NAF
PCDD/Fs																		
Total PCDD/Fs	158	0	0.0%	348	0	0.0%	--	--	--	5	0	0.0%	NAF	NAF	NAF	NAF	NAF	NAF
TCDD TEQ - mammalian WHO 2005 TEFs	162	0	0.0%	348	0	0.0%	--	--	--	7	0	0.0%	1	0	0.0%	NAF	NAF	NAF
Herbicides																		
Silvex®	--	--	--	--	--	--	18	0	0.0%	--	--	--	--	--	--	--	--	--
Organochlorine Pesticides																		
4,4'-DDD	--	--	--	--	--	--	--	--	--	96	2	2.1%	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	--	--	96	0	0.0%	--	--	--	--	--	--
Total of 2,4' and 4,4'-DDD (Sum DDD)	280	2	0.7%	457	44	9.6%	31	1	3.2%	96	2	2.1%	21	0	0.0%	4	0	0.0%
Total of 2,4' and 4,4'-DDE (Sum DDE)	280	3	1.1%	457	20	4.4%	31	2	6.5%	96	5	5.2%	21	0	0.0%	4	0	0.0%
Total of 2,4' and 4,4'-DDT (Sum DDT)	280	8	2.9%	457	74	16.2%	31	1	3.2%	96	2	2.1%	21	0	0.0%	4	0	0.0%
Total of 2,4' and 4,4'-DDD, -DDE, -DDT (Total DDx)	280	12	4.3%	457	91	19.9%	31	4	12.9%	96	7	7.3%	21	0	0.0%	4	0	0.0%
Aldrin	274	0	0.0%	471	1	0.2%	--	--	--	68	1	1.5%	19	0	0.0%	4	0	0.0%
gamma-Hexachlorocyclohexane	274	2	0.7%	471	20	4.2%	--	--	--	68	1	1.5%	19	0	0.0%	4	0	0.0%
Total Chlordanes	277	3	1.1%	457	67	14.7%	--	--	--	66	5	7.6%	19	0	0.0%	4	0	0.0%
Dieldrin	277	2	0.7%	471	30	6.4%	--	--	--	66	0	0.0%	19	0	0.0%	4	0	0.0%
Polycyclic Aromatic Hydrocarbons[a]																		
LPAHs																		
Naphthalene	--	--	--	100	0	0.0%	369	0	0.0%	336	0	0.0%	42	0	0.0%	58	0	0.0%
Phenanthrene	--	--	--	100	0	0.0%	170	0	0.0%	327	1	0.3%	42	0	0.0%	59	0	0.0%
Total LPAHs	398	0	0.0%	96	0	0.0%	--	--	--	--	--	--	42	0	0.0%	59	0	0.0%
HPAHs																		
Benzo(a)pyrene	228	0	0.0%	--	--	--	170	0	0.0%	327	0	0.0%	42	0	0.0%	58	0	0.0%
Total HPAHs	398	0	0.0%	96	0	0.0%	170	0	0.0%	--	--	--	42	0	0.0%	59	0	0.0%
Total PAHs	398	0	0.0%	96	0	0.0%	170	0	0.0%	327	1	0.3%	42	0	0.0%	59	0	0.0%
Total Carcinogenic PAHs	398	0	0.0%	93	0	0.0%	170	0	0.0%	327	0	0.0%	42	0	0.0%	59	0	0.0%
Phthalates																		
Bis(2-ethylhexyl) phthalate	--	--	--	399	0	0.0%	--	--	--	204	0	0.0%	24	0	0.0%	4	0	0.0%
Butylbenzyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	24	0	0.0%	4	0	0.0%
Semivolatile Organic Compounds																		
1,2-Dichlorobenzene	--	--	--	--	--	--	X	X	X	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	374	0	0.0%	472	6	1.3%	--	--	--	82	1	1.2%	24	0	0.0%	4	0	0.0%

Table 2.1-2. Summary of N-Qualified Data in RI Data Set.

	Surface Water			Biota			TZW			Loading / Stormwater			Riparian Surface Soils/Sediments			Riparian Subsurface Soils/Sediments		
Analyte	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified	# Analyzed	# N-Qualified	% N-Qualified
Phenols																		
Pentachlorophenol	--	--	--	--	--	--	11	0	0.0%	41	0	0.0%	22	0	0.0%	1	0	0.0%
Benzyl Alcohol	--	--	--	--	--	--	--	--	--	--	--	--	24	0	0.0%	--	--	--
Volatile Organic Compounds																		
1,1,2-Trichloroethane	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	154	0	0.0%	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Benzene	--	--	--	--	--	--	316	0	0.0%	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	--	--	--	--	275	0	0.0%	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	316	0	0.0%	--	--	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	316	0	0.0%	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	--	--	312	0	0.0%	--	--	--	--	--	--	--	--	--
Total xylenes	--	--	--	--	--	--	316	0	0.0%	--	--	--	--	--	--	--	--	--
Petroleum (TPH)																		
Diesel-Range Hydrocarbons	--	--	--	--	--	--	135	0	0.0%	115	0	0.0%	17	0	0.0%	39	0	0.0%
Gasoline-Range Hydrocarbons	--	--	--	--	--	--	81	0	0.0%	60	0	0.0%	--	--	--	--	--	--
Residual-Range Hydrocarbons	--	--	--	--	--	--	124	0	0.0%	11	0	0.0%	1	0	0.0%	26	0	0.0%
Total Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	--	--	--	18	0	0.0%	26	0	0.0%

Notes:

For all summed analytes the counts (# of N-qualified samples of total # of samples) indicate the number of summed results that include one or more N-qualified result in the sum.

[a] For biota samples PAHs are summarized for clam tissues only.

-- Not an IC for this media
HPAH - high molecular weight PAH
LPAH - low molecular weight PAH
NAF - not analyzed for in this matrix
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
RI - remedial investigation
TEF - toxicity equivalency factor
TEQ - toxic equivalent concentration
TPH - total petroleum hydrocarbon
TZW - transition zone water

Table 2.1-3. Data Treatment Summary for the RI and Baseline RAs.

Type	BERA	BHHRA	Background	RI
Data Set	• Category 1 QA2 only	• Category 1 QA2 only	• Category 1 QA2 only	• Category 1 QA1 and Category 1 QA2
Summation Rules	• Non-detects for analytes detected at least once in the data set for a given medium[a] are included in the summation at 1/2 the DL. • Non-detects for analytes never detected within the data set for a given medium are excluded from summation. • If none of the analytes were detected, then the highest DL is the selected value for the total, and a U qualifier (and detect flag = "N") is added. • If any of the values going into a total are qualified, then the total value is qualified also.	• Same as BERA, except that medium-specific data sets for the BHHRA are defined differently from the BERA in some cases based on relevant HH exposure scenarios (e.g., biota data sets for the BHHRA are defined based on a given species and tissue type).	• Same as BERA	• ND = 0 in all sums[b] • If any of the values going into a total are estimated (J qualified), then the total value is estimated (J qualified). If one or more N qualified result is included in the sum, then the sum is N qualified. • If all analytes in a total are non-detects, then the highest detection limit is used for the total.
TEQ Calculations	• Detected values are multiplied by the TEF. • Non-detects for analytes detected at least once in the data set for a given medium are included in the summation at 1/2 the DL and multiplied by the TEF. • Non-detects for analytes never detected within the data set for a given medium are excluded from summation. • If none of the analytes are detected, the DLs are multiplied by their respective TEF and the maximum individual value for the total is used, with a U qualifier (and detect flag = "N"). • The weighted components are summed for each sample.	• Same as BERA, except that medium-specific data sets for the BHHRA are defined differently from the BERA in some cases based on relevant HH exposure scenarios (e.g., biota data sets for the BHHRA are defined based on a given species and tissue type).	• Same as BERA	• Detected values are multiplied by the TEF. • ND values are set to zero for the calculation[b]. • The weighted components are summed for each sample.
Field Replicates[c]	• When calculating a mean or a UCL, and when reporting data in general, replicates are always included in the data set as discrete samples. • When generating Thiessen polygons (or any other task which spatially weights data), replicates are included as long as they have unique coordinates. Replicates that share coordinates with the parent sample are excluded from these data sets.	• Same as BERA	• Replicates averaged rather than considered discrete samples (reflecting attempt to avoid bias of overweighting a single sample location. The potential for bias is greater in the background data set due to the much smaller sample size as compared to the study area data set for all media).	• Same as BERA

Table 2.1-3. Data Treatment Summary for the RI and Baseline RAs.

Type	BERA	BHHRA	Background	RI
OC-normalization	For each organic analyte in the sediment data set, calculate the organic carbon-normalized (OC-norm) concentration as follows: • For all calculations, use the fractional organic carbon content, f_{oc} (TOC%/100). • Organic carbon-normalized values were calculated as Cdw/ foc, where Cdw is the dry-weight concentration in mg/kg. • No upper TOC limit was set that would exclude normalization; however, for higher TOC values (>4:0%), each individual sample was evaluated for possible anthropogenic contributions to organic carbon (e.g., woodwaste, petroleum, NAPLs or sewage) that may have confounded partitioning assumptions. • For TOC < 0.2% or high values with contribution from anthropogenic wastes (see previous bullet), no organic carbon-normalized value was calculated. In these few cases, sample data were evaluated on a dry-weight basis only. • For samples without TOC data, the value was estimated using a regression equation based on site-specific TOC and grain size (as percent fines) from the upriver reach (RM >15.3).	n/a	• Same as BERA	n/a

Notes:

[a] BERA data sets assessed for detection status include benthic tissue (all species), fish tissue (all species), surface sediment, surface water, and shallow transition zone water.

[b] The rationale for being different from the risk assessment approach: The use of ND = 0 in the summation approach allows for clearer presentation of the measured (detected) distribution of chemicals. It is recognized that summation of long lists of chemicals can be highly skewed by the detection limits, essentially smoothing out the data distribution and obscuring patterns. In contrast, for the risk assessments, application of ½ DLs is appropriate in the sums because it conservatively minimizes the potential for underestimation in determination of risk.

[c] This refers specifically to post-SCRA treatment of field replicates. Lab replicates and split samples are handled consistently before being entered in the SCRA; specifically, both lab replicates and splits are averaged before entry into the SCRA.

n/a - not applicable
DL - detection limit
BERA - baseline ecological risk assessment
BLRA - baseline risk assessment
BHHRA - baseline human health risk assessment
foc - fraction of organic carbon
HH - human health
NAPL - non-aqueous phase liquid
ND - non-detect
OC - organic carbon
RA - risk assessments
RI - remedial investigation
SCRA - site characterization and risk assessment
TEF - toxicity equivalency factor
TEQ - toxic equivalent concentration
TOC - total organic carbon
UCL - upper confidence limit

Reason codes for qualifiers:
J - The associated numerical value is an estimated quantity.
N - Presumptive evidence of presence of material; identification of the compound is not definitive.
U - The material was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

Table 2.1-4. Individual Analytes in Calculated Totals by Data Set.

Chemical Sums	RI Data Set	BHHRA Data Set	BERA Data Set
Total PCBs (Aroclors or congeners)	X	X	X
Total PCB congeners without dioxin-like congeners		X	
Total PCDD/Fs (sum of homologs)	X		
Total PCDD/Fs (sum of individual congeners)			X
PCB and TCDD TEQ	X	X	X
Total DDx	X		X
Total DDD, total DDE, total DDT	X	X	X
Total LPAHs, total HPAHs, total PAHs	X		X
Total cPAH reported in BaPEq	X	X[a]	
Total petroleum hydrocarbons	X		X
Total endosulfan	X	X	X
Total chlordanes	X	X	X
Total xylene	X	X	X
Benzene, toluene, ethylbenzene, and total xylene (BTEX)	X		
Total fines	X		X

Notes:

[a] For mapping purposes only.

BaPEq - benzo(a)pyrene equivalents
BERA - baseline ecological risk assessment
BHHRA - baseline human health risk assessment
cPAH - carcinogenic PAH
DDx - sum of 2,4'- and 4,4'-DDD, DDE, and DDT
HPAH - high molecular weight PAH
LPAH - low molecular weight PAH
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
RI - remedial investigation
TEQ - toxic equivalent concentration

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This document is currently under review by US EPA and its federal, state, and tribal partners, and is subject to change in whole or in part.

Table 2.1-5. Number of Analytes Required for Each Calculated Total.

Chemical Name	Expected Analytes	'A' qualify (Limited)	Do Not Sum
Total PCBs Aroclors (calc'd)	7 or 9	<7	<2
Total PCB Congeners (calc'd)	209	<150	<100
Total PCDD/Fs (calc'd)	17	<17	<10
Total DDx (calc'd)	6	<6	--
Sum DDD (calc'd)	2	<2	--
Sum DDE (calc'd)	2	<2	--
Sum DDT (calc'd)	2	<2	--
Total HPAHs (calc'd)	10	<10	<5
Total LPAHs (calc'd)	7	<7	<3
Total PAHs (calc'd)	17	<17	<10
Total Chlordanes (calc'd)	5	<5	--
Total Endosulfan (calc'd)	3	<3	--
Total Xylene (calc'd)	2	<2	--

Notes:

DDx - sum of 2,4'- and 4,4'-DDD, DDE, and DDT
HPAH - high molecular weight PAH
LPAH - low molecular weight PAH
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans

Table 2.1-6. RI Data Set Selection Criteria.

Data Type	Primary Sources/Data Quality Selection	Additional Inclusion or Exclusion Criteria
Sediment	LWG and Other Parties/Category 1 QA1 or Category 1 QA2 collected since May 1, 1997; see Table 2.0-1	- Include samples collected from an elevation below or equal to +13 ft NAVD88[a] - Exclude Ross Island Lagoon samples from Downtown Reach - Exclude sediment samples subsequently dredged or capped from summary statistics but include in figures and maps with flags
Sediment - Background	LWG and Other Parties/Category 1 QA2	- Include surface sediment (0–30 cm) - Include samples collected from RM 15.3 to 24.8
Sediment Trap	LWG In-river/ Category 1 QA2	
Riparian Zone (Riverbank) Sediment and Soil	Other Parties/Category 1 and Category 2; see Table E7-1	- Include surface samples (0–40 cm) - Include samples collected between an elevation of +13 ft and +20 ft NAVD88[b] - Select samples from RM 1.9 to 11.8
Surface Water – Nature and Extent	LWG/Category 1 QA2 | City of Portland TSS data/no category	- Exclude surface water data collected by other parties except for City of Portland TSS data
Surface Water - Background	LWG/Category 1 QA2	- Include surface water data from RM 11 and 16 (Stations W023 and W024)
Stormwater	LWG and Other Parties/Category 1 QA1 or Category 1 QA2; see Table 4.4-2	- Include data collected since January 1, 2004 (approximate time at which DEQ's JSCS program began)
TZW	LWG and Other Parties/Category 1 QA1 or Category 1 QA2	
Seep	Seep data collected by other parties/ Category 1 QA2	- Include all Outfall 22B seep data regardless of collection date
Biota	LWG/Category 1 QA2 fish, fish stomach contents, and invertebrates | ODHS/EPA/ATSDR Study/Category 1 QA2 adult sturgeon, adult spring Chinook, adult Pacific lamprey	- Exclude biota tissue data collected by other parties except for the ODHS et al. (2003) study

Notes:

[a] An elevation of +13 ft NAVD88 (mean high water mark [MHWM]) is the elevation defining the shoreline boundary of the Portland Harbor Superfund Site. This elevation is based on a DEQ memorandum dated July 9, 2003 to EPA regarding the upland/in-water boundary for the Superfund Site (DEQ 2003b). The MHWM is based on the monthly average water level for the 16-year period from 1987 to 2002.

[b] An elevation of +20 ft NAVD88 (ordinary high water mark [OHWM]) is the upper edge of the riverbank (DEQ 2003b). The OHWM defines the elevation beyond which inundation by the river is limited to extreme flow events.

ATSDR - Agency for Toxic Substances and Disease Registry
DEQ - Oregon Department of Environmental Quality
EPA - U.S. Environmental Protection Agency
JSCS - joint source control strategy
LWG - Lower Willamette Group
NAVD88 - North American Vertical Datum 1988
ODHS - Oregon Department of Human Services
QA - quality assurance
RI - remedial investigation
RM - river mile
TSS - total suspended solids
TZW - transition zone water

Table 2.1-7. BHHRA Data Set Selection Criteria.

Data Type	Primary Sources/Data Quality Selection	Additional Inclusion or Exclusion Criteria
Sediment	LWG and Other Parties/Category 1 QA2 collected since May 1, 1997 - see Table 2.0-1	- Include surface sediment collected from 0 to 30.5 cm - Exclude samples collected from the navigation channel - Exclude samples subsequently dredged or capped
Surface Water	LWG/Category 1 QA2	
TZW	LWG and Other Parties/Category 1 QA2	- Include shallow TZW collected from 0 to 38 cm
Seep	Seep data collected by other parties	- Include seep data from Outfall 22B
Biota	LWG/Category 1 QA2 fish, clam, and crayfish | ODHS Study adult sturgeon, adult spring Chinook, and adult Pacific lamprey	- Exclude biota tissue data collected by other parties except for the ODHS study. See Appendix F.

Notes:

BHHRA - baseline human health risk assessment
LWG - Lower Willamette Group
ODHS - Oregon Department of Human Services
QA - quality assurance
TZW - transition zone water

Table 2.1-8. BERA Data Set Selection Criteria.

Data Type	Primary Sources/Data Quality Selection	Additional Inclusion or Exclusion Criteria
Sediment	LWG and Other Parties/Category 1 QA2 collected since May 1, 1997; see Table 2.0-1	- Include surface sediment collected from 0 to 30.5 cm - Exclude samples subsequently dredged or capped
Surface Water	LWG/Category 1 QA2	
TZW	LWG and Other Parties/Category 1 QA2	
Biota	LWG/Category 1 QA2 fish, invertebrate, and fish stomach contents	- Exclude biota tissue data collected by other parties. See Appendix G.
Bioassay	LWG-collected bioassay data using *Chironomus dilutus* and *Hyalella azteca*.	

Notes:

BERA - baseline ecological risk assessment
LWG - Lower Willamette Group
QA - quality assurance
TZW - transition zone water

Table 2.2-1. Summary of Sampling Dates for LWG Sampling Rounds in the RI Data Set.

Task Description	Media	Beginning of Sampling	End of Sampling
Round 1A tissue samples	Tissue	6/25/2002	6/27/2002
Round 1 tissue samples	Tissue	7/22/2002	11/12/2002
Round 1 HHRA beach sediment	Sediment	10/10/2002	10/14/2002
Round 1 collocated surface sediment	Sediment	10/16/2002	11/12/2002
Round 2A sediment grabs	Sediment	7/19/2004	11/5/2004
Round 2A beach sediment composites	Sediment	7/26/2004	11/5/2004
Round 2A sediment cores	Sediment	9/21/2004	11/11/2004
Natural attenuation cores	Sediment	10/20/2004	10/22/2004
Round 2A surface water event 1	Surface water	11/8/2004	12/2/2004
Round 2A surface water event 1	Surface water from XAD column	11/9/2004	12/1/2004
Round 2A surface water event 1	Surface water from XAD filter	11/9/2004	12/1/2004
Groundwater pathway assessment pilot study	Transition Zone Water	11/19/2004	2/8/2005
Groundwater pathway assessment pilot study	Sediment	1/18/2005	1/21/2005
Round 2A surface water event 2	Surface water	3/1/2005	3/17/2005
Round 2A surface water event 2	Surface water from XAD column	3/1/2005	3/15/2005
Round 2A surface water event 2	Surface water from XAD filter	3/1/2005	3/15/2005
Round 2A tissue, juvenile chinook	Tissue	5/10/2005	5/14/2005
Round 2A surface water event 3	Surface water	7/5/2005	7/20/2005
Round 2A surface water event 3	Surface water from XAD column	7/6/2005	7/19/2005
Round 2A surface water event 3	Surface water from XAD filter	7/6/2005	7/19/2005
Round 2A tissue, multiplate	Tissue	9/6/2005	9/15/2005
Round 2A GW pathway assessment transition zone water	Transition Zone Water	10/3/2005	12/1/2005
Round 2B sediment cores	Sediment	10/18/2005	10/28/2005
Round 2A benthic tissue	Tissue	11/28/2005	3/9/2006
Round 2A GW pathway assessment collocated sediment grabs	Sediment	11/29/2005	12/2/2005
Round 2B tissue, lamprey	Tissue	11/30/2005	11/30/2005
Round 2B tissue, freshwater mussel	Tissue	12/5/2005	12/13/2005
Round 2A benthic sediment	Sediment	12/6/2005	12/20/2005
Round 3 surface water January 2006	Surface water	1/19/2006	1/21/2006
Round 3 surface water January 2006	Surface water from XAD column	1/19/2006	1/21/2006
Round 3 surface water January 2006	Surface water from XAD filter	1/19/2006	1/21/2006
Round 3 surface water September 2006	Surface water	9/4/2006	9/13/2006
Round 3 surface water September 2006	Surface water from XAD column	9/4/2006	9/13/2006
Round 3 surface water September 2006	Surface water from XAD filter	9/4/2006	9/13/2006
Round 3 lamprey tissue composites	Tissue	9/20/2006	10/4/2006
Round 3 surface water November 2006	Surface water	11/2/2006	11/5/2006
Round 3 surface water November 2006	Surface water from XAD column	11/2/2006	11/5/2006
Round 3 surface water November 2006	Surface water from XAD filter	11/2/2006	11/5/2006
Round 3 surface water 2007 high flow event	Surface water	1/15/2007	3/10/2007
Round 3 surface water 2007 high flow event	Surface water from XAD column	1/15/2007	3/10/2007
Round 3 surface water 2007 high flow event	Surface water from XAD filter	1/15/2007	3/10/2007
Round 3 in river sediment trap event 1	Sediment from sediment trap	1/30/2007	2/2/2007
Round 3 sediment from upstream and downstream	Sediment	1/30/2007	2/8/2007
Round 3A sediment for radioisotope analyses	Sediment	2/6/2007	2/6/2007
Round 3A sturgeon	Tissue	2/21/2007	3/6/2007
Round 3A stormwater outfalls (March 2007 Storm Event)	Outfall water (stormwater)	3/26/2007	3/27/2007
Round 3A stormwater outfalls (April 2007 Storm Event I)	Outfall water (stormwater)	4/9/2007	4/9/2007
Round 3A stormwater outfalls (April 2007 Storm Event II)	Outfall water (stormwater)	4/18/2007	4/18/2007
Round 3A stormwater outfalls (April 2007 Storm Event III)	Outfall water (stormwater)	4/23/2007	4/23/2007
Round 3 in river sediment trap event 2	Sediment from sediment trap	4/30/2007	5/2/2007
Round 3A stormwater outfalls (May 2007 Storm Event I)	Outfall water (stormwater)	5/3/2007	5/3/2007
Round 3A stormwater outfalls (May 2007 Storm Event II) - grab samples	Outfall water (stormwater)	5/21/2007	5/22/2007
Round 3A stormwater outfalls - Sediment Traps	Sediment from sediment trap	5/24/2007	7/5/2007
Round 3A stormwater outfalls (June 2007 Storm Event I) - grab samples	Outfall water (stormwater)	6/5/2007	6/5/2007
Round 3A stormwater outfalls (June 2007 Storm Event II)	Outfall water (stormwater)	6/10/2007	6/11/2007
Round 3 in river sediment trap event 3	Sediment from sediment trap	8/8/2007	8/17/2007
Round 3B biota	Tissue	8/28/2007	11/16/2007
Willamette Cove sampling and analysis	Sediment	9/21/2007	9/21/2007
Round 3B biota - collocated sediments	Sediment	10/15/2007	12/6/2007
Round 3 in river sediment trap event 4	Sediment from sediment trap	11/13/2007	11/14/2007
Round 3B sediment grabs	Sediment	11/14/2007	12/6/2007

Table 2.2-1. Summary of Sampling Dates for LWG Sampling Rounds in the RI Data Set.

Task Description	Media	Beginning of Sampling	End of Sampling
Round 3B stormwater outfalls (November 16, 2007 Storm Event)	Outfall water (stormwater)	11/16/2007	11/16/2007
Round 3B stormwater outfalls (November 27, 2007 Storm Event)	Outfall water (stormwater)	11/27/2007	11/27/2007
Round 3B stormwater outfalls (November 29, 2007 Storm Event)	Outfall water (stormwater)	11/29/2007	11/29/2007
Round 3B sediment cores	Sediment	12/10/2007	1/17/2008
Round 3B stormwater outfalls - sediment traps	Sediment from sediment trap	12/20/2007	2/12/2008
Round 3B stormwater outfalls (January 09, 2008 Storm Event)	Outfall water (stormwater)	1/9/2008	1/9/2008
Round 3B stormwater outfalls (January 11, 2008 Storm Event)	Outfall water (stormwater)	1/11/2008	1/11/2008
Round 3B stormwater outfalls (January 15, 2008 Storm Event)	Outfall water (stormwater)	1/15/2008	1/15/2008
Round 3B stormwater outfalls (January 28, 2008 Storm Event)	Outfall water (stormwater)	1/28/2008	1/28/2008
Round 3B stormwater outfalls (January 30, 2008 Storm Event)	Outfall water (stormwater)	1/30/2008	1/30/2008

Notes:

GW - groundwater
HHRA - human health risk assessment
LWG - Lower Willamette Group
RI - remedial investigation
XAD column - A stainless-steel column filled with Amberlite® XAD®-2, a hydrophobic crosslinked polystyrene copolymer resin
XAD filter - a 0.5-mm glass fiber filter cartridge

Table 2.2-2. RI Data Set Sample Summary.

	LWG				Other Parties				
Media	**normal**	**replicate**	**split**	**lab rep**	**normal**	**replicate**	**split**	**lab rep**	**Total**
Sediment									
Catch basin					277	4			281
In-river sediment trap	52								52
T4 in-river sediment trap					8				8
Stormwater outfall sediment trap	41	3							44
T4 stormwater outfall sediment trap					6				6
Beach composite	42	4							46
Collocated with tissue	101	10							111
Collocated with TZW	43	7							50
Surface for radioisotopes	3								3
Subsurface for radioisotopes	108								108
Surface	845	45			1,029	30			1,949
Subsurface	1,086	71			1,006	5			2,168
Tissue									
Black crappie (fillet)	2	2							4
Black crappie (fillet without skin)	2	2							4
Black crappie (whole body)	2	2							4
Brown bullhead (fillet without skin)	4	8							12
Brown bullhead (whole body)	4	5							9
Carp (body without fillet)	9								9
Carp (fillet)	11	4							15
Carp (fillet without skin)	2	4							6
Carp (whole body)	3	4							7
Chinook, adult (fillet)					3				3
Chinook, adult (fillet without skin)					3				3
Chinook, adult (whole body)					4				4
Chinook, juvenile (stomach contents)	6								6
Chinook, juvenile (whole body)	11	8							19
Clam (body without shell)	46								46
Clam (depurated w/o shell)	5								5
Bioaccumulation test clam (body without shell)	33	2			11				46
Bioaccumulation test *Lumbriculus variegatus* (whole body)	33	2			11				46
Crayfish (whole body)	33	3							36
Lamprey, adult (whole body)					4				4
Lamprey, ammocoetes (whole body)	6	1							7
Lamprey, macropthalmia (whole body)	3								3
Largescale sucker (whole body)	5	1							6
Multiplate invertebrates (whole body)	7								7
Mussel (body without shell)	7								7
Northern pikeminnow (whole body)	5	1							6
Peamouth (whole body)	4								4
Sculpin (whole body)	40	3							43
Smallmouth bass (body without fillet)	18								18
Smallmouth bass (fillet)	23								23
Smallmouth bass (fillet without skin)	5								5
Smallmouth bass (whole body)	10	10							20
Sturgeon (fillet without skin)					5				5
Sturgeon (stomach contents)	3								3
Sturgeon (whole body)	15								15
Water									
Transition zone water	201	45			174				420
Pore water					376	14			390
Groundwater					206				206
Stormwater	149		25	37	236	3		1	451
GE Stormwater					12		4		16
T4 Stormwater					32		8		40
Seep					6				6
Surface water	170	16			291	3			480
Surface water by XAD column	116	5							121
Surface water by 0.5μm glass fiber filter	116	5							121

Notes:

LWG - Lower Willamette Group
RI - remedial investigation
T4 - Port of Portland Terminal 4
TZW - transition zone water
XAD - Amberlite® XAD®-2 is a hydrophobic crosslinked polystyrene copolymer resin

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Subsurface Sediment							
Grain Size							
< 0.075 mm		2		232			234
> 0.075 mm				63			63
>10 Phi clay				42			42
>9 Phi clay	17	61	11	977		3	1,069
8-9 Phi clay	17	61	11	1,019		3	1,111
9-10 Phi clay				42			42
Clay	2	7		304			313
Coarse sand	17	61	11	1,193		3	1,285
Coarse silt	17	61	11	1,019		3	1,111
Fine gravel	17	61	11	1,049		3	1,141
Fine sand	17	61	11	1,193		3	1,285
Fine silt	17	61	11	1,019		3	1,111
Fines	19	71	11	1,346		3	1,450
Granule				24			24
Gravel	2	10		223			235
Mean grain size	2			19			21
Median grain size	2			19			21
Medium gravel	17	61	11	1,070		3	1,162
Medium sand	17	61	11	1,193		3	1,285
Medium silt	17	61	11	1,019		3	1,111
Medium-fine gravel				24			24
Sand	2	10		165			177
Sieve 10		2		174			176
Sieve 100				15			15
Sieve 140		2		159			161
Sieve 20		2		174			176
Sieve 200		2		174			176
Sieve 230				5			5
Sieve 4		2		174			176
Sieve 40		2		174			176
Sieve 60		2		174			176
Silt	2	7		304			313
Very coarse sand	17	61	11	1,190		3	1,282
Very fine sand	17	61	11	1,190		3	1,282
Very fine silt	17	61	11	1,019		3	1,111
Atterberg Limits							
Liquid Limit				63			63
Plastic Limit				71			71
Plasticity Index				63			63
Conventionals							
Acid Volatile Sulfides	9			25			34
Ammonia	7	12		187			206
Cyanide				101			101
Moisture				34			34
Nitrate				2			2
pH				24			24
Phosphorus		15					15
Specific Gravity	17	25	11	1,002			1,055
Sulfate				26			26
Sulfide	7	2		195			204
Total organic carbon	33	62	14	1,696	54	3	1,862
Total solids	36	64	14	1,848	60	3	2,025
Total volatile solids	7			158			165
Metals							
Aluminum	17	61	14	1,053		3	1,148
Antimony	24	93	14	1,220	57	3	1,411
Arsenic	33	93	14	1,549	59	3	1,751
Arsenic pentavalent				8			8
Arsenic trivalent				8			8
Barium		15		106			121
Beryllium		15		105			120
Cadmium	33	93	14	1,554	59	3	1,756
Calcium				78			78
Chromium	33	93	14	1,485	40	3	1,668
Chromium hexavalent				45			45
Cobalt				37			37
Copper	33	93	14	1,549	59	3	1,751
Iron				81			81
Lead	33	93	14	1,651	59	3	1,853

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Magnesium				78			78
Manganese				107			107
Mercury	33	93	14	1,433	59	3	1,635
Nickel	33	93	14	1,529	59	3	1,731
Potassium				78			78
Selenium	17	70		1,058		3	1,148
Silver	33	78	14	1,481	59	3	1,668
Sodium				78			78
Thallium		15		105			120
Tin				3			3
Titanium				27			27
Vanadium				37			37
Zinc	33	93	14	1,639	59	3	1,841
Butylins							
Butyltin ion		46		310	35	3	394
Dibutyltin ion		46		310	36	3	395
Tetrabutyltin		46		311	36	3	396
Tributyltin				6			6
Tributyltin ion		61		328	36	3	428
PCB Aroclors							
Aroclor 1016	33	75	14	1,414	52	3	1,591
Aroclor 1221	33	75	14	1,414	52	3	1,591
Aroclor 1232	33	75	14	1,414	52	3	1,591
Aroclor 1242	33	75	14	1,414	52	3	1,591
Aroclor 1248	33	75	14	1,414	52	3	1,591
Aroclor 1254	33	75	14	1,414	52	3	1,591
Aroclor 1260	33	75	14	1,414	52	3	1,591
Aroclor 1262	17	71	14	1,196		3	1,301
Aroclor 1268	17	71	14	1,196		3	1,301
Total PCB Aroclors	33	75	14	1,414	52	3	1,591
PCB Congeners							
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)				151			151
PCB001				151			151
PCB002				151			151
PCB003				151			151
PCB004 & 010				151			151
PCB005 & 008				151			151
PCB006				151			151
PCB007 & 009				151			151
PCB011				151			151
PCB012 & 013				151			151
PCB014				151			151
PCB015				151			151
PCB016 & 032				151			151
PCB017				151			151
PCB018				151			151
PCB019				151			151
PCB020 & 021 & 033				151			151
PCB022				151			151
PCB023				151			151
PCB024 & 027				151			151
PCB025				151			151
PCB026				151			151
PCB028				151			151
PCB029				151			151
PCB030				151			151
PCB031				151			151
PCB034				151			151
PCB035				151			151
PCB036				151			151
PCB037				151			151
PCB038				151			151
PCB039				151			151
PCB040				151			151
PCB041 & 064 & 071 & 072				151			151
PCB042 & 059				151			151
PCB043 & 049				151			151
PCB044				151			151
PCB045				151			151
PCB046				151			151
PCB047				151			151

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB048 & 075				151			151
PCB050				151			151
PCB051				151			151
PCB052 & 069				151			151
PCB053				151			151
PCB054				151			151
PCB055				151			151
PCB056 & 060				151			151
PCB057				151			151
PCB058				151			151
PCB061 & 070				151			151
PCB062				151			151
PCB063				151			151
PCB065				151			151
PCB066 & 076				151			151
PCB067				151			151
PCB068				151			151
PCB073				151			151
PCB074				151			151
PCB077				151			151
PCB078				151			151
PCB079				151			151
PCB080				151			151
PCB081				151			151
PCB082				151			151
PCB083				151			151
PCB084 & 092				151			151
PCB085 & 116				151			151
PCB086				151			151
PCB087 & 117 & 125				151			151
PCB088 & 091				151			151
PCB089				151			151
PCB090 & 101				151			151
PCB093				151			151
PCB094				151			151
PCB095 & 098 & 102				151			151
PCB096				151			151
PCB097				151			151
PCB099				151			151
PCB100				151			151
PCB103				151			151
PCB104				151			151
PCB105				151			151
PCB106 & 118				151			151
PCB107 & 109				151			151
PCB108 & 112				151			151
PCB110				151			151
PCB111 & 115				151			151
PCB113				151			151
PCB114				151			151
PCB119				151			151
PCB120				151			151
PCB121				151			151
PCB122				151			151
PCB123				151			151
PCB124				151			151
PCB126				151			151
PCB127				151			151
PCB128 & 162				151			151
PCB129				151			151
PCB130				151			151
PCB131				151			151
PCB132 & 161				151			151
PCB133 & 142				151			151
PCB134 & 143				151			151
PCB135				151			151
PCB136				151			151
PCB137				151			151
PCB138 & 163 & 164				151			151
PCB139 & 149				151			151
PCB140				151			151
PCB141				151			151
PCB144				151			151

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB145				151			151
PCB146 & 165				151			151
PCB147				151			151
PCB148				151			151
PCB150				151			151
PCB151				151			151
PCB152				151			151
PCB153				151			151
PCB154				151			151
PCB155				151			151
PCB156				151			151
PCB157				151			151
PCB158 & 160				151			151
PCB159				151			151
PCB166				151			151
PCB167				151			151
PCB168				151			151
PCB169				151			151
PCB170				151			151
PCB171				151			151
PCB172				151			151
PCB173				151			151
PCB174				151			151
PCB175				151			151
PCB176				151			151
PCB177				151			151
PCB178				151			151
PCB179				151			151
PCB180				151			151
PCB181				151			151
PCB182 & 187				151			151
PCB183				151			151
PCB184				151			151
PCB185				151			151
PCB186				151			151
PCB188				151			151
PCB189				151			151
PCB190				151			151
PCB191				151			151
PCB192				151			151
PCB193				151			151
PCB194				151			151
PCB195				151			151
PCB196 & 203				151			151
PCB197				151			151
PCB198				151			151
PCB199				151			151
PCB200				151			151
PCB201				151			151
PCB202				151			151
PCB204				151			151
PCB205				151			151
PCB206				151			151
PCB207				151			151
PCB208				151			151
PCB209				151			151
Total PCB Congeners				151			151
PCB Homologs							
Dichlorobiphenyl homologs				151			151
Heptachlorobiphenyl homologs				151			151
Hexachlorobiphenyl homologs				151			151
Monochlorobiphenyl homologs				151			151
Nonachlorobiphenyl homologs				151			151
Octachlorobiphenyl homologs				151			151
Pentachlorobiphenyl homologs				151			151
Tetrachlorobiphenyl homologs				151			151
Trichlorobiphenyl homologs				151			151
PCDD/F Homologs							
Heptachlorodibenzofuran homologs	17	26		244		3	290
Heptachlorodibenzo-p-dioxin homologs	17	26		244		3	290
Hexachlorodibenzofuran homologs	17	26		245		3	291
Hexachlorodibenzo-p-dioxin homologs	17	26		244		3	290

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Octachlorodibenzofuran	17	26		249		3	295
Octachlorodibenzo-p-dioxin	17	26		249		3	295
Pentachlorodibenzofuran homologs	17	26		245		3	291
Pentachlorodibenzo-p-dioxin homologs	17	26		245		3	291
Tetrachlorodibenzofuran homologs	17	26		244		3	290
Tetrachlorodibenzo-p-dioxin homologs	17	26		244		3	290
Total PCDD/F	17	26		245		3	291
PCDD/Fs							
1,2,3,4,6,7,8-Heptachlorodibenzofuran	17	26		249		3	295
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	17	26		249		3	295
1,2,3,4,7,8,9-Heptachlorodibenzofuran	17	26		249		3	295
1,2,3,4,7,8-Hexachlorodibenzofuran	17	26		248		3	294
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	17	26		249		3	295
1,2,3,6,7,8-Hexachlorodibenzofuran	17	26		249		3	295
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	17	26		248		3	294
1,2,3,7,8,9-Hexachlorodibenzofuran	17	26		249		3	295
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	17	26		249		3	295
1,2,3,7,8-Pentachlorodibenzofuran	17	26		249		3	295
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	17	26		249		3	295
2,3,4,6,7,8-Hexachlorodibenzofuran	17	26		249		3	295
2,3,4,7,8-Pentachlorodibenzofuran	17	26		249		3	295
2,3,7,8-Tetrachlorodibenzofuran	17	26		248		3	294
2,3,7,8-Tetrachlorodibenzo-p-dioxin	17	26		249		3	295
Dioxin/furan TCDD toxicity equivalent (ND = 0)	17	26		249		3	295
Total TCDD toxicity equivalent (ND = 0)	17	26		344		3	390
Pesticides							
2,4'-DDD	17	63	14	1,187		3	1,284
2,4'-DDE	17	63	14	1,187		3	1,284
2,4'-DDT	17	63	14	1,187		3	1,284
4,4'-DDD	33	63	14	1,384	52	3	1,549
4,4'-DDE	33	63	14	1,384	52	3	1,549
4,4'-DDT	33	63	14	1,383	52	3	1,548
Aldrin	33	63	14	1,154	33	3	1,300
alpha-Endosulfan	28	63	14	1,108	33	3	1,249
alpha-Hexachlorocyclohexane	28	63	14	1,099	33	3	1,240
Azinphosmethyl				2			2
beta-Endosulfan	28	63	14	1,108	33	3	1,249
beta-Hexachlorocyclohexane	28	63	14	1,108	33	3	1,249
Chlordane (cis & trans)				72			72
Chlordane (technical)				14			14
Chlorpyrifos				2			2
cis-Chlordane	24	63	14	1,110	33	3	1,247
cis-Nonachlor	17	63	14	957		3	1,054
Coumaphos				2			2
delta-Hexachlorocyclohexane	28	63	14	1,105	33	3	1,246
Demeton				2			2
Diazinon				2			2
Dichlorvos				2			2
Dieldrin	33	63	14	1,154	33	3	1,300
Dimethoate				2			2
Disulfoton				2			2
Endosulfan sulfate	28	63	14	1,108	33	3	1,249
Endrin	28	63	14	1,114	33	3	1,255
Endrin aldehyde	28	63	14	1,108	33	3	1,249
Endrin ketone	19	63	14	1,083	33	3	1,215
EPN				2			2
Ethoprop				2			2
Fensulfothion				2			2
Fenthion				2			2
gamma-Hexachlorocyclohexane	33	63	14	1,154	33	3	1,300
Heptachlor	33	63	14	1,154	33	3	1,300
Heptachlor epoxide	28	63	14	1,114	33	3	1,255
Hexachlorocyclohexanes				9			9
Malathion				2			2
Methoxychlor	28	63	14	1,114	33	3	1,255
Methyl parathion				2			2
Mevinphos				2			2
Mirex	17	63	14	949		3	1,046
Oxychlordane	17	63	14	957		3	1,054
Parathion				2			2
Phorate				2			2
Prothiophos				2			2

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Ronnel				2			2
Sulprofos				2			2
Tetrachlorvinphos				2			2
Total Chlordanes	33	63	14	1,134	33	3	1,280
Total Endosulfan	28	63	14	1,114	33	3	1,255
Total of 2,4' and 4,4'-DDD	33	63	14	1,384	52	3	1,549
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	33	63	14	1,383	52	3	1,548
Total of 2,4' and 4,4'-DDE	33	63	14	1,384	52	3	1,549
Total of 2,4' and 4,4'-DDT	33	63	14	1,383	52	3	1,548
Total of 4,4'-DDD, -DDE, -DDT	33	19		1,125	52		1,229
Toxaphene	28	63	14	1,114	33	3	1,255
trans-Chlordane	24	63	14	1,090	33	3	1,227
trans-Nonachlor	17	63	14	957		3	1,054
Trichloronate				2			2
Herbicides							
2,4,5-T				186			186
2,4-D				186			186
2,4-DB				186			186
Dalapon				186			186
Dicamba				186			186
Dichloroprop				186			186
Dinoseb				186			186
MCPA				186			186
MCPP				186			186
Silvex				186			186
PAHs							
1,6,7-Trimethylnaphthalene				242			242
1-Methylnaphthalene		32	14	508		3	557
1-Methylphenanthrene				242			242
2,6-Dimethylnaphthalene				242			242
2-Methylnaphthalene	31	75	14	1,622	56	3	1,801
Acenaphthene	33	75	14	1,693	56	3	1,874
Acenaphthylene	33	75	14	1,690	56	3	1,871
Anthracene	33	75	14	1,690	56	3	1,871
Benzo(a)anthracene	33	75	14	1,693	56	3	1,874
Benzo(a)pyrene	33	75	14	1,693	56	3	1,874
Benzo(b)fluoranthene	33	75	14	1,693	56	3	1,874
Benzo(b+k)fluoranthene	16			510	56		582
Benzo(e)pyrene		32		359		3	394
Benzo(g,h,i)perylene	33	75	14	1,693	56	3	1,874
Benzo(k)fluoranthene	33	75	14	1,693	56	3	1,874
C1-Chrysene		32		139		3	174
C1-Dibenzothiophene		32		139		3	174
C1-Fluoranthene/pyrene		32		139		3	174
C1-Fluorene		32		139		3	174
C1-Naphthalene				22			22
C1-Phenanthrene/anthracene		32		139		3	174
C2-Chrysene		32		139		3	174
C2-Dibenzothiophene		32		139		3	174
C2-Fluoranthene/pyrene		32		117		3	152
C2-Fluorene		32		139		3	174
C2-Naphthalene		32		139		3	174
C2-Phenanthrene/anthracene		32		139		3	174
C3-Chrysene		32		139		3	174
C3-Dibenzothiophene		32		139		3	174
C3-Fluoranthene/pyrene		32		117		3	152
C3-Fluorene		32		139		3	174
C3-Naphthalene		32		139		3	174
C3-Phenanthrene/anthracene		32		139		3	174
C4-Chrysene		32		139		3	174
C4-Naphthalene		32		139		3	174
C4-Phenanthrene/anthracene		32		139		3	174
Chrysene	33	75	14	1,693	56	3	1,874
Dibenzo(a,h)anthracene	33	75	14	1,692	56	3	1,873
Dibenzothiophene		32	14	218		3	267
Fluoranthene	33	75	14	1,693	56	3	1,874
Fluorene	33	75	14	1,690	56	3	1,871
High Molecular Weight PAH	33	75	14	1,693	56	3	1,874
Indeno(1,2,3-cd)pyrene	33	75	14	1,693	56	3	1,874
Low Molecular Weight PAH	33	75	14	1,693	56	3	1,874
Naphthalene	34	76	14	1,730	56	3	1,913
Perylene		32		359		3	394

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Phenanthrene	33	75	14	1,693	56	3	1,874
Pyrene	33	75	14	1,693	56	3	1,874
Total cPAHs	33	75	14	1,693	56	3	1,874
Total PAHs	33	75	14	1,693	56	3	1,874
Phthalates							
Bis(2-ethylhexyl) phthalate	24	63	14	1,525	56	3	1,685
Butylbenzyl phthalate	24	63	14	1,525	56	3	1,685
Dibutyl phthalate	24	63	14	1,525	56	3	1,685
Diethyl phthalate	24	63	14	1,519	56	3	1,679
Dimethyl phthalate	24	63	14	1,525	56	3	1,685
Di-n-octyl phthalate	24	63	14	1,519	56	3	1,679
SVOCs							
1,2,4-Trichlorobenzene	22	63	14	1,234	56	3	1,392
1,2-Dichlorobenzene	24	63	14	1,263	52	3	1,419
1,3-Dichlorobenzene	24	63	14	1,263	52	3	1,419
1,4-Dichlorobenzene	25	64	14	1,308	52	3	1,466
2,4-Dinitrotoluene	19	63	14	1,090	37	3	1,226
2,6-Dinitrotoluene	19	63	14	1,090	37	3	1,226
2-Chloronaphthalene	19	63	14	1,101	37	3	1,237
2-Nitroaniline	19	63	14	1,090	37	3	1,226
3,3'-Dichlorobenzidine	19	63	14	1,090	37	3	1,226
3-Nitroaniline	19	63	14	1,090	37	3	1,226
4-Bromophenyl phenyl ether	19	63	14	1,090	37	3	1,226
4-Chloroaniline	19	63	14	1,090	37	3	1,226
4-Chlorophenyl phenyl ether	19	63	14	1,090	37	3	1,226
4-Nitroaniline	19	63	14	1,090	37	3	1,226
Aniline	17	55	14	1,007	37	3	1,133
Azobenzene	17	63	14	1,004		3	1,101
Benzoic acid	24	54	14	1,194	56	3	1,345
Benzyl alcohol	24	63	14	1,198	56	3	1,358
Bis(2-chloro-1-methylethyl) ether				57			57
Bis(2-chloroethoxy) methane	19	63	14	1,090	37	3	1,226
Bis(2-chloroethyl) ether	19	63	14	1,090	37	3	1,226
Bis(2-chloroisopropyl) ether	19	63	14	1,033	37	3	1,169
Carbazole	17	63	14	1,059		3	1,156
Dibenzofuran	33	63	14	1,366	56	3	1,535
Diphenyl				242			242
Hexachlorobenzene	24	63	14	1,226	56	3	1,386
Hexachlorobutadiene	24	63	14	1,298	56	3	1,458
Hexachlorocyclopentadiene	19	63	14	1,085	37	3	1,221
Hexachloroethane	22	63	14	1,186	56	3	1,344
Isophorone	19	63	14	1,090	37	3	1,226
Nitrobenzene	19	63	14	1,090	37	3	1,226
N-Nitrosodimethylamine	17	63	14	1,007	37	3	1,141
N-Nitrosodiphenylamine	24	63	14	1,201	56	3	1,361
N-Nitrosodipropylamine	19	63	14	1,090	37	3	1,226
Retene				11			11
Phenols							
2,3,4,5-Tetrachlorophenol	17	51	14	1,003		3	1,088
2,3,4,6;2,3,5,6-Tetrachlorophenol coelution				520			520
2,3,5,6-Tetrachlorophenol	17	51	14	483		3	568
2,4,5-Trichlorophenol	19	51	14	1,131	37	3	1,255
2,4,6-Trichlorophenol	19	51	14	1,131	37	3	1,255
2,4-Dichlorophenol	19	63	14	1,132	37	3	1,268
2,4-Dimethylphenol	24	61	14	1,243	56	3	1,401
2,4-Dinitrophenol	19	63	14	1,127	37	3	1,263
2-Chlorophenol	19	63	14	1,132	37	3	1,268
2-Methylphenol	24	63	14	1,243	56	3	1,403
2-Nitrophenol	19	63	14	1,123	37	3	1,259
3- and 4-Methylphenol Coelution	2			52	56		110
4,6-Dinitro-2-methylphenol	19	63	14	1,132	37	3	1,268
4-Chloro-3-methylphenol	19	63	14	1,132	37	3	1,268
4-Methylphenol	22	63	14	1,188		3	1,290
4-Nitrophenol	19	63	14	1,130	37	3	1,266
Pentachlorophenol	24	51	14	1,247	55	3	1,394
Phenol	24	63	14	1,243	56	3	1,403
VOCs							
1,1,1,2-Tetrachloroethane	18	20		522	26		586
1,1,1-Trichloroethane	18	20		531	26		595
1,1,2,2-Tetrachloroethane	18	20		531	26		595
1,1,2-Trichloro-1,2,2-trifluoroethane				9			9

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
1,1,2-Trichloroethane	18	20		531	26		595
1,1-Dichloroethane	18	20		531	26		595
1,1-Dichloroethene	18	20		531	26		595
1,1-Dichloropropene				17	26		43
1,2,3-Trichlorobenzene				19	26		45
1,2,3-Trichloropropane	18	20		522	26		586
1,2,4-Trimethylbenzene				17	26		43
1,2-Dibromo-3-chloropropane				26	26		52
1,2-Dichloroethane	18	20		531	26		595
1,2-Dichloropropane	18	20		531	26		595
1,3,5-Trimethylbenzene				17	26		43
1,3-Dichloropropane				17	26		43
1,4-Dichloro-trans-2-butene	18	20		505			543
1-Methyl-4-isopropylbenzene				8	26		34
2,2-Dichloropropane				17	26		43
2-Chloroethyl vinyl ether	18	20		505			543
2-Chlorotoluene				17	26		43
4-Chlorotoluene				17	26		43
Acetone	18	20		522	26		586
Acrolein	18	20		505			543
Acrylonitrile	18	20		505			543
Benzene	18	22		574	41		655
Bromobenzene				17	26		43
Bromochloromethane	18	20		524	26		588
Bromodichloromethane	18	20		531	26		595
Bromoform	18	20		531	26		595
Bromomethane	18	20		531	26		595
BTEX	18	22		587	41		668
Carbon disulfide	18	20		531	26		595
Carbon tetrachloride	18	20		531	26		595
Chlorobenzene	18	20		531	26		595
Chlorodibromomethane	18	20		531	26		595
Chloroethane	18	20		531	26		595
Chloroform	18	20		531	26		595
Chloromethane	18	20		531	26		595
cis-1,2-Dichloroethene	18	20		128	26		192
cis-1,3-Dichloropropene	18	20		531	26		595
Dichlorodifluoromethane	18	20		531	26		595
Ethylbenzene	18	22		587	41		668
Ethylene dibromide	18	20		522	26		586
Hexahydrobenzene				9			9
Isopropylbenzene	18	20		531	26		595
m,p-Xylene	18	22		574	41		655
Methyl acetate				9			9
Methyl iodide	18	20		505			543
Methyl isobutyl ketone	18	20		522	26		586
Methyl n-butyl ketone	18	20		531	26		595
Methyl tert-butyl ether	18	22		522			562
Methylcyclohexane				9			9
Methylene bromide	18	20		522	26		586
Methylene chloride	18	20		531	26		595
Methylethyl ketone	18	20		522	26		586
Methylisopropylbenzene				9			9
n-Butylbenzene				17	26		43
n-Propylbenzene				17	26		43
o-Xylene	18	22		574	41		655
Sec-butylbenzene				17	26		43
Styrene	18	20		531	26		595
tert-Butylbenzene				17	26		43
Tetrachloroethene	18	20		562	26		626
Toluene	18	22		574	41		655
trans-1,2-Dichloroethene	18	20		531	26		595
trans-1,3-Dichloropropene	18	20		531	26		595
Trichloroethene	18	20		562	41		641
Trichlorofluoromethane	18	20		531	26		595
Vinyl acetate	18	20		512			550
Vinyl chloride	18	20		531	26		595
Xylene	18	22		587	41		668
Petroleum							
C10-C12 Aliphatics		12		16			28
C10-C12 Aromatics		12		16			28
C12-C13 Aromatics		2					

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
C12-C16 Aliphatics		12		16			28
C12-C16 Aromatics		12		16			28
C16-C21 Aliphatics		12		16			28
C16-C21 Aromatics		12		16			28
C21-C34 Aliphatics		12		16			28
C21-C34 Aromatics		12		16			28
C5-C6 Aliphatics		2					
C6-C8 Aliphatics		2					
C8-C10 Aliphatics		12		16			28
C8-C10 Aromatics		12		16			28
Decane		2					
Diesel-Range Hydrocarbons	17	49	14	1,142	52		1,274
Diesel-Range Hydrocarbons (silica gel treated)		32	14	256		3	305
Dodecane		2					
Gasoline-Range Hydrocarbons	18	35		855	19		927
Heavy-Oil-Range Hydrocarbons				12	52		64
Jet fuel A		15		1	52		68
JP-4 jet fuel				1	19		20
Kerosene		15		1	52		68
Lube oil				17	52		69
Mineral spirits		15		1	52		68
Motor oil		9		105			114
Naphtha distillate				1	19		20
Non-petroleum hydrocarbons				1	52		53
n-Hexane		2					
Octane		2					
Pencil pitch				16			16
Pentane		2					
Phytane				3			3
Pristane				3			3
Residual-Range Hydrocarbons	17	25	14	1,009			1,065
Residual-Range Hydrocarbons (silica gel treated)		32	14	256		3	305
Total Petroleum Hydrocarbons	17	49	14	1,142	52		1,274
Total Petroleum Hydrocarbons (silica gel treated)		32	14	256		3	305
Radioisotopes							
Beryllium-7				108			108
Cesium-137				108			108
Lead-210				108			108
Radium-226				108			108
Surface Sediment							
Grain Size							
< 0.075 mm				55		2	57
> 0.075 mm				10		2	12
>10 Phi clay				114		3	117
>9 Phi clay	21	90	17	890		50	1,068
8-9 Phi clay	21	90	17	1,005		53	1,186
9-10 Phi clay				114		3	117
Clay		17		382	38	7	444
Coarse sand	21	92	17	1,123	14	71	1,338
Coarse silt	21	90	17	1,005		53	1,186
Fine gravel	21	90	17	973		53	1,154
Fine sand	21	92	17	1,123	14	71	1,338
Fine silt	21	90	17	1,005		53	1,186
Fines	21	116	17	1,460	38	80	1,732
Gravel		24		414	14	20	472
Mean grain size				1			1
Median grain size				1			1
Medium gravel	21	90	17	973		53	1,154
Medium sand	21	92	17	1,123	14	71	1,338
Medium silt	21	90	17	1,005		53	1,186
Sand		24		336	24	9	393
Sieve 10				49			49
Sieve 100				2			2
Sieve 140				47			47
Sieve 20				49			49
Sieve 200				49			49
Sieve 230				4			4
Sieve 4				49			49
Sieve 40				49			49
Sieve 60				49			49
Silt		17		387	38	7	449
Very coarse sand	21	92	17	1,121	14	71	1,336

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Very fine sand	21	92	17	1,121	14	71	1,336
Very fine silt	21	90	17	1,005		53	1,186
Atterberg Limits							
Liquid Limit				26			26
Plastic Limit				55			55
Plasticity Index				26			26
Conventionals							
Acid Volatile Sulfides	4			76			80
Ammonia		2	1	525		40	568
Cyanide				21			21
Moisture				2		2	4
Oxidation-Reduction Potential				2			2
Perchlorate				13			13
pH				2			2
Phosphorus		4					4
Specific Gravity	17	10	15	807		27	876
Sulfide		2	1	528		40	571
Total organic carbon	25	96	17	1,649	40	77	1,904
Total solids	25	95	17	1,433	40	74	1,684
Total volatile solids				191		22	213
Metals							
Aluminum	21	89	17	1,253		63	1,443
Antimony	21	161	17	1,425	40	72	1,736
Arsenic	25	169	17	1,601	40	77	1,929
Arsenic pentavalent				11			11
Arsenic trivalent				11			11
Barium		36		256		10	302
Beryllium		44		260		10	314
Cadmium	25	169	17	1,565	40	72	1,888
Calcium				155		1	156
Chromium	25	165	17	1,552	14	66	1,839
Chromium hexavalent			1	67			68
Cobalt				155		10	165
Copper	25	169	17	1,573	40	72	1,896
Iron				174			174
Lead	25	169	17	1,596	40	72	1,919
Magnesium				155			155
Manganese	4	5		285		10	304
Mercury	25	163	17	1,529	40	72	1,846
Methylmercury				5			5
Nickel	25	169	17	1,531	40	72	1,854
Potassium				155			155
Selenium	21	97	7	1,208		36	1,369
Silver	25	139	17	1,527	40	72	1,820
Sodium				155			155
Thallium	4	17		278		10	309
Tin				16			16
Titanium				75			75
Vanadium				155		10	165
Zinc	25	169	17	1,588	40	72	1,911
Butyltins							
Butyltin ion	4	113	1	288	14	8	428
Dibutyltin dichloride				5			5
Dibutyltin ion	4	113	1	288	14	8	428
Monobutyltin trichloride				5			5
Tetrabutyltin	4	138	1	293	14	8	458
Tributyltin		17		8			25
Tributyltin chloride				5			5
Tributyltin ion	4	125	1	329	14	8	481
PCB Aroclors							
Aroclor 1016	25	170	17	1,220	40	81	1,553
Aroclor 1221	25	170	17	1,219	40	81	1,552
Aroclor 1232	25	170	17	1,219	40	81	1,552
Aroclor 1242	25	170	17	1,220	40	81	1,553
Aroclor 1248	25	170	17	1,220	40	81	1,553
Aroclor 1254	25	170	17	1,220	40	81	1,553
Aroclor 1260	25	170	17	1,220	40	81	1,553
Aroclor 1262	21	100	17	945		63	1,146
Aroclor 1268	21	100	17	945		63	1,146
Aroclors	25	170	17	1,221	40	81	1,554

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB Congeners							
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)	4	5	2	269		26	306
PCB001	4	5	1	257		26	293
PCB002	4	5	1	257		26	293
PCB003	4	5	1	257		26	293
PCB004				11		10	21
PCB004 & 010	4	5	1	246		16	272
PCB005				11		10	21
PCB005 & 008	4	5	1	246		16	272
PCB006	4	5	1	257		26	293
PCB007				11		10	21
PCB007 & 009	4	5	1	246		16	272
PCB008				90		10	100
PCB009				11		10	21
PCB010				11		10	21
PCB011	4	5	1	257		26	293
PCB012						10	10
PCB012 & 013	4	5	1	257		16	283
PCB013						10	10
PCB014	4	5	1	257		26	293
PCB015	4	5	1	257		26	293
PCB016				11		10	21
PCB016 & 032	4	5	1	246		16	272
PCB017	4	5	1	257		26	293
PCB018	4	5	1	325		26	361
PCB018 & 030				11			11
PCB019	4	5	1	257		26	293
PCB020						10	10
PCB020 & 021 & 033	4	5	1	246		16	272
PCB020 & 028				11			11
PCB021						10	10
PCB021 & 033				11			11
PCB022	4	5	1	257		26	293
PCB023	4	5	1	257		26	293
PCB024				11		10	21
PCB024 & 027	4	5	1	246		16	272
PCB025	4	5	1	257		26	293
PCB026	4	5	1	246		26	282
PCB026 & 029				11			11
PCB027				11		10	21
PCB028	4	5	1	325		26	361
PCB029	4	5	1	246		26	282
PCB030	4	5	1	246		26	282
PCB031	4	5	1	257		26	293
PCB032				11		10	21
PCB033						10	10
PCB034	4	5	1	257		26	293
PCB035	4	5	1	257		26	293
PCB036	4	5	1	257		26	293
PCB037	4	5	1	257		26	293
PCB038	4	5	1	257		26	293
PCB039	4	5	1	257		26	293
PCB040	4	5	1	246		26	282
PCB040 & 041 & 071				11			11
PCB041						10	10
PCB041 & 064 & 071 & 072	4	5	1	246		16	272
PCB042				11		10	21
PCB042 & 059	4	5	1	246		16	272
PCB043				11		10	21
PCB043 & 049	4	5	1	246		16	272
PCB044	4	5	1	325		26	361
PCB044 & 047 & 065				11			11
PCB045	4	5	1	246		26	282
PCB045 & 051				11			11
PCB046	4	5	1	257		26	293
PCB047	4	5	1	246		26	282
PCB048				11		10	21
PCB048 & 075	4	5	1	246		16	272
PCB049						10	10
PCB049 & 069				11			11
PCB050	4	5	1	246		26	282
PCB050 & 053				11			11
PCB051	4	5	1	246		26	282

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB052				90		10	100
PCB052 & 069	4	5	1	246		16	272
PCB053	4	5	1	246		26	282
PCB054	4	5	1	257		26	293
PCB055	4	5	1	257		26	293
PCB056				11		10	21
PCB056 & 060	4	5	1	246		16	272
PCB057	4	5	1	257		26	293
PCB058	4	5	1	257		26	293
PCB059						10	10
PCB059 & 062 & 075				11			11
PCB060				11		10	21
PCB061						10	10
PCB061 & 070	4	5	1	246		16	272
PCB061 & 070 & 074 & 076				11			11
PCB062	4	5	1	246		26	282
PCB063	4	5	1	257		26	293
PCB064				11		10	21
PCB065	4	5	1	246		26	282
PCB066				90		10	100
PCB066 & 076	4	5	1	246		16	272
PCB067	4	5	1	257		26	293
PCB068	4	5	1	257		26	293
PCB069						10	10
PCB070						10	10
PCB071						10	10
PCB072				11		10	21
PCB073	4	5	1	257		26	293
PCB074	4	5	1	246		26	282
PCB075						10	10
PCB076						10	10
PCB077	4	5	2	269		26	306
PCB078	4	5	1	257		26	293
PCB079	4	5	1	257		26	293
PCB080	4	5	1	257		26	293
PCB081	4	5	2	269		26	306
PCB082	4	5	1	257		26	293
PCB083	4	5	1	246		26	282
PCB083 & 099				11			11
PCB084				11		10	21
PCB084 & 092	4	5	1	246		16	272
PCB085						10	10
PCB085 & 116	4	5	1	246		16	272
PCB085 & 116 & 117				11			11
PCB086	4	5	1	246		26	282
PCB086 & 087 & 097 & 108 & 119 & 125				11			11
PCB087						10	10
PCB087 & 117 & 125	4	5	1	246		16	272
PCB088						10	10
PCB088 & 091	4	5	1	257		16	283
PCB089	4	5	1	257		26	293
PCB090						10	10
PCB090 & 101	4	5	1	246		16	272
PCB090 & 101 & 113				11			11
PCB091						10	10
PCB092				11		10	21
PCB093	4	5	1	246		26	282
PCB093 & 095 & 098 & 100 & 102				11			11
PCB094	4	5	1	257		26	293
PCB095						10	10
PCB095 & 098 & 102	4	5	1	246		16	272
PCB096	4	5	1	257		26	293
PCB097	4	5	1	246		26	282
PCB098						10	10
PCB099	4	5	1	246		26	282
PCB100	4	5	1	246		26	282
PCB101				79		10	89
PCB102						10	10
PCB103	4	5	1	257		26	293
PCB104	4	5	1	257		26	293
PCB105	4	5	2	348		26	385
PCB106				11		10	21
PCB106 & 118	4	5	2	258		16	285

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB107						10	10
PCB107 & 109	4	5	1	246		16	272
PCB107 & 124				11			11
PCB108						10	10
PCB108 & 112	4	5	1	246		16	272
PCB109				11		10	21
PCB110	4	5	1	246		26	282
PCB110 & 115				11			11
PCB111				11		10	21
PCB111 & 115	4	5	1	246		16	272
PCB112				11		10	21
PCB113	4	5	1	246		26	282
PCB114	4	5	2	269		26	306
PCB115						10	10
PCB116						10	10
PCB117						10	10
PCB118				90		10	100
PCB119	4	5	1	246		26	282
PCB120	4	5	1	257		26	293
PCB121	4	5	1	257		26	293
PCB122	4	5	1	257		26	293
PCB123	4	5	2	269		26	306
PCB124	4	5	1	246		26	282
PCB125						10	10
PCB126	4	5	2	269		26	306
PCB127	4	5	1	257		26	293
PCB128				79			79
PCB128 & 162	4	5	1	246		16	272
PCB128 & 166				11			11
PCB129	4	5	1	246		26	282
PCB129 & 138 & 160 & 163				11			11
PCB130	4	5	1	257		26	293
PCB131	4	5	1	257		26	293
PCB132				11		10	21
PCB132 & 161	4	5	1	246		16	272
PCB133				11		10	21
PCB133 & 142	4	5	1	246		16	272
PCB134						10	10
PCB134 & 143	4	5	1	257		16	283
PCB135	4	5	1	246		26	282
PCB135 & 151 & 154				11			11
PCB136	4	5	1	257		26	293
PCB137	4	5	1	257		26	293
PCB138				79		10	89
PCB138 & 163 & 164	4	5	1	246		16	272
PCB139						10	10
PCB139 & 140				11			11
PCB139 & 149	4	5	1	246		16	272
PCB140	4	5	1	246		26	282
PCB141	4	5	1	257		26	293
PCB142				11		10	21
PCB143						10	10
PCB144	4	5	1	257		26	293
PCB145	4	5	1	257		26	293
PCB146				11		10	21
PCB146 & 165	4	5	1	246		16	272
PCB147	4	5	1	246		26	282
PCB147 & 149				11			11
PCB148	4	5	1	257		26	293
PCB149						10	10
PCB150	4	5	1	257		26	293
PCB151	4	5	1	246		26	282
PCB152	4	5	1	257		26	293
PCB153	4	5	1	325		26	361
PCB153 & 168				11			11
PCB154	4	5	1	246		26	282
PCB155	4	5	1	256		26	292
PCB156	4	5	2	269		26	306
PCB157	4	5	2	269		26	306
PCB158				11		10	21
PCB158 & 160	4	5	1	246		16	272
PCB159	4	5	1	257		26	293
PCB160						10	10

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
PCB161				11		10	21
PCB162				11		10	21
PCB163						10	10
PCB164				11		10	21
PCB165				11		10	21
PCB166	4	5	1	246		26	282
PCB167	4	5	2	269		26	306
PCB168	4	5	1	246		26	282
PCB169	4	5	2	269		26	306
PCB170	4	5	1	336		26	372
PCB171	4	5	1	246		26	282
PCB171 & 173				11			11
PCB172	4	5	1	257		26	293
PCB173	4	5	1	246		26	282
PCB174	4	5	1	257		26	293
PCB175	4	5	1	257		26	293
PCB176	4	5	1	257		26	293
PCB177	4	5	1	257		26	293
PCB178	4	5	1	257		26	293
PCB179	4	5	1	257		26	293
PCB180	4	5	1	325		26	361
PCB180 & 193				11			11
PCB181	4	5	1	257		26	293
PCB182				11		10	21
PCB182 & 187	4	5	1	246		16	272
PCB183	4	5	1	246		26	282
PCB183 & 185				11			11
PCB184	4	5	1	257		26	293
PCB185	4	5	1	246		26	282
PCB186	4	5	1	257		26	293
PCB187				90		10	100
PCB188	4	5	1	257		26	293
PCB189	4	5	2	269		26	306
PCB190	4	5	1	257		26	293
PCB191	4	5	1	257		26	293
PCB192	4	5	1	257		26	293
PCB193	4	5	1	246		26	282
PCB194	4	5	1	257		26	293
PCB195	4	5	1	257		26	293
PCB196				11		10	21
PCB196 & 203	4	5	1	246		16	272
PCB197	4	5	1	246		26	282
PCB197 & 200				11			11
PCB198	4	5	1	246		26	282
PCB198 & 199				11			11
PCB199	4	5	1	246		26	282
PCB200	4	5	1	246		26	282
PCB201	4	5	1	257		26	293
PCB202	4	5	1	257		26	293
PCB203				11		10	21
PCB204	4	5	1	257		26	293
PCB205	4	5	1	257		26	293
PCB206	4	5	1	257		26	293
PCB207	4	5	1	257		26	293
PCB208	4	5	1	257		26	293
PCB209	4	5	1	257		26	293
Total PCB Congeners	4	5	1	257		26	293
PCB Homologs							
Dichlorobiphenyl homologs	4	5	1	257		26	293
Heptachlorobiphenyl homologs	4	5	1	257		26	293
Hexachlorobiphenyl homologs	4	5	1	257		26	293
Monochlorobiphenyl homologs	4	5	1	257		26	293
Nonachlorobiphenyl homologs	4	5	1	257		26	293
Octachlorobiphenyl homologs	4	5	1	257		26	293
Pentachlorobiphenyl homologs	4	5	1	257		26	293
Tetrachlorobiphenyl homologs	4	5	1	257		26	293
Trichlorobiphenyl homologs	4	5	1	257		26	293
PCDD/F Homologs							
Heptachlorodibenzofuran homologs	21	44	2	229		39	335
Heptachlorodibenzo-p-dioxin homologs	21	44	2	229		39	335
Hexachlorodibenzofuran homologs	21	44	2	229		39	335
Hexachlorodibenzo-p-dioxin homologs	21	44	2	229		39	335

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Octachlorodibenzofuran	21	44	2	232		48	347
Octachlorodibenzo-p-dioxin	21	44	2	232		49	348
Pentachlorodibenzofuran homologs	21	44	2	229		39	335
Pentachlorodibenzo-p-dioxin homologs	21	44	2	229		39	335
Tetrachlorodibenzofuran homologs	21	44	2	229		39	335
Tetrachlorodibenzo-p-dioxin homologs	21	44	2	228		39	334
Total PCDD/F	21	44	2	229		39	335
PCDD/Fs							
1,2,3,4,6,7,8-Heptachlorodibenzofuran	21	44	2	232		49	348
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	21	44	2	232		49	348
1,2,3,4,7,8,9-Heptachlorodibenzofuran	21	44	2	232		49	348
1,2,3,4,7,8-Hexachlorodibenzofuran	21	44	2	232		49	348
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	21	44	2	232		49	348
1,2,3,6,7,8-Hexachlorodibenzofuran	21	44	2	232		49	348
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	21	44	2	232		49	348
1,2,3,7,8,9-Hexachlorodibenzofuran	21	44	2	232		49	348
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	21	44	2	232		49	348
1,2,3,7,8-Pentachlorodibenzofuran	21	44	2	232		49	348
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	21	44	2	232		49	348
2,3,4,6,7,8-Hexachlorodibenzofuran	21	44	2	232		49	348
2,3,4,7,8-Pentachlorodibenzofuran	21	44	2	232		49	348
2,3,7,8-Tetrachlorodibenzofuran	21	44	2	232		49	348
2,3,7,8-Tetrachlorodibenzo-p-dioxin	21	44	2	232		49	348
Dioxin/furan TCDD toxicity equivalent (ND = 0)	21	44	2	232		49	348
Total TCDD toxicity equivalent (ND = 0)	21	44	2	380		54	501
Pesticides							
2,4'-DDD	21	89	17	1,094		63	1,284
2,4'-DDE	21	89	17	1,093		63	1,283
2,4'-DDT	21	89	17	1,094		63	1,284
4,4'-DDD	25	95	17	1,241	40	81	1,499
4,4'-DDE	25	95	17	1,239	40	81	1,497
4,4'-DDT	25	95	17	1,241	40	81	1,499
Aldrin	25	91	17	1,177	14	77	1,401
alpha-Endosulfan	25	91	17	1,169	14	75	1,391
alpha-Hexachlorocyclohexane	25	91	17	1,160	14	75	1,382
beta-Endosulfan	25	91	17	1,169	14	75	1,391
beta-Hexachlorocyclohexane	25	91	17	1,169	14	75	1,391
Chlordane (cis & trans)				191		3	194
Chlordane (technical)				4			4
cis-Chlordane	21	91	17	1,152	14	77	1,372
cis-Nonachlor	21	89	17	1,034		63	1,224
delta-Hexachlorocyclohexane	25	91	17	1,167	14	75	1,389
Dieldrin	25	91	17	1,177	14	77	1,401
Endosulfan sulfate	25	91	17	1,168	14	75	1,390
Endrin	25	91	17	1,169	14	75	1,391
Endrin aldehyde	25	91	17	1,169	14	75	1,391
Endrin ketone	21	91	17	1,155	14	75	1,373
gamma-Hexachlorocyclohexane	25	91	17	1,177	14	77	1,401
Heptachlor	25	91	17	1,177	14	77	1,401
Heptachlor epoxide	25	91	17	1,169	14	75	1,391
Hexachlorocyclohexanes				9			9
Methoxychlor	25	91	17	1,169	14	75	1,391
Mirex	21	89	17	940		63	1,130
Oxychlordane	21	89	17	1,035		63	1,225
Total Chlordanes	25	91	17	1,175	14	77	1,399
Total Endosulfan	25	91	17	1,168	14	75	1,390
Total of 2,4' and 4,4'-DDD	25	95	17	1,241	40	81	1,499
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	25	95	17	1,241	40	81	1,499
Total of 2,4' and 4,4'-DDE	25	95	17	1,239	40	81	1,497
Total of 2,4' and 4,4'-DDT	25	95	17	1,241	40	81	1,499
Total of 4,4'-DDD, -DDE, -DDT	21	12	7	1,026	40	39	1,145
Toxaphene	25	91	17	1,168	14	75	1,390
trans-Chlordane	21	91	17	1,154	14	77	1,374
trans-Nonachlor	21	89	17	1,034		63	1,224
Herbicides							
2,4,5-T			1	221		3	225
2,4-D			1	221		3	225
2,4-DB			1	221		3	225
Dalapon			1	221		3	225
Dicamba			1	221		3	225
Dichloroprop			1	221		3	225

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Dinoseb			1	221		3	225
MCPA			1	221		3	225
MCPP			1	221		3	225
Silvex			1	221		3	225
PAHs							
1,6,7-Trimethylnaphthalene				56			56
1-Methylnaphthalene	4	83	10	252		32	381
1-Methylphenanthrene				56			56
2,6-Dimethylnaphthalene				56			56
2-Methylnaphthalene	25	131	17	1,494	40	71	1,778
Acenaphthene	25	171	17	1,714	40	78	2,045
Acenaphthylene	25	171	17	1,714	40	77	2,044
Anthracene	25	171	17	1,714	40	78	2,045
Benzo(a)anthracene	25	171	17	1,714	40	78	2,045
Benzo(a)pyrene	25	171	17	1,714	40	78	2,045
Benzo(b)fluoranthene	25	171	17	1,618	40	78	1,949
Benzo(b+k)fluoranthene	4	6		669	40	18	737
Benzo(e)pyrene	4	83	10	272		32	401
Benzo(g,h,i)perylene	25	171	17	1,714	40	77	2,044
Benzo(j+k)fluoranthene				35			35
Benzo(k)fluoranthene	25	171	17	1,583	40	78	1,914
Benzofluoranthenes				35			35
C1-Chrysene	4	83	10	243		32	372
C1-Dibenzothiophene	4	83	10	243		32	372
C1-Fluoranthene/pyrene	4	83	10	243		32	372
C1-Fluorene	4	83	10	243		32	372
C1-Naphthalene				62			62
C1-Phenanthrene/anthracene	4	83	10	243		32	372
C2-Chrysene	4	83	10	243		32	372
C2-Dibenzothiophene	4	83	10	243		32	372
C2-Fluoranthene/pyrene	4	83	10	216		32	345
C2-Fluorene	4	83	10	243		32	372
C2-Naphthalene	4	83	10	243		32	372
C2-Phenanthrene/anthracene	4	83	10	243		32	372
C3-Chrysene	4	83	10	243		32	372
C3-Dibenzothiophene	4	83	10	243		32	372
C3-Fluoranthene/pyrene	4	83	10	216		32	345
C3-Fluorene	4	83	10	243		32	372
C3-Naphthalene	4	83	10	243		32	372
C3-Phenanthrene/anthracene	4	83	10	243		32	372
C4-Chrysene	4	83	10	243		32	372
C4-Dibenzothiophene				35			35
C4-Naphthalene	4	83	10	243		32	372
C4-Phenanthrene/anthracene	4	83	10	243		32	372
Chrysene	25	171	17	1,714	40	78	2,045
Dibenzo(a,h)anthracene	25	171	17	1,714	40	78	2,045
Dibenzothiophene	4	83	10	243		32	372
Fluoranthene	25	171	17	1,725	40	78	2,056
Fluorene	25	171	17	1,714	40	78	2,045
High Molecular Weight PAH	25	171	17	1,714	40	78	2,045
Indeno(1,2,3-cd)pyrene	25	171	17	1,714	40	78	2,045
Low Molecular Weight PAH	25	171	17	1,714	40	78	2,045
Naphthalene	25	171	17	1,719	40	78	2,050
Perylene	4	83	10	272		32	401
Phenanthrene	25	171	17	1,714	40	77	2,044
Pyrene	25	171	17	1,714	40	78	2,045
Total cPAHs	25	171	17	1,714	40	78	2,045
Total PAHs	25	171	17	1,714	40	78	2,045
Phthalates							
Bis(2-ethylhexyl) phthalate	21	95	17	1,524	40	72	1,769
Butylbenzyl phthalate	21	95	17	1,515	40	72	1,760
Dibutyl phthalate	21	95	17	1,514	40	72	1,759
Diethyl phthalate	21	95	17	1,510	40	72	1,755
Dimethyl phthalate	21	95	17	1,515	40	72	1,760
Di-n-octyl phthalate	21	95	17	1,510	40	72	1,755
SVOCs							
1,2,4-Trichlorobenzene	21	95	17	1,338	40	72	1,583
1,2-Dichlorobenzene	21	95	17	1,399	40	72	1,644
1,2-Diphenylhydrazine						10	10
1,3-Dichlorobenzene	21	95	17	1,399	40	72	1,644
1,4-Dichlorobenzene	21	95	17	1,404	40	72	1,649

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
2,4-Dinitrotoluene	21	91	17	1,300	14	63	1,506
2,6-Dinitrotoluene	21	91	17	1,300	14	63	1,506
2-Chloronaphthalene	21	106	17	1,300	14	63	1,521
2-Nitroaniline	21	91	17	1,300	14	63	1,506
3,3'-Dichlorobenzidine	21	91	17	1,300	14	63	1,506
3-Nitroaniline	21	91	17	1,300	14	63	1,506
4-Bromophenyl phenyl ether	21	91	17	1,300	14	63	1,506
4-Chloroaniline	21	91	17	1,300	14	63	1,506
4-Chlorophenyl phenyl ether	21	91	17	1,300	14	63	1,506
4-Nitroaniline	21	91	17	1,300	14	63	1,506
Aniline	21	91	17	1,095	14	63	1,301
Azobenzene	21	89	17	999		53	1,179
Benzoic acid	21	93	17	1,366	38	72	1,607
Benzyl alcohol	21	95	17	1,369	40	72	1,614
Bis(2-chloro-1-methylethyl) ether		2		233	2	10	247
Bis(2-chloroethoxy) methane	21	91	17	1,300	14	63	1,506
Bis(2-chloroethyl) ether	21	91	17	1,300	14	63	1,506
Bis(2-chloroisopropyl) ether	21	89	17	1,067	12	53	1,259
Carbazole	21	89	17	1,281		63	1,471
Dibenzofuran	25	109	17	1,501	40	72	1,764
Diphenyl				91			91
Hexachlorobenzene	21	95	17	1,392	40	72	1,637
Hexachlorobutadiene	21	95	17	1,423	40	72	1,668
Hexachlorocyclopentadiene	21	91	17	1,294	14	63	1,500
Hexachloroethane	21	95	17	1,346	40	72	1,591
Isophorone	21	91	17	1,300	14	63	1,506
Nitrobenzene	21	91	17	1,300	14	63	1,506
N-Nitrosodimethylamine	21	91	17	1,112	14	63	1,318
N-Nitrosodiphenylamine	21	95	17	1,371	40	72	1,616
N-Nitrosodipropylamine	21	91	17	1,300	14	63	1,506
Pyridine				1			1
Phenols							
2,3,4,5-Tetrachlorophenol	21	89	17	999		63	1,189
2,3,4,6;2,3,5,6-Tetrachlorophenol coelution			6	568		18	592
2,3,4,6-Tetrachlorophenol				149		10	159
2,3,5,6-Tetrachlorophenol	21	89	11	510		35	666
2,4,5-Trichlorophenol	21	91	17	1,356	14	63	1,562
2,4,6-Trichlorophenol	21	91	17	1,356	14	63	1,562
2,4-Dichlorophenol	21	89	17	1,373	14	63	1,577
2,4-Dimethylphenol	21	25	17	1,436	38	67	1,604
2,4-Dinitrophenol	21	89	17	1,335	14	63	1,539
2-Chlorophenol	21	89	17	1,356	14	63	1,560
2-Methylphenol	21	93	17	1,427	38	72	1,668
2-Nitrophenol	21	89	17	1,347	14	63	1,551
3- and 4-Methylphenol Coelution		4		42	24	7	77
3,4-Dichlorophenol	1	5		7			13
3,5-Dichlorophenol	1	5		7			13
4,6-Dinitro-2-methylphenol	21	89	17	1,355	14	63	1,559
4-Chloro-3-methylphenol	21	89	17	1,356	14	63	1,560
4-Methylphenol	21	89	17	1,390	14	65	1,596
4-Nitrophenol	21	89	17	1,353	14	63	1,557
Cresol				1			1
Pentachlorophenol	21	95	17	1,503	38	78	1,752
Phenol	21	93	17	1,427	40	72	1,670
Tetrachlorophenol				17			17
VOCs							
1,1,1,2-Tetrachloroethane	6	8	1	320	2	3	340
1,1,1-Trichloroethane	6	8	1	320	2	13	350
1,1,2,2-Tetrachloroethane	6	8	1	320	2	13	350
1,1,2-Trichloro-1,2,2-trifluoroethane				1		10	11
1,1,2-Trichloroethane	6	8	1	320	2	13	350
1,1-Dichloroethane	6	8	1	315	2	13	345
1,1-Dichloroethene	6	8	1	320	2	10	347
1,1-Dichloropropene		2		54	2		58
1,2,3-Trichlorobenzene		2		54	2	10	68
1,2,3-Trichloropropane	6	8	1	320	2	3	340
1,2,4-Trimethylbenzene		2		57	2		61
1,2-Dibromo-3-chloropropane		2		54	2	10	68
1,2-Dichloroethane	6	8	1	320	2	13	350
1,2-Dichloroethene				8			8
1,2-Dichloropropane	6	8	1	320	2	13	350
1,3,5-Trimethylbenzene		2		57	2		61

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
1,3-Dichloropropane		2		54	2		58
1,3-Dichloropropene				8			8
1,4-Dichloro-trans-2-butene	6	6	1	267		3	283
1,4-Dioxane						10	10
1-Methyl-4-isopropylbenzene		2		37	2		41
2,2-Dichloropropane		2		54	2		58
2-Chloroethyl vinyl ether	6	6	1	267		3	283
2-Chlorotoluene		2		54	2		58
4-Chlorotoluene		2		54	2		58
Acetone	6	8	1	320	2	13	350
Acrolein	6	6	1	267		3	283
Acrylonitrile	6	6	1	267		3	283
Benzene	6	12	1	393	28	17	457
Bromobenzene		2		54	2		58
Bromochloromethane	6	8	1	320	2	13	350
Bromodichloromethane	6	8	1	320	2	13	350
Bromoethane				1			1
Bromoform	6	8	1	320	2	13	350
Bromomethane	6	8	1	320	2	13	350
BTEX	6	12	1	412	28	17	476
Butylbenzene				8			8
Carbon disulfide	6	8	1	317	2	13	347
Carbon tetrachloride	6	8	1	320	2	13	350
Chlorobenzene	6	8	1	329	2	13	359
Chlorodibromomethane	6	8	1	320	2	13	350
Chloroethane	6	8	1	323	2	13	353
Chloroform	6	8	1	320	2	13	350
Chloromethane	6	8	1	320	2	13	350
cis-1,2-Dichloroethene	6	8	1	126	2	10	153
cis-1,3-Dichloropropene	6	8	1	312	2	13	342
Dichlorodifluoromethane	6	8	1	320	2	13	350
Ethylbenzene	6	12	1	412	28	17	476
Ethylene dibromide	6	8	1	320	2	13	350
Hexahydrobenzene						10	10
Isopropylbenzene	6	8	1	323	2	13	353
m,p-Xylene	6	12	1	383	28	17	447
Methyl acetate						10	10
Methyl iodide	6	6	1	267		3	283
Methyl isobutyl ketone	6	8	1	311	2	13	341
Methyl n-butyl ketone	6	8	1	320	2	13	350
Methyl tert-butyl ether	6	6	1	294		13	320
Methylcyclohexane						10	10
Methylene bromide	6	8	1	320	2	3	340
Methylene chloride	6	8	1	320	2	13	350
Methylethyl ketone	6	8	1	311	2	13	341
Methylisopropylbenzene				17			17
n-Butylbenzene		2		46	2		50
n-Propylbenzene		2		57	2		61
o-Xylene	6	12	1	383	28	17	447
Sec-butylbenzene		2		54	2		58
Styrene	6	8	1	320	2	13	350
tert-Butylbenzene		2		51	2		55
Tetrachloroethene	6	8	1	380	2	13	410
Toluene	6	12	1	384	28	17	448
trans-1,2-Dichloroethene	6	8	1	317	2	13	347
trans-1,3-Dichloropropene	6	8	1	317	2	13	347
Trichloroethene	6	12	1	380	28	17	444
Trichlorofluoromethane	6	8	1	320	2	13	350
Vinyl acetate	6	6	1	267		3	283
Vinyl chloride	6	8	1	320	2	13	350
Xylene	6	12	1	412	28	17	476
Petroleum							
C10-C12 Aliphatics				5			5
C10-C12 Aromatics				5			5
C12-C16 Aliphatics				5			5
C12-C16 Aromatics				5			5
C16-C21 Aliphatics				5			5
C16-C21 Aromatics				5			5
C21-C34 Aliphatics				5			5
C21-C34 Aromatics				5			5
C8-C10 Aliphatics				5			5
C8-C10 Aromatics				5			5

Table 2.2-3. Summary of Sediment Sample Counts in the RI Data Set.

Analyte	Downstream	Downtown Reach	Multnomah Channel	Study Area	Ross Island Lagoon[a]	Upriver	Grand Total
Diesel-Range Hydrocarbons	17	50	11	834	26	43	981
Diesel-Range Hydrocarbons (silica gel treated)		78	10	213		32	333
Fuel oil no. 2				1			1
Gasoline-Range Hydrocarbons	17	24	1	465	26	16	549
Heavy-Oil-Range Hydrocarbons		14		26	26	4	70
Jet fuel A		18		1	26	4	49
JP-4 jet fuel		14		1	26	4	45
Kerosene		18		1	26	4	49
Lube oil		14		143	26	4	187
Mineral spirits		18		1	26	4	49
Motor oil		22		27			49
Naphtha distillate		14		1	26	4	45
Non-petroleum hydrocarbons		14			26	4	44
Pencil pitch				44			44
Phytane				44			44
Pristane				44			44
Residual-Range Hydrocarbons	17	10	11	638		39	715
Residual-Range Hydrocarbons (silica gel treated)		78	10	213		32	333
Total Petroleum Hydrocarbons	17	50	11	834	26	43	981
Total Petroleum Hydrocarbons (silica gel treated)		78	10	213		32	333
Radioisotopes							
Beryllium-7				111			111
Cesium-137				111			111
Lead-210				111			111
Radium-226				111			111

Notes:

[a] Data collected within Ross Island Lagoon were not presented in Section 5.

BTEX - benzene, toluene, ethylbenzene, and total xylene
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
SVOC - semivolatile organic compound
VOC - volatile organic compound

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
Grain Size	
Coarse sand	44
Medium sand	44
Fine sand	44
Coarse silt	44
Medium silt	44
Fine silt	44
Very fine silt	44
>9 Phi clay	44
8-9 Phi clay	44
Fine gravel	44
Fines	44
Medium gravel	44
Very coarse sand	44
Very fine sand	44
Conventionals	
Specific Gravity	40
Sulfide	1
Total organic carbon	51
Total solids	52
Metals	
Aluminum	50
Antimony	50
Arsenic	50
Cadmium	50
Chromium	50
Chromium hexavalent	45
Copper	50
Lead	50
Mercury	50
Nickel	50
Selenium	50
Silver	50
Zinc	50
2-Methylnaphthalene	49
Acenaphthene	49
Acenaphthylene	49
Anthracene	49
Benzo(a)anthracene	49
Benzo(a)pyrene	49
Benzo(b)fluoranthene	49
Benzo(g,h,i)perylene	49
Benzo(k)fluoranthene	49
Chrysene	49
Dibenzo(a,h)anthracene	49
Fluoranthene	49
Fluorene	49
High Molecular Weight PAH	49
Indeno(1,2,3-cd)pyrene	49
Low Molecular Weight PAH	49
Naphthalene	51
Phenanthrene	49
Pyrene	49

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
Total cPAHs	49
Total PAHs	49
Butyltins	
Butyltin ion	48
Dibutyltin ion	48
Tetrabutyltin	48
Tributyltin ion	48
PCB Aroclors	
Aroclor 1016	48
Aroclor 1221	48
Aroclor 1232	48
Aroclor 1242	48
Aroclor 1248	48
Aroclor 1254	48
Aroclor 1260	48
Aroclor 1262	48
Aroclor 1268	48
Total PCB Aroclors	48
PCB Congeners	
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)	52
PCB001	52
PCB002	52
PCB003	52
PCB004 & 010	52
PCB005 & 008	52
PCB006	52
PCB007 & 009	52
PCB011	52
PCB012 & 013	52
PCB014	52
PCB015	52
PCB016 & 032	52
PCB017	52
PCB018	52
PCB019	52
PCB020 & 021 & 033	52
PCB022	52
PCB023	52
PCB024 & 027	52
PCB025	52
PCB026	52
PCB028	52
PCB029	52
PCB030	52
PCB031	52
PCB034	52
PCB035	52
PCB036	52
PCB037	52
PCB038	52
PCB039	52
PCB040	52

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
PCB041 & 064 & 071 & 072	52
PCB042 & 059	52
PCB043 & 049	52
PCB044	52
PCB045	52
PCB046	52
PCB047	52
PCB048 & 075	52
PCB050	52
PCB051	52
PCB052 & 069	52
PCB053	52
PCB054	52
PCB055	52
PCB056 & 060	52
PCB057	52
PCB058	52
PCB061 & 070	52
PCB062	52
PCB063	52
PCB065	52
PCB066 & 076	52
PCB067	52
PCB068	52
PCB073	52
PCB074	52
PCB077	52
PCB078	52
PCB079	52
PCB080	52
PCB081	52
PCB082	52
PCB083	52
PCB084 & 092	52
PCB085 & 116	52
PCB086	52
PCB087 & 117 & 125	52
PCB088 & 091	52
PCB089	52
PCB090 & 101	52
PCB093	52
PCB094	52
PCB095 & 098 & 102	52
PCB096	52
PCB097	52
PCB099	52
PCB100	52
PCB103	52
PCB104	52
PCB105	52
PCB106 & 118	52
PCB107 & 109	52
PCB108 & 112	52
PCB110	52

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
PCB111 & 115	52
PCB113	52
PCB114	52
PCB119	52
PCB120	52
PCB121	52
PCB122	52
PCB123	52
PCB124	52
PCB126	52
PCB127	52
PCB128 & 162	52
PCB129	52
PCB130	52
PCB131	52
PCB132 & 161	52
PCB133 & 142	52
PCB134 & 143	52
PCB135	52
PCB136	52
PCB137	52
PCB138 & 163 & 164	52
PCB139 & 149	52
PCB140	52
PCB141	52
PCB144	52
PCB145	52
PCB146 & 165	52
PCB147	52
PCB148	52
PCB150	52
PCB151	52
PCB152	52
PCB153	52
PCB154	52
PCB155	52
PCB156	52
PCB157	52
PCB158 & 160	52
PCB159	52
PCB166	52
PCB167	52
PCB168	52
PCB169	52
PCB170	52
PCB171	52
PCB172	52
PCB173	52
PCB174	52
PCB175	52

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
PCB176	52
PCB177	52
PCB178	52
PCB179	52
PCB180	52
PCB181	52
PCB182 & 187	52
PCB183	52
PCB184	52
PCB185	52
PCB186	52
PCB188	52
PCB189	52
PCB190	52
PCB191	52
PCB192	52
PCB193	52
PCB194	52
PCB195	52
PCB196 & 203	52
PCB197	52
PCB198	52
PCB199	52
PCB200	52
PCB201	52
PCB202	52
PCB204	52
PCB205	52
PCB206	52
PCB207	52
PCB208	52
PCB209	52
Total PCB Congeners	52
PCB Homologs	
Dichlorobiphenyl homologs	52
Heptachlorobiphenyl homologs	52
Hexachlorobiphenyl homologs	52
Monochlorobiphenyl homologs	52
Nonachlorobiphenyl homologs	52
Octachlorobiphenyl homologs	52
Pentachlorobiphenyl homologs	52
Tetrachlorobiphenyl homologs	52
Trichlorobiphenyl homologs	52

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
PCDD/F Homologs	
Heptachlorodibenzofuran homologs	48
Heptachlorodibenzo-p-dioxin homologs	48
Hexachlorodibenzofuran homologs	48
Hexachlorodibenzo-p-dioxin homologs	48
Octachlorodibenzofuran	48
Octachlorodibenzo-p-dioxin	48
Pentachlorodibenzofuran homologs	48
Pentachlorodibenzo-p-dioxin homologs	48
Tetrachlorodibenzofuran homologs	48
Tetrachlorodibenzo-p-dioxin homologs	48
Total PCDD/F	48
PCDD/Fs	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	48
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	48
1,2,3,4,7,8,9-Heptachlorodibenzofuran	48
1,2,3,4,7,8-Hexachlorodibenzofuran	48
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	48
1,2,3,6,7,8-Hexachlorodibenzofuran	48
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	48
1,2,3,7,8,9-Hexachlorodibenzofuran	48
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	48
1,2,3,7,8-Pentachlorodibenzofuran	48
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	48
2,3,4,6,7,8-Hexachlorodibenzofuran	48
2,3,4,7,8-Pentachlorodibenzofuran	48
2,3,7,8-Tetrachlorodibenzofuran	48
2,3,7,8-Tetrachlorodibenzo-p-dioxin	48
Dioxin/furan TCDD toxicity equivalent (ND = 0)	48
Total TCDD toxicity equivalent (ND = 0)	52
Pesticides	
2,4'-DDD	50
2,4'-DDE	50
2,4'-DDT	50
4,4'-DDD	50
4,4'-DDE	50
4,4'-DDT	50
Aldrin	50
alpha-Endosulfan	50
alpha-Hexachlorocyclohexane	50
beta-Endosulfan	50
beta-Hexachlorocyclohexane	50
cis-Chlordane	50
cis-Nonachlor	50
delta-Hexachlorocyclohexane	50
Dieldrin	50
Endosulfan sulfate	50
Endrin	50
Endrin aldehyde	50
Endrin ketone	50
gamma-Hexachlorocyclohexane	50
Heptachlor	50

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
Heptachlor epoxide	50
Methoxychlor	50
Mirex	50
Oxychlordane	50
Total Chlordanes	50
Total Endosulfan	50
Total of 2,4' and 4,4'-DDD	50
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	50
Total of 2,4' and 4,4'-DDE	50
Total of 2,4' and 4,4'-DDT	50
Toxaphene	50
trans-Chlordane	50
trans-Nonachlor	50
Herbicides	
2,4,5-T	47
2,4-D	47
2,4-DB	47
Dalapon	47
Dicamba	47
Dichloroprop	47
Dinoseb	47
MCPA	47
MCPP	47
Silvex	47
Phthalates	
Bis(2-ethylhexyl) phthalate	49
Butylbenzyl phthalate	49
Dibutyl phthalate	49
Diethyl phthalate	49
Dimethyl phthalate	49
Di-n-octyl phthalate	49
SVOCs	
1,2,4-Trichlorobenzene	49
1,2-Dichlorobenzene	49
1,3-Dichlorobenzene	49
1,4-Dichlorobenzene	51
2,4-Dinitrotoluene	49
2,6-Dinitrotoluene	49
2-Chloronaphthalene	49
2-Nitroaniline	49
3,3'-Dichlorobenzidine	49
3-Nitroaniline	49
4-Bromophenyl phenyl ether	49
4-Chloroaniline	49
4-Chlorophenyl phenyl ether	49
4-Nitroaniline	49
Aniline	49
Azobenzene	49
Benzoic acid	49
Benzyl alcohol	49
Bis(2-chloroethoxy) methane	49
Bis(2-chloroethyl) ether	49

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
Bis(2-chloroisopropyl) ether	49
Carbazole	49
Dibenzofuran	49
Hexachlorobenzene	50
Hexachlorobutadiene	50
Hexachlorocyclopentadiene	49
Hexachloroethane	50
Isophorone	49
Nitrobenzene	49
N-Nitrosodimethylamine	49
N-Nitrosodiphenylamine	49
N-Nitrosodipropylamine	49
Phenols	
2,3,4,5-Tetrachlorophenol	44
2,3,5,6-Tetrachlorophenol	44
2,4,5-Trichlorophenol	32
2,4,6-Trichlorophenol	44
2,4-Dichlorophenol	49
2,4-Dimethylphenol	49
2,4-Dinitrophenol	49
2-Chlorophenol	49
2-Methylphenol	49
2-Nitrophenol	49
4,6-Dinitro-2-methylphenol	49
4-Chloro-3-methylphenol	49
4-Methylphenol	49
4-Nitrophenol	49
Pentachlorophenol	44
Phenol	49
VOCs	
1,1,1,2-Tetrachloroethane	48
1,1,1-Trichloroethane	48
1,1,2,2-Tetrachloroethane	48
1,1,2-Trichloroethane	48
1,1-Dichloroethane	48
1,1-Dichloroethene	48
1,2,3-Trichloropropane	48
1,2-Dichloroethane	48
1,2-Dichloropropane	48
1,4-Dichloro-trans-2-butene	48
2-Chloroethyl vinyl ether	48
Acetone	48
Acrolein	48
Acrylonitrile	48
Benzene	48
Bromochloromethane	48
Bromodichloromethane	48
Bromoform	48
Bromomethane	48
BTEX	48
Carbon disulfide	48
Carbon tetrachloride	48
Chlorobenzene	48

Table 2.2-4. Summary of LWG Sediment Trap Sample Counts.

Analyte	# of LWG Samples
Chlorodibromomethane	48
Chloroethane	48
Chloroform	48
Chloromethane	48
cis-1,2-Dichloroethene	48
cis-1,3-Dichloropropene	48
Dichlorodifluoromethane	48
Ethylbenzene	48
Ethylene dibromide	48
Isopropylbenzene	48
m,p-Xylene	48
Methyl iodide	48
Methyl isobutyl ketone	48
Methyl n-butyl ketone	48
Methyl tert-butyl ether	48
Methylene bromide	48
Methylene chloride	48
Methylethyl ketone	48
o-Xylene	48
Styrene	48
Tetrachloroethene	48
Toluene	48
trans-1,2-Dichloroethene	48
trans-1,3-Dichloropropene	48
Trichloroethene	48
Trichlorofluoromethane	48
Vinyl acetate	48
Vinyl chloride	48
Xylene	48
Petroleum	
Diesel-Range Hydrocarbons	47
Gasoline-Range Hydrocarbons	49
Residual-Range Hydrocarbons	47
Total Petroleum Hydrocarbons	47

Notes:

BTEX - benzene, toluene, ethylbenzene, and total xylene
cPAH - carcinogenic polycyclic aromatic hydrocarbon
LWG - Lower Willamette Group
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
SVOCs - semivolatile organic compounds
VOCs - volatile organic compounds

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
Conventionals																							
Alkalinity																						12	12
Bicarbonate																						8	8
Chloride																						20	20
Conductivity	24			25			26												46			23	144
Cyanide																						180	180
Cyanide (dissolved)																						180	180
Cyanide amenable to chlorination																						180	180
Cyanide amenable to chlorination (dissolved)																						180	180
Depth	17			25			26												46				114
Dissolved organic carbon	25			25			24			4			14			40			42			186	360
Dissolved oxygen	23			25			26												46			23	143
Free cyanide																						180	180
Free cyanide (dissolved)																						180	180
Hardness as CaCO3	25			25			24			4			4						38				120
Hardness as CaCO3 (dissolved)													10			40			4				54
Nitrate																						8	8
Nitrite																						8	8
Oxidation-Reduction Potential	11			25			26												46			22	130
Perchlorate	2			2			2						2			6			6				20
pH	24			25			26												46			23	144
Salinity																						8	8
Sulfate																						19	19
Sulfide																						180	180
Temperature	24			25			26												46			23	144
Total dissolved solids	25			25			24			4			14			40			42				174
Total organic carbon	25			25			24			4			14			40			42			188	362
Total suspended solids	25			25			24			4			14			40			42			213	387
Total suspended solids w/0.45 um filter																16			38				54
Turbidity																			46				46
Metals																							
Aluminum				25			24			4			14			40			42			4	153
Aluminum (dissolved)				25			24			4			14			40			42				149
Antimony	25			25			24			4			14			40			42			12	186
Antimony (dissolved)	25			25			24			4			14			40			42			8	182
Arsenic	25			25			24			4			14			40			42			64	238
Arsenic (dissolved)	25			25			24			4			14			40			42			8	182
Barium																						4	4
Beryllium																						4	4
Cadmium	25			25			24			4			14			40			42			12	186
Cadmium (dissolved)	25			25			24			4			14			40			42			8	182
Calcium																						20	20
Calcium (dissolved)																						8	8
Chromium	25			25			24			4			14			40			42			50	224
Chromium (dissolved)	25			25			24			4			14			40			42				174
Chromium hexavalent	2			2			2						2			6			6				20
Cobalt																						4	4
Copper	25			25			24			4			14			40			42			58	232
Copper (dissolved)	25			25			24			4			14			40			42			8	182
Iron																						200	200
Iron (dissolved)																						188	188
Lead	25			25			24			4			14			40			42			12	186
Lead (dissolved)	25			25			24			4			14			40			42			8	182
Magnesium																						20	20
Magnesium (dissolved)																						8	8
Manganese																						24	24
Manganese (dissolved)																						8	8
Mercury	25			25			24			4			14			40			42			20	194
Mercury (dissolved)	25			25			24			4			14			40			42			8	182
Nickel	25			25			24			4			14			40			42			12	186

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
Nickel (dissolved)	25			25			24			4			14			40			42			8	182
Potassium																						20	20
Potassium (dissolved)																						8	8
Selenium	25			25			24			4			14			40			42			4	178
Selenium (dissolved)	25			25			24			4			14			40			42				174
Silver	25			25			24			4			14			40			42			12	186
Silver (dissolved)	25			25			24			4			14			40			42			8	182
Sodium																						20	20
Sodium (dissolved)																						8	8
Thallium	25																					4	29
Thallium (dissolved)	25																						25
Vanadium																						4	4
Zinc	25			25			24			4			14			40			42			58	232
Zinc (dissolved)	25			25			24			4			14			40			42			8	182
Butyltins																							
Butyltin ion	25			25			24			4			14			40			42			8	182
Dibutyltin ion	25			25			24			4			14			40			42			8	182
Tetrabutyltin	25			25			24			4			14			40			42			8	182
Tributyltin ion	25			25			24			4			14			40			42			8	182
PCB Aroclors																							
Aroclor 1016	21			17			16															12	66
Aroclor 1221	21			17			16															12	66
Aroclor 1232	21			17			16															12	66
Aroclor 1242	21			17			16															12	66
Aroclor 1248	21			17			16															12	66
Aroclor 1254	21			17			16															12	66
Aroclor 1260	21			17			16															12	66
Aroclor 1262	21			17			16															4	58
Aroclor 1268	21			17			16															4	58
Total PCB Aroclors	21			17			16															12	66
PCB Congeners																							
Dioxin-like PCB congener TCDD TEQ (ND = 0)		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB001		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB002		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB003		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB004		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB005		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB006		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB007		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB008		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB009		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB010		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB011		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB012																						4	4
PCB012 & 013		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB013																						4	4
PCB014		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB015		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB016		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB017		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB018																						4	4
PCB018 & 030		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB019		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB020																						4	4
PCB020 & 028		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB021																						4	4
PCB021 & 033		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB022		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB023		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB024		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
PCB025		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB026																						4	4
PCB026 & 029		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB027		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB028																						4	4
PCB029																						4	4
PCB030																						4	4
PCB031		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB032		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB033																						4	4
PCB034		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB035		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB036		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB037		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB038		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB039		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB040																						4	4
PCB040 & 041 & 071		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB041																						4	4
PCB042		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB043		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB044																						4	4
PCB044 & 047 & 065		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB045																						4	4
PCB045 & 051		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB046		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB047																						4	4
PCB048		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB049																						4	4
PCB049 & 069		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB050																						4	4
PCB050 & 053		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB051																						4	4
PCB052		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB053																						4	4
PCB054		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB055		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB056		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB057		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB058		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB059																						4	4
PCB059 & 062 & 075		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB060		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB061																						4	4
PCB061 & 070 & 074 & 076		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB062																						4	4
PCB063		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB064		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB065																						4	4
PCB066		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB067		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB068		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB069																						4	4
PCB070																						4	4
PCB071																						4	4
PCB072		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB073		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB074																						4	4
PCB075																						4	4
PCB076																						4	4

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
PCB077		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB078		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB079		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB080		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB081		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB082		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB083																						4	4
PCB083 & 099		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB084		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB085																						4	4
PCB085 & 116 & 117		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB086																						4	4
PCB086 & 087 & 097 & 108 & 119 & 125		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB087																						4	4
PCB088																						4	4
PCB088 & 091		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB089		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB090																						4	4
PCB090 & 101 & 113		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB091																						4	4
PCB092		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB093																						4	4
PCB093 & 095 & 098 & 100 & 102		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB094		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB095																						4	4
PCB096		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB097																						4	4
PCB098																						4	4
PCB099																						4	4
PCB100																						4	4
PCB101																						4	4
PCB102																						4	4
PCB103		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB104		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB105		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB106		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB107																						4	4
PCB107 & 124		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB108																						4	4
PCB109		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB110																						4	4
PCB110 & 115		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB111		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB112		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB113																						4	4
PCB114		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB115																						4	4
PCB116																						4	4
PCB117																						4	4
PCB118		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB119																						4	4
PCB120		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB121		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB122		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB123		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB124																						4	4
PCB125																						4	4
PCB126		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB127		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB128 & 166		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
PCB129																						4	4
PCB129 & 138 & 160 & 163		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB130		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB131		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB132		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB133		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB134																						4	4
PCB134 & 143		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB135																						4	4
PCB135 & 151 & 154		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB136		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB137		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB138																						4	4
PCB139																						4	4
PCB139 & 140		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB140																						4	4
PCB141		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB142		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB143																						4	4
PCB144		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB145		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB146		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB147																						4	4
PCB147 & 149		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB148		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB149																						4	4
PCB150		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB151																						4	4
PCB152		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB153																						4	4
PCB153 & 168		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB154																						4	4
PCB155		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB156																						4	4
PCB156 & 157		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB157																						4	4
PCB158		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB159		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB160																						4	4
PCB161		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB162		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB163																						4	4
PCB164		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB165		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB166																						4	4
PCB167		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB168																						4	4
PCB169		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB170		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB171																						4	4
PCB171 & 173		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB172		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB173																						4	4
PCB174		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB175		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB176		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB177		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB178		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB179		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB180																						4	4

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
PCB180 & 193		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB181		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB182		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB183																						4	4
PCB183 & 185		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB184		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB185																						4	4
PCB186		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB187		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB188		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB189		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB190		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB191		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB192		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB193																						4	4
PCB194		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB195		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB196		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB197																						4	4
PCB197 & 200		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB198																						4	4
PCB198 & 199		8	8		8	8		8	7		3	3		14	14		40	40		40	40		241
PCB199																						4	4
PCB200																						4	4
PCB201		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB202		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB203		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB204		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB205		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB206		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB207		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB208		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB209		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Total PCB Congeners		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
PCB Homologs																							
Dichlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Heptachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Hexachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Monochlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		29	40	4	234
Nonachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Octachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Pentachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Tetrachlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245
Trichlorobiphenyl homologs		8	8		8	8		8	7		3	3		14	14		40	40		40	40	4	245

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
PCDD/Fs																							
1,2,3,4,6,7,8-Heptachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,4,7,8,9-Heptachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,4,7,8-Hexachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,6,7,8-Hexachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,7,8,9-Hexachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,7,8-Pentachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
1,2,3,7,8-Pentachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
2,3,4,6,7,8-Hexachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
2,3,4,7,8-Pentachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
2,3,7,8-Tetrachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
2,3,7,8-Tetrachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
Dioxin/furan TCDD toxicity equivalent (ND = 0)		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
Total TCDD toxicity equivalent (ND = 0)		8	8		8	8		8	8		3	3		14	14		40	40		40	40	4	246
PCDD/F Homologs																							
Heptachlorodibenzofuran homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Heptachlorodibenzo-p-dioxin homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Hexachlorodibenzofuran homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Hexachlorodibenzo-p-dioxin homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Octachlorodibenzofuran		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
Octachlorodibenzo-p-dioxin		6	6		6	6		6	6		3	3		14	14		22	22		22	22	4	162
Pentachlorodibenzofuran homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Pentachlorodibenzo-p-dioxin homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Tetrachlorodibenzofuran homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Tetrachlorodibenzo-p-dioxin homologs		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Total PCDD/F		6	6		6	6		6	6		3	3		14	14		22	22		22	22		158
Pesticides																							
2,4'-DDD	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
2,4'-DDE	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
2,4'-DDT	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
4,4'-DDD	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
4,4'-DDD (dissolved)																						3	3
4,4'-DDE	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
4,4'-DDE (dissolved)																						3	3
4,4'-DDT	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
4,4'-DDT (dissolved)																						3	3
Aldrin	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
alpha-Endosulfan	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
alpha-Hexachlorocyclohexane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
alpha-Hexachlorocyclohexane (dissolved)																						3	3
beta-Endosulfan	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
beta-Hexachlorocyclohexane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
cis-Chlordane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
cis-Chlordane (dissolved)																						3	3
cis-Nonachlor	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
delta-Hexachlorocyclohexane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Dieldrin	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Dieldrin (dissolved)																						3	3
Endosulfan (dissolved)																						1	1
Endosulfan sulfate	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Endrin	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Endrin (dissolved)																						3	3
Endrin aldehyde	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Endrin ketone	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
gamma-Hexachlorocyclohexane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Heptachlor	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
Heptachlor epoxide	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Heptachlor epoxide (dissolved)																						3	3
Methoxychlor	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Methoxychlor (dissolved)																						3	3
Mirex	19			17			16															4	56
Oxychlordane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Total Chlordanes	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Total Chlordanes (dissolved)																						3	3
Total Endosulfan	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Total of 2,4' and 4,4'-DDD	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
Total of 2,4' and 4,4'-DDD (dissolved)																						3	3
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
Total of 2,4' and 4,4'-DDD, -DDE, -DDT (dissolved)																						3	3
Total of 2,4' and 4,4'-DDE	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
Total of 2,4' and 4,4'-DDE (dissolved)																						3	3
Total of 2,4' and 4,4'-DDT	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	12	282
Total of 2,4' and 4,4'-DDT (dissolved)																						3	3
Total of 4,4'-DDD, -DDE, -DDT	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26				8	212
Toxaphene	19			17			16									18			14			4	88
trans-Chlordane	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
trans-Chlordane (dissolved)																						3	3
trans-Nonachlor	19	8	8	17	8	8	16	8	8		3	3		14	14	18	26	26	14	26	26	4	274
Herbicides																							
2,4,5-T	25			25			24			4			14			40			42				174
2,4-D	25			25			24			4			14			40			42				174
2,4-DB	25			25			24						14			40			42				170
Dalapon	25			25			24						14			40			42				170
Dicamba	25			25			24						14			40			42				170
Dichloroprop	25			25			24			4			14			40			42				174
Dinoseb	25			25			24						14			40			42				170
MCPA	25			25			24						14			40			42				170
MCPP	25			25			24						14			40			42				170
Silvex	25			25			24			4			14			40			42				174
PAHs																							
1-Methylnaphthalene																						10	10
2-Methylnaphthalene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	23	367
Acenaphthene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Acenaphthylene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Anthracene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Benzo(a)anthracene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	40	384
Benzo(a)pyrene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Benzo(b)fluoranthene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Benzo(b+k)fluoranthene																						14	14
Benzo(g,h,i)perylene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Benzo(j+k)fluoranthene		8	8		8	8		8	8		3	3		14	14		22	22		22	22		170
Benzo(k)fluoranthene	25			25			24			4			14			40			42			59	233
Chrysene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	40	384
Dibenzo(a,h)anthracene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Fluoranthene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Fluorene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
High Molecular Weight PAH	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Indeno(1,2,3-cd)pyrene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Low Molecular Weight PAH	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Naphthalene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	82	426
Phenanthrene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Pyrene	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Total cPAHs	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Total PAHs	25	8	8	25	8	8	24	8	8	4	3	3	14	14	14	40	22	22	42	22	22	59	403
Phthalates																							
Bis(2-ethylhexyl) phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
Butylbenzyl phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235
Dibutyl phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235
Diethyl phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235
Dimethyl phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235
Di-n-octyl phthalate	25	8	8	25	8	8	24	8	8	4			14			40			42			13	235
SVOCs																							
1,2,4-Trichlorobenzene	25			25			24			4			14			40			42			36	210
1,2-Dichlorobenzene	25			25			24			4			14			40			42			36	210
1,2-Diphenylhydrazine																						4	4
1,3-Dichlorobenzene	25			25			24			4			14			40			42			36	210
1,4-Dichlorobenzene	25			25			24			4			14			40			42			36	210
2,4-Dinitrotoluene	25			25			24			4			14			40			42			5	179
2,6-Dinitrotoluene	25			25			24			4			14			40			42			5	179
2-Chloronaphthalene	25			25			24			4			14			40			42			15	189
2-Nitroaniline	25			25			24			4			14			40			42			5	179
3,3'-Dichlorobenzidine	25			25			24			4			14			40			42			5	179
3-Nitroaniline	25			25			24			4			14			40			42			5	179
4-Bromophenyl phenyl ether	25			25			24			4			14			40			42			5	179
4-Chloroaniline	25			25			24			4			14			40			42			5	179
4-Chlorophenyl phenyl ether	25			25			24			4			14			40			42			5	179
4-Nitroaniline	25			25			24			4			14			40			42			5	179
Aniline	25			25			24			4			14			40			42			4	178
Azobenzene	25			25			24			4			14			40			42				174
Benzoic acid	25			25			24			4			14			40			42			13	187
Benzyl alcohol	25			25			24			4			14			40			42			13	187
Bis(2-chloro-1-methylethyl) ether																						4	4
Bis(2-chloroethoxy) methane	25			25			24			4			14			40			42			5	179
Bis(2-chloroethyl) ether	25			25			24			4			14			40			42			5	179
Bis(2-chloroisopropyl) ether	25			25			24			4			14			40			42			1	175
Carbazole	25			25			24			4			14			40			42			4	178
Dibenzofuran	25			25			24			4			14			40			42			23	197
Hexachlorobenzene	25	8	8	26	8	8	24	8	8	4	3	3	14	14	14	42	26	26	42	26	26	13	376
Hexachlorobenzene (dissolved)																						3	3
Hexachlorobutadiene	25	8	8	26	8	8	24	8	8	4	3	3	14	14	14	42	26	26	42	26	26	36	399
Hexachlorocyclopentadiene	25			25			24			4			14			40			42			5	179
Hexachloroethane	25			26			24			4			14			40			42			13	188
Isophorone	25			25			24			4			14			40			42			5	179
Nitrobenzene	25			25			24			4			14			40			42			5	179
N-Nitrosodimethylamine	25			25			24			4			14			40			42			4	178
N-Nitrosodiphenylamine	25			25			24			4			14			40			42			13	187
N-Nitrosodipropylamine	25			25			24			4			14			40			42			5	179
Retene																						10	10
Phenols																							
2,3,4,5-Tetrachlorophenol																						4	4
2,3,4,6-Tetrachlorophenol				25			24			4			14			40			42			4	153
2,4,5-Trichlorophenol	25			25			24			4			14			40			42			5	179
2,4,6-Trichlorophenol	25			25			24			4			14			40			42			5	179
2,4-Dichlorophenol	25			25			24			4			14			40			42			5	179
2,4-Dimethylphenol	25			25			24			4			14			40			42			13	187
2,4-Dinitrophenol	25			25			24			4			14			40			42			5	179
2-Chlorophenol	25			25			24			4			14			40			42			5	179
2-Methylphenol	25			25			24			4			14			40			42			13	187
2-Nitrophenol	25			25			24			4			14			40			42			5	179
3- and 4-Methylphenol Coelution																						9	9
4,6-Dinitro-2-methylphenol	25			25			24			4			14			40			42			5	179
4-Chloro-3-methylphenol	25			25			24			4			14			40			42			5	179
4-Methylphenol	25			25			24			4			14			40			42			4	178
4-Nitrophenol	25			25			24			4			14			40			42			5	179
Pentachlorophenol	25			25			24			4			14			40			42			40	214
Phenol	25			25			24			4			14			40			42			13	187

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
VOCs																							
1,1,1,2-Tetrachloroethane																						23	23
1,1,1-Trichloroethane																						27	27
1,1,2,2-Tetrachloroethane																						27	27
1,1,2-Trichloro-1,2,2-trifluoroethane																						4	4
1,1,2-Trichloroethane																						27	27
1,1-Dichloroethane																						27	27
1,1-Dichloroethene																						27	27
1,1-Dichloropropene																						23	23
1,2,3-Trichlorobenzene																						27	27
1,2,3-Trichloropropane																						23	23
1,2,4-Trimethylbenzene																						23	23
1,2-Dibromo-3-chloropropane																						27	27
1,2-Dichloroethane																						27	27
1,2-Dichloropropane																						27	27
1,3,5-Trimethylbenzene																						23	23
1,3-Dichloropropane																						23	23
1,4-Dioxane																						4	4
1-Methyl-4-isopropylbenzene																						23	23
2,2-Dichloropropane																						23	23
2-Chlorotoluene																						23	23
4-Chlorotoluene																						23	23
Acetone																						27	27
Acrylonitrile																						23	23
Benzene																						35	35
Bromobenzene																						23	23
Bromochloromethane																						27	27
Bromodichloromethane																						27	27
Bromoform																						27	27
Bromomethane																						27	27
BTEX																						35	35
Carbon disulfide																						27	27
Carbon tetrachloride																						27	27
Chlorobenzene																						27	27
Chlorodibromomethane																						27	27
Chloroethane																						27	27
Chloroform																						27	27
Chloromethane																						27	27
cis-1,2-Dichloroethene																						27	27
cis-1,3-Dichloropropene																						27	27
Dichlorodifluoromethane																						27	27
Ethylbenzene																						35	35
Ethylene dibromide																						27	27
Hexahydrobenzene																						4	4
Isopropylbenzene																						27	27
m,p-Xylene																						35	35
Methyl acetate																						4	4
Methyl isobutyl ketone																						27	27
Methyl n-butyl ketone																						27	27
Methyl tert-butyl ether																						27	27
Methylcyclohexane																						4	4
Methylene bromide																						23	23
Methylene chloride																						27	27
Methylethyl ketone																						27	27
n-Butylbenzene																						23	23
n-Propylbenzene																						23	23
o-Xylene																						35	35
Sec-butylbenzene																						23	23
Styrene																						27	27
tert-Butylbenzene																						23	23

Table 2.2-5. Summary of Surface Water Sample Counts in the RI Data Set.[a,b]

	Sampling Date																					Other Parties	
	LWG - November 2004			LWG - March 2005			LWG - July 2005			LWG - January 2006			LWG - September 2006			LWG - November 2006			LWG - January-March 2007				
Analyte	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	surface water from XAD column	surface water particulates from XAD filter	surface water	Grand Total
Tetrachloroethene																						27	27
Toluene																						35	35
trans-1,2-Dichloroethene																						27	27
trans-1,3-Dichloropropene																						27	27
Trichloroethene																						35	35
Trichlorofluoromethane																						27	27
Vinyl chloride																						27	27
Xylene																						35	35
Grand Total	3,902	2,026	2,026	3,847	2,026	2,026	3,688	2,026	1,856	444	762	762	1,642	3,556	3,556	5,324	8,806	8,806	5,748	8,769	8,780	7,837	88,215

Notes:

[a] LWG surface water samples were collected by peristaltic pump. Non-LWG surface water samples were collected using either a grab sampler or pumping device.

[b] With the exception of City of Portland-generated total suspended solids data, no other non-LWG surface water data are included in Section 5.

BTEX - benzene, toluene, ethylbenzene, and total xylene
LWG - Lower Willamette Group
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
RI - remedial investigation
SVOC - semivolatile organic compound
VOC - volatile organic compound
XAD - Amberlite® XAD®-2 is a hydrophobic crosslinked polystyrene copolymer resin
XAD filter - a 0.5mm glass fiber filter cartridge

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
Grain Size							
< 0.075 mm						8	8
Sieve 140						8	8
Sieve 20						8	8
Sieve 200						8	8
Sieve 40						8	8
Sieve 60						8	8
Conventionals							
Alkalinity				6			6
Chloride				6			6
Conductivity	51			21			72
Cyanide				2			2
Dissolved organic carbon	119	6	26	2			153
Dissolved oxygen				4			4
Flow				8			8
Hardness as CaCO3				8			8
Nitrate				6			6
Nitrite				6			6
Oxidation-Reduction Potential				5			5
Oxygen				1			1
pH	56			49			105
Phosphate				2			2
Phosphorus				3			3
Silica				2			2
Sulfate				6			6
Temperature	56			21			77
Total dissolved solids				6			6
Total organic carbon	141	6	26	16	40	8	237
Total solids					44	8	52
Total suspended solids	146	8	26	84			264
Turbidity	56		26	14			96
Metals							
Aluminum	121		27	41	19		208
Aluminum (dissolved)	82		27	9			118
Antimony	121	8	27	82	19		257
Antimony (dissolved)	82	8	27	7			124
Arsenic	123	8	27	110	19	8	295
Arsenic (dissolved)	82	8	27	38			155
Barium				83			83
Barium (dissolved)				20			20
Beryllium		8		47			55
Beryllium (dissolved)		8		2			10
Boron				4			4
Boron (dissolved)				2			2
Cadmium	121	8	27	126	19	8	309
Cadmium (dissolved)	82	8	27	40			157
Calcium				31			31
Calcium (dissolved)				2			2
Chromium	121	8	27	147	19	8	330
Chromium (dissolved)	82	8	27	45			162
Chromium hexavalent				5			5
Cobalt				17			17
Cobalt (dissolved)				8			8
Copper	121	8	27	182	19	8	365
Copper (dissolved)	82	8	27	53			170
Iron				31			31
Iron (dissolved)				5			5
Lead	121	8	27	179	19	8	362
Lead (dissolved)	82	8	27	50			167
Magnesium				31			31
Magnesium (dissolved)				5			5
Manganese				123			123
Manganese (dissolved)				28			28

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
Mercury	126	8	27	114	19	7	301
Mercury (dissolved)	84	8	27	29			148
Molybdenum				18			18
Molybdenum (dissolved)				7			7
Nickel	121	8	27	136	19	8	319
Nickel (dissolved)	82	8	27	39			156
Potassium				22			22
Potassium (dissolved)				2			2
Selenium	121	8	27	76	19	8	259
Selenium (dissolved)	82	8	27	25			142
Silicon				2			2
Silicon (dissolved)				2			2
Silver	121	7	27	95	19	8	277
Silver (dissolved)	82	8	27	31			148
Sodium				22			22
Sodium (dissolved)				2			2
Thallium		8		48			56
Thallium (dissolved)		8		14			22
Tin				18			18
Titanium (dissolved)				3			3
Vanadium				37			37
Vanadium (dissolved)				9			9
Zinc	121	8	27	186	19	8	369
Zinc (dissolved)	82	8	27	53			170
Butyltins							
Tributyltin ion				7			7
PCB Aroclors							
Aroclor 1016		6	26	57		8	97
Aroclor 1016 (dissolved)		5	18	1			24
Aroclor 1221		6	26	59		8	99
Aroclor 1221 (dissolved)		5	18	1			24
Aroclor 1232		6	26	57		8	97
Aroclor 1232 (dissolved)		5	18	1			24
Aroclor 1242		6	26	84		8	124
Aroclor 1242 (dissolved)		5	18	1			24
Aroclor 1248		6	26	84		8	124
Aroclor 1248 (dissolved)		5	18	1			24
Aroclor 1254		6	26	84		8	124
Aroclor 1254 (dissolved)		5	18	1			24
Aroclor 1260		6	26	84		8	124
Aroclor 1260 (dissolved)		5	18	1			24
Aroclor 1262			26	2		8	36
Aroclor 1262 (dissolved)			18				18
Aroclor 1268			26	2		8	36
Aroclor 1268 (dissolved)			18				18
Total PCB Aroclors		6	26	83		8	123
Total PCB Aroclors (dissolved)		5	18	1			24
PCB Congeners							
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)	98	8			35		141
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0) (dissolved)	11	8					19
PCB001	103	8			35		146
PCB001 (dissolved)	11	8					19
PCB002	103	8			35		146
PCB002 (dissolved)	11	8					19
PCB003	103	8			35		146
PCB003 (dissolved)	11	8					19
PCB004		8					8
PCB004 & 010	103				35		138
PCB004 & 010 (dissolved)	11						11
PCB004 (dissolved)		8					8
PCB005		8					8
PCB005 & 008	103				35		138
PCB005 & 008 (dissolved)	11						11

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB005 (dissolved)		8					8
PCB006	103	8			35		146
PCB006 (dissolved)	11	8					19
PCB007		8					8
PCB007 & 009	103				35		138
PCB007 & 009 (dissolved)	11						11
PCB007 (dissolved)		8					8
PCB008		8					8
PCB008 (dissolved)		8					8
PCB009		8					8
PCB009 (dissolved)		8					8
PCB010		8					8
PCB010 (dissolved)		8					8
PCB011	103	8			35		146
PCB011 (dissolved)	11	8					19
PCB012 & 013	103	8			35		146
PCB012 & 013 (dissolved)	11	8					19
PCB014	103	8			35		146
PCB014 (dissolved)	11	8					19
PCB015	103	8			35		146
PCB015 (dissolved)	11	8					19
PCB016		8					8
PCB016 & 032	103				35		138
PCB016 & 032 (dissolved)	11						11
PCB016 (dissolved)		8					8
PCB017	103	8			35		146
PCB017 (dissolved)	11	8					19
PCB018	103				35		138
PCB018 & 030		8					8
PCB018 & 030 (dissolved)		8					8
PCB018 (dissolved)	11						11
PCB019	103	8			35		146
PCB019 (dissolved)	11	8					19
PCB020 & 021 & 033	103				35		138
PCB020 & 021 & 033 (dissolved)	11						11
PCB020 & 028		8					8
PCB020 & 028 (dissolved)		8					8
PCB021 & 033		8					8
PCB021 & 033 (dissolved)		8					8
PCB022	103	8			35		146
PCB022 (dissolved)	11	8					19
PCB023	103	8			35		146
PCB023 (dissolved)	11	8					19
PCB024		8					8
PCB024 & 027	103				35		138
PCB024 & 027 (dissolved)	11						11
PCB024 (dissolved)		8					8
PCB025	103	8			35		146
PCB025 (dissolved)	11	8					19
PCB026	103				35		138
PCB026 & 029		8					8
PCB026 & 029 (dissolved)		8					8
PCB026 (dissolved)	11						11
PCB027		8					8
PCB027 (dissolved)		8					8
PCB028	103				35		138
PCB028 (dissolved)	11						11
PCB029	103				35		138
PCB029 (dissolved)	11						11
PCB030	103				35		138
PCB030 (dissolved)	11						11
PCB031	103	8			35		146
PCB031 (dissolved)	11	8					19
PCB032		8					8

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB032 (dissolved)		8					8
PCB034	103	8			35		146
PCB034 (dissolved)	11	8					19
PCB035	103	8			35		146
PCB035 (dissolved)	11	8					19
PCB036	103	8			35		146
PCB036 (dissolved)	11	8					19
PCB037	103	8			35		146
PCB037 (dissolved)	11	8					19
PCB038	103	8			35		146
PCB038 (dissolved)	11	8					19
PCB039	103	8			35		146
PCB039 (dissolved)	11	8					19
PCB040	103				35		138
PCB040 & 041 & 071		8					8
PCB040 & 041 & 071 (dissolved)		8					8
PCB040 (dissolved)	11						11
PCB041 & 064 & 071 & 072	103				35		138
PCB041 & 064 & 071 & 072 (dissolved)	11						11
PCB042		8					8
PCB042 & 059	103				35		138
PCB042 & 059 (dissolved)	11						11
PCB042 (dissolved)		8					8
PCB043		8					8
PCB043 & 049	103				35		138
PCB043 & 049 (dissolved)	11						11
PCB043 (dissolved)		8					8
PCB044	103				35		138
PCB044 & 047 & 065		8					8
PCB044 & 047 & 065 (dissolved)		8					8
PCB044 (dissolved)	11						11
PCB045	103				35		138
PCB045 & 051		8					8
PCB045 & 051 (dissolved)		8					8
PCB045 (dissolved)	11						11
PCB046	103	8			35		146
PCB046 (dissolved)	11	8					19
PCB047	103				35		138
PCB047 (dissolved)	11						11
PCB048		8					8
PCB048 & 075	103				35		138
PCB048 & 075 (dissolved)	11						11
PCB048 (dissolved)		8					8
PCB049 & 069		8					8
PCB049 & 069 (dissolved)		8					8
PCB050	103				35		138
PCB050 & 053		8					8
PCB050 & 053 (dissolved)		8					8
PCB050 (dissolved)	11						11
PCB051	103				35		138
PCB051 (dissolved)	11						11
PCB052		8					8
PCB052 & 069	103				35		138
PCB052 & 069 (dissolved)	11						11
PCB052 (dissolved)		8					8
PCB053	103				35		138
PCB053 (dissolved)	11						11
PCB054	103	8			35		146
PCB054 (dissolved)	11	8					19
PCB055	103	8			35		146
PCB055 (dissolved)	11	8					19
PCB056		8					8
PCB056 & 060	103				35		138
PCB056 & 060 (dissolved)	11						11

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB056 (dissolved)		8					8
PCB057	103	8			35		146
PCB057 (dissolved)	11	8					19
PCB058	103	8			35		146
PCB058 (dissolved)	11	8					19
PCB059 & 062 & 075		8					8
PCB059 & 062 & 075 (dissolved)		8					8
PCB060		8					8
PCB060 (dissolved)		8					8
PCB061 & 070	103				35		138
PCB061 & 070 & 074 & 076		8					8
PCB061 & 070 & 074 & 076 (dissolved)		8					8
PCB061 & 070 (dissolved)	11						11
PCB062	103				35		138
PCB062 (dissolved)	11						11
PCB063	103	8			35		146
PCB063 (dissolved)	11	8					19
PCB064		8					8
PCB064 (dissolved)		8					8
PCB065	103				35		138
PCB065 (dissolved)	11						11
PCB066		8					8
PCB066 & 076	103				35		138
PCB066 & 076 (dissolved)	11						11
PCB066 (dissolved)		8					8
PCB067	103	8			35		146
PCB067 (dissolved)	11	8					19
PCB068	103	8			35		146
PCB068 (dissolved)	11	8					19
PCB072		8					8
PCB072 (dissolved)		8					8
PCB073	103	8			35		146
PCB073 (dissolved)	11	8					19
PCB074	103				35		138
PCB074 (dissolved)	11						11
PCB077	103	8			35		146
PCB077 (dissolved)	11	8					19
PCB078	103	8			35		146
PCB078 (dissolved)	11	8					19
PCB079	103	8			35		146
PCB079 (dissolved)	11	8					19
PCB080	103	8			35		146
PCB080 (dissolved)	11	8					19
PCB081	103	8			35		146
PCB081 (dissolved)	11	8					19
PCB082	103	8			35		146
PCB082 (dissolved)	11	8					19
PCB083	103				35		138
PCB083 & 099		8					8
PCB083 & 099 (dissolved)		8					8
PCB083 (dissolved)	11						11
PCB084		8					8
PCB084 & 092	103				35		138
PCB084 & 092 (dissolved)	11						11
PCB084 (dissolved)		8					8
PCB085 & 116	103				35		138
PCB085 & 116 & 117		8					8
PCB085 & 116 & 117 (dissolved)		8					8
PCB085 & 116 (dissolved)	11						11
PCB086	103				35		138
PCB086 & 087 & 097 & 108 & 119 & 125		8					8
PCB086 & 087 & 097 & 108 & 119 & 125 (dissolved)		8					8
PCB086 (dissolved)	11						11
PCB087 & 117 & 125	103				35		138

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB087 & 117 & 125 (dissolved)	11						11
PCB088 & 091	103	8			35		146
PCB088 & 091 (dissolved)	11	8					19
PCB089	103	8			35		146
PCB089 (dissolved)	11	8					19
PCB090 & 101	103				35		138
PCB090 & 101 & 113		8					8
PCB090 & 101 & 113 (dissolved)		8					8
PCB090 & 101 (dissolved)	11						11
PCB092		8					8
PCB092 (dissolved)		8					8
PCB093	103				35		138
PCB093 & 095 & 098 & 100 & 102		8					8
PCB093 & 095 & 098 & 100 & 102 (dissolved)		8					8
PCB093 (dissolved)	11						11
PCB094	103	8			35		146
PCB094 (dissolved)	11	8					19
PCB095 & 098 & 102	103				35		138
PCB095 & 098 & 102 (dissolved)	11						11
PCB096	103	8			35		146
PCB096 (dissolved)	11	8					19
PCB097	103				35		138
PCB097 (dissolved)	11						11
PCB099	103				35		138
PCB099 (dissolved)	11						11
PCB100	103				35		138
PCB100 (dissolved)	11						11
PCB103	103	8			35		146
PCB103 (dissolved)	11	8					19
PCB104	103	8			35		146
PCB104 (dissolved)	11	8					19
PCB105	103	8			35		146
PCB105 (dissolved)	11	8					19
PCB106		8					8
PCB106 & 118	103				35		138
PCB106 & 118 (dissolved)	11						11
PCB106 (dissolved)		8					8
PCB107 & 109	103				35		138
PCB107 & 109 (dissolved)	11						11
PCB107 & 124		8					8
PCB107 & 124 (dissolved)		8					8
PCB108 & 112	103				35		138
PCB108 & 112 (dissolved)	11						11
PCB109		8					8
PCB109 (dissolved)		8					8
PCB110	103				35		138
PCB110 & 115		8					8
PCB110 & 115 (dissolved)		8					8
PCB110 (dissolved)	11						11
PCB111		8					8
PCB111 & 115	103				35		138
PCB111 & 115 (dissolved)	11						11
PCB111 (dissolved)		8					8
PCB112		8					8
PCB112 (dissolved)		8					8
PCB113	103				35		138
PCB113 (dissolved)	11						11
PCB114	103	8			35		146
PCB114 (dissolved)	11	8					19
PCB118		8					8
PCB118 (dissolved)		8					8
PCB119	103				35		138
PCB119 (dissolved)	11						11
PCB120	103	8			35		146

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB120 (dissolved)	11	8					19
PCB121	103	8			35		146
PCB121 (dissolved)	11	8					19
PCB122	103	8			35		146
PCB122 (dissolved)	11	8					19
PCB123	103	8			35		146
PCB123 (dissolved)	11	8					19
PCB124	103				35		138
PCB124 (dissolved)	11						11
PCB126	103	8			35		146
PCB126 (dissolved)	11	8					19
PCB127	103	8			35		146
PCB127 (dissolved)	11	8					19
PCB128 & 162	103				35		138
PCB128 & 162 (dissolved)	11						11
PCB128 & 166		8					8
PCB128 & 166 (dissolved)		8					8
PCB129	103				35		138
PCB129 & 138 & 160 & 163		8					8
PCB129 & 138 & 160 & 163 (dissolved)		8					8
PCB129 (dissolved)	11						11
PCB130	103	8			35		146
PCB130 (dissolved)	11	8					19
PCB131	103	8			35		146
PCB131 (dissolved)	11	8					19
PCB132		8					8
PCB132 & 161	103				35		138
PCB132 & 161 (dissolved)	11						11
PCB132 (dissolved)		8					8
PCB133		8					8
PCB133 & 142	103				35		138
PCB133 & 142 (dissolved)	11						11
PCB133 (dissolved)		8					8
PCB134 & 143	103	8			35		146
PCB134 & 143 (dissolved)	11	8					19
PCB135	103				35		138
PCB135 & 151 & 154		8					8
PCB135 & 151 & 154 (dissolved)		8					8
PCB135 (dissolved)	11						11
PCB136	103	8			35		146
PCB136 (dissolved)	11	8					19
PCB137	103	8			35		146
PCB137 (dissolved)	11	8					19
PCB138 & 163 & 164	103				35		138
PCB138 & 163 & 164 (dissolved)	11						11
PCB139 & 140		8					8
PCB139 & 140 (dissolved)		8					8
PCB139 & 149	103				35		138
PCB139 & 149 (dissolved)	11						11
PCB140	103				35		138
PCB140 (dissolved)	11						11
PCB141	103	8			35		146
PCB141 (dissolved)	11	8					19
PCB142		8					8
PCB142 (dissolved)		8					8
PCB144	103	8			35		146
PCB144 (dissolved)	11	8					19
PCB145	103	8			35		146
PCB145 (dissolved)	11	8					19
PCB146		8					8
PCB146 & 165	103				35		138
PCB146 & 165 (dissolved)	11						11
PCB146 (dissolved)		8					8
PCB147	103				35		138

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB147 & 149		8					8
PCB147 & 149 (dissolved)		8					8
PCB147 (dissolved)	11						11
PCB148	103	8			35		146
PCB148 (dissolved)	11	8					19
PCB150	103	8			35		146
PCB150 (dissolved)	11	8					19
PCB151	103				35		138
PCB151 (dissolved)	11						11
PCB152	103	8			35		146
PCB152 (dissolved)	11	8					19
PCB153	103				35		138
PCB153 & 168		8					8
PCB153 & 168 (dissolved)		8					8
PCB153 (dissolved)	11						11
PCB154	103				35		138
PCB154 (dissolved)	11						11
PCB155	103	8			35		146
PCB155 (dissolved)	11	8					19
PCB156	103				35		138
PCB156 & 157		8					8
PCB156 & 157 (dissolved)		8					8
PCB156 (dissolved)	11						11
PCB157	103				35		138
PCB157 (dissolved)	11						11
PCB158		8					8
PCB158 & 160	103				35		138
PCB158 & 160 (dissolved)	11						11
PCB158 (dissolved)		8					8
PCB159	103	8			35		146
PCB159 (dissolved)	11	8					19
PCB161		8					8
PCB161 (dissolved)		8					8
PCB162		8					8
PCB162 (dissolved)		8					8
PCB164		8					8
PCB164 (dissolved)		8					8
PCB165		8					8
PCB165 (dissolved)		8					8
PCB166	103				35		138
PCB166 (dissolved)	11						11
PCB167	103	8			35		146
PCB167 (dissolved)	11	8					19
PCB168	103				35		138
PCB168 (dissolved)	11						11
PCB169	103	8			35		146
PCB169 (dissolved)	11	8					19
PCB170	103	8			35		146
PCB170 (dissolved)	11	8					19
PCB171	103				35		138
PCB171 & 173		8					8
PCB171 & 173 (dissolved)		8					8
PCB171 (dissolved)	11						11
PCB172	103	8			35		146
PCB172 (dissolved)	11	8					19
PCB173	103				35		138
PCB173 (dissolved)	11						11
PCB174	103	8			35		146
PCB174 (dissolved)	11	8					19
PCB175	103	8			35		146
PCB175 (dissolved)	11	8					19
PCB176	103	8			35		146
PCB176 (dissolved)	11	8					19
PCB177	103	8			35		146

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
PCB177 (dissolved)	11	8					19
PCB178	103	8			35		146
PCB178 (dissolved)	11	8					19
PCB179	103	8			35		146
PCB179 (dissolved)	11	8					19
PCB180	103				35		138
PCB180 & 193		8					8
PCB180 & 193 (dissolved)		8					8
PCB180 (dissolved)	11						11
PCB181	103	8			35		146
PCB181 (dissolved)	11	8					19
PCB182		8					8
PCB182 & 187	103				35		138
PCB182 & 187 (dissolved)	11						11
PCB182 (dissolved)		8					8
PCB183	103				35		138
PCB183 & 185		8					8
PCB183 & 185 (dissolved)		8					8
PCB183 (dissolved)	11						11
PCB184	103	8			35		146
PCB184 (dissolved)	11	8					19
PCB185	103				35		138
PCB185 (dissolved)	11						11
PCB186	103	8			35		146
PCB186 (dissolved)	11	8					19
PCB187		8					8
PCB187 (dissolved)		8					8
PCB188	103	8			35		146
PCB188 (dissolved)	11	8					19
PCB189	103	8			35		146
PCB189 (dissolved)	11	8					19
PCB190	103	8			35		146
PCB190 (dissolved)	11	8					19
PCB191	103	8			35		146
PCB191 (dissolved)	11	8					19
PCB192	103	8			35		146
PCB192 (dissolved)	11	8					19
PCB193	103				35		138
PCB193 (dissolved)	11						11
PCB194	103	8			35		146
PCB194 (dissolved)	11	8					19
PCB195	103	8			35		146
PCB195 (dissolved)	11	8					19
PCB196		8					8
PCB196 & 203	103				35		138
PCB196 & 203 (dissolved)	11						11
PCB196 (dissolved)		8					8
PCB197	103				35		138
PCB197 & 200		8					8
PCB197 & 200 (dissolved)		8					8
PCB197 (dissolved)	11						11
PCB198	103				35		138
PCB198 & 199		8					8
PCB198 & 199 (dissolved)		8					8
PCB198 (dissolved)	11						11
PCB199	103				35		138
PCB199 (dissolved)	11						11
PCB200	103				35		138
PCB200 (dissolved)	11						11
PCB201	103	8			35		146
PCB201 (dissolved)	11	8					19
PCB202	103	8			35		146
PCB202 (dissolved)	11	8					19
PCB203		8					8

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
PCB203 (dissolved)		8					8
PCB204	103	8			35		146
PCB204 (dissolved)	11	8					19
PCB205	103	8			35		146
PCB205 (dissolved)	11	8					19
PCB206	103	8			35		146
PCB206 (dissolved)	11	8					19
PCB207	103	8			35		146
PCB207 (dissolved)	11	8					19
PCB208	103	8			35		146
PCB208 (dissolved)	11	8					19
PCB209	103	8			35		146
PCB209 (dissolved)	11	8					19
Total PCB Congeners	98	8			35		141
Total PCB Congeners (dissolved)	11	8					19
PCB Homologs							
Dichlorobiphenyl homologs	98	8			35		141
Dichlorobiphenyl homologs (dissolved)	11	8					19
Heptachlorobiphenyl homologs	98	8			35		141
Heptachlorobiphenyl homologs (dissolved)	11	8					19
Hexachlorobiphenyl homologs	98	8		2	35		143
Hexachlorobiphenyl homologs (dissolved)	11	8					19
Monochlorobiphenyl homologs	98	8			35		141
Monochlorobiphenyl homologs (dissolved)	11	8					19
Nonachlorobiphenyl homologs	98	8			35		141
Nonachlorobiphenyl homologs (dissolved)	11	8					19
Octachlorobiphenyl homologs	98	8			35		141
Octachlorobiphenyl homologs (dissolved)	11	8					19
Pentachlorobiphenyl homologs	98	8			35		141
Pentachlorobiphenyl homologs (dissolved)	11	8					19
Tetrachlorobiphenyl homologs	98	8			35		141
Tetrachlorobiphenyl homologs (dissolved)	11	8					19
Trichlorobiphenyl homologs	98	8			35		141
Trichlorobiphenyl homologs (dissolved)	11	8					19
PCDD/Fs							
1,2,3,4,6,7,8-Heptachlorodibenzofuran				6			6
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				6			6
1,2,3,4,7,8,9-Heptachlorodibenzofuran				6			6
1,2,3,4,7,8-Hexachlorodibenzofuran				6			6
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin				6			6
1,2,3,6,7,8-Hexachlorodibenzofuran				6			6
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin				6			6
1,2,3,7,8,9-Hexachlorodibenzofuran				6			6
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin				6			6
1,2,3,7,8-Pentachlorodibenzofuran				6			6
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				6			6
2,3,4,6,7,8-Hexachlorodibenzofuran				6			6
2,3,4,7,8-Pentachlorodibenzofuran				6			6
2,3,7,8-Tetrachlorodibenzofuran				6			6
2,3,7,8-Tetrachlorodibenzo-p-dioxin				6			6
Dioxin/furan TCDD toxicity equivalent (ND = 0)				6			6
Total TCDD toxicity equivalent (ND = 0)	98	8		6	35		147
Total TCDD toxicity equivalent (ND = 0) (dissolved)	11	8					19
PCDD/F Homologs							
Heptachlorodibenzofuran homologs				4			4
Heptachlorodibenzo-p-dioxin homologs				4			4
Hexachlorodibenzofuran homologs				4			4
Hexachlorodibenzo-p-dioxin homologs				4			4
Octachlorodibenzofuran				6			6
Octachlorodibenzo-p-dioxin				6			6
Pentachlorodibenzofuran homologs				4			4
Pentachlorodibenzo-p-dioxin homologs				4			4
Tetrachlorodibenzofuran homologs				4			4

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
Tetrachlorodibenzo-p-dioxin homologs				4			4
Total PCDD/F				4			4
Pesticides							
2,4'-DDD	11		23	6	29	8	77
2,4'-DDD (dissolved)	2		16				18
2,4'-DDE	11		23	6	29	8	77
2,4'-DDE (dissolved)	2		16				18
2,4'-DDT	11		23	6	29	8	77
2,4'-DDT (dissolved)	2		16				18
4,4'-DDD	11		23	14	29	8	85
4,4'-DDD (dissolved)	2		16				18
4,4'-DDE	11		23	14	29	8	85
4,4'-DDE (dissolved)	2		16				18
4,4'-DDT	11		23	14	29	8	85
4,4'-DDT (dissolved)	2		16				18
Aldrin	11		23	14	29		77
Aldrin (dissolved)	2		16				18
alpha-Endosulfan	11		23	14	29		77
alpha-Endosulfan (dissolved)	2		16				18
alpha-Hexachlorocyclohexane	11		23	14	29		77
alpha-Hexachlorocyclohexane (dissolved)	2		16				18
beta-Endosulfan	11		23	14	29		77
beta-Endosulfan (dissolved)	2		16				18
beta-Hexachlorocyclohexane	11		23	14	29		77
beta-Hexachlorocyclohexane (dissolved)	2		16				18
Bromoxynil				4			4
Chlordane (technical)			12	6			18
Chlordane (technical) (dissolved)			9				9
Chlordecone				2			2
cis-Chlordane	11		23	12	29		75
cis-Chlordane (dissolved)	2		16				18
cis-Nonachlor	11		23	4	29		67
cis-Nonachlor (dissolved)	2		16				18
delta-Hexachlorocyclohexane	11		23	14	29		77
delta-Hexachlorocyclohexane (dissolved)	2		16				18
Dieldrin	11		23	14	29		77
Dieldrin (dissolved)	2		16				18
Endosulfan sulfate	11		23	14	29		77
Endosulfan sulfate (dissolved)	2		16				18
Endrin	11		23	14	29		77
Endrin (dissolved)	2		16				18
Endrin aldehyde	11		23	14	29		77
Endrin aldehyde (dissolved)	2		16				18
Endrin ketone	11		23	14	29		77
Endrin ketone (dissolved)	2		16				18
gamma-Hexachlorocyclohexane	11		23	14	29		77
gamma-Hexachlorocyclohexane (dissolved)	2		16				18
Heptachlor	11		23	14	29		77
Heptachlor (dissolved)	2		16				18
Heptachlor epoxide	11		23	14	29		77
Heptachlor epoxide (dissolved)	2		16				18
Isobenzan				2			2
Methoxychlor	11		23	14	29		77
Methoxychlor (dissolved)	2		16				18
Mirex	11		23	2	29		65
Mirex (dissolved)	2		16				18
Oxychlordane	11		23	4	29		67
Oxychlordane (dissolved)	2		16				18
Total Chlordanes	11		23	12	29		75
Total Chlordanes (dissolved)	2		16				18
Total Endosulfan	11		23	14	29		77
Total Endosulfan (dissolved)	2		16				18
Total of 2,4' and 4,4'-DDD	11		23	14	29	8	85
Total of 2,4' and 4,4'-DDD (dissolved)	2		16				18

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	11		23	14	29	8	85
Total of 2,4' and 4,4'-DDD, -DDE, -DDT (dissolved)	2		16				18
Total of 2,4' and 4,4'-DDE	11		23	14	29	8	85
Total of 2,4' and 4,4'-DDE (dissolved)	2		16				18
Total of 2,4' and 4,4'-DDT	11		23	14	29	8	85
Total of 2,4' and 4,4'-DDT (dissolved)	2		16				18
Total of 4,4'-DDD, -DDE, -DDT				6		8	14
Toxaphene	11		23	10	29		73
Toxaphene (dissolved)	2		16				18
trans-Chlordane	11		23	12	29		75
trans-Chlordane (dissolved)	2		16				18
trans-Nonachlor	11		23	4	29		67
trans-Nonachlor (dissolved)	2		16				18
Herbicides							
2,4,5-T	89			6	17		112
2,4,5-T (dissolved)	10						10
2,4-D	89			6	17		112
2,4-D (dissolved)	10						10
2,4-DB	89			6	17		112
2,4-DB (dissolved)	10						10
Dalapon	89			6	17		112
Dalapon (dissolved)	10						10
Dicamba	89			6	17		112
Dicamba (dissolved)	10						10
Dichloroprop	89			6	17		112
Dichloroprop (dissolved)	10						10
Dinoseb	89			6	17		112
Dinoseb (dissolved)	10						10
MCPA	89			6	17		112
MCPA (dissolved)	10						10
MCPP	89			6	17		112
MCPP (dissolved)	10						10
Silvex	89			6	17		112
Silvex (dissolved)	10						10
Polycyclic Aromatic Hydrocarbons							
1,6,7-Trimethylnaphthalene						8	8
1-Methylnaphthalene				18		8	26
1-Methylphenanthrene						8	8
2,6-Dimethylnaphthalene						8	8
2-Methylnaphthalene	103	8	29	55	22	8	225
2-Methylnaphthalene (dissolved)	11	8	21	1			41
Acenaphthene	103	8	29	131	22	8	301
Acenaphthene (dissolved)	11	8	21	1			41
Acenaphthylene	103	8	29	131	22	8	301
Acenaphthylene (dissolved)	11	8	21	1			41
Anthracene	103	8	29	131	22	8	301
Anthracene (dissolved)	11	8	21	1			41
Benzo(a)anthracene	103	8	29	131	22	8	301
Benzo(a)anthracene (dissolved)	11	8	21	1			41
Benzo(a)pyrene	103	8	29	131	22	8	301
Benzo(a)pyrene (dissolved)	11	8	21	1			41
Benzo(b)fluoranthene	103	8	29	125	22	8	295
Benzo(b)fluoranthene (dissolved)	11	8	21	1			41
Benzo(b+k)fluoranthene				5		8	13
Benzo(e)pyrene						8	8
Benzo(g,h,i)perylene	103	8	29	131	22	8	301
Benzo(g,h,i)perylene (dissolved)	11	8	21	1			41
Benzo(k)fluoranthene	103	8	29	125	22	8	295
Benzo(k)fluoranthene (dissolved)	11	8	21	1			41
Benzofluoranthenes				8			8
Chrysene	103	8	29	131	22	8	301
Chrysene (dissolved)	11	8	21	1			41
Dibenzo(a,h)anthracene	103	8	29	131	22	8	301

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	LWG	GE	Port of Portland Terminal 4	Additional Data from Other Parties	LWG	Port of Portland Terminal 4	Grand Total
Dibenzo(a,h)anthracene (dissolved)	11	8	21	1			41
Fluoranthene	103	8	29	131	22	8	301
Fluoranthene (dissolved)	11	8	21	1			41
Fluorene	103	8	29	131	22	8	301
Fluorene (dissolved)	11	8	21	1			41
High Molecular Weight PAH	103	8	29	107	22	8	277
High Molecular Weight PAH (dissolved)	11	8	21	1			41
Indeno(1,2,3-cd)pyrene	103	8	29	131	22	8	301
Indeno(1,2,3-cd)pyrene (dissolved)	11	8	21	1			41
Low Molecular Weight PAH	103	8	29	107	22	8	277
Low Molecular Weight PAH (dissolved)	11	8	21	1			41
Naphthalene	103	8	29	140	22	8	310
Naphthalene (dissolved)	11	8	21	1			41
Perylene						8	8
Phenanthrene	103	8	29	131	22	8	301
Phenanthrene (dissolved)	11	8	21	1			41
Pyrene	103	8	29	131	22	8	301
Pyrene (dissolved)	11	8	21	1			41
Total cPAHs	103	8	18	130	22	8	289
Total cPAHs (dissolved)	11	8	11	1			31
Total PAHs	103	8	29	107	22	8	277
Total PAHs (dissolved)	11	8	21	1			41
Phthalates							
Bis(2-ethylhexyl) phthalate	48	7	26	101	22	8	212
Bis(2-ethylhexyl) phthalate (dissolved)	8	7	6				21
Butylbenzyl phthalate	48	7	26	101	22	8	212
Butylbenzyl phthalate (dissolved)	8	7	6				21
Dibutyl phthalate	48	7	26	98	22	8	209
Dibutyl phthalate (dissolved)	8	7	6				21
Diethyl phthalate	48	7	26	95	22	8	206
Diethyl phthalate (dissolved)	8	7	6				21
Dimethyl phthalate	48	7	26	94	22	8	205
Dimethyl phthalate (dissolved)	8	7	6				21
Di-n-octyl phthalate	48	7	26	96	22	8	207
Di-n-octyl phthalate (dissolved)	8	7	6				21
Semivolatile Organic Compounds							
1,2,4-Trichlorobenzene				46			46
1,2-Dichlorobenzene				49			49
1,3-Dichlorobenzene				49			49
1,4-Dichlorobenzene				49			49
2,4-Dinitrotoluene				27			27
2,6-Dinitrotoluene				27			27
2-Chloronaphthalene				27			27
2-Nitroaniline				27			27
3,3'-Dichlorobenzidine				24			24
3-Nitroaniline				27			27
4-Bromophenyl phenyl ether				27			27
4-Chloroaniline				27			27
4-Chlorophenyl phenyl ether				27			27
4-Nitroaniline				25			25
Aniline				10			10
Benzoic acid				26			26
Benzyl alcohol				27			27
Bis(2-chloroethoxy) methane				27			27
Bis(2-chloroethyl) ether				27			27
Bis(2-chloroisopropyl) ether				30			30
Carbazole				17			17
Dibenzofuran	68		8	37	22		135
Dibenzofuran (dissolved)	11		8				19
Diethylnitrosamine				2			2
Diphenyl						8	8
Hexachlorobenzene	11		23	27	29		90
Hexachlorobenzene (dissolved)	2		16				18

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
Hexachlorobutadiene	11		23	46	29		109
Hexachlorobutadiene (dissolved)	2		16				18
Hexachlorocyclopentadiene				27			27
Hexachloroethane	11		23	27	29		90
Hexachloroethane (dissolved)	2		16				18
Isophorone				27			27
Nitrobenzene				27			27
N-Nitrosodimethylamine				8			8
N-Nitrosodiphenylamine				27			27
N-Nitrosodipropylamine				27			27
Phenols							
2,3,4,6-Tetrachlorophenol				8			8
2,4,5-Trichlorophenol				28			28
2,4,6-Trichlorophenol				28			28
2,4-Dichlorophenol				28			28
2,4-Dimethylphenol				27			27
2,4-Dinitrophenol				27			27
2,6-Dichlorophenol				4			4
2-Chlorophenol				28			28
2-Methylphenol				28			28
2-Nitrophenol				28			28
3- and 4-Methylphenol Coelution				24			24
4,6-Dinitro-2-methylphenol				28			28
4-Chloro-3-methylphenol				28			28
4-Methylphenol				11			11
4-Nitrophenol				28			28
Pentachlorophenol				28			28
Phenol				28			28
Tetrachlorophenol				4			4
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane				28			28
1,1,1-Trichloroethane				30			30
1,1,2,2-Tetrachloroethane				28			28
1,1,2-Trichloroethane				28			28
1,1-Dichloroethane				30			30
1,1-Dichloroethene				33			33
1,1-Dichloropropene				28			28
1,2,3-Trichlorobenzene				28			28
1,2,3-Trichloropropane				28			28
1,2,4-Trimethylbenzene				47			47
1,2-Dibromo-3-chloropropane				28			28
1,2-Dichloroethane				31			31
1,2-Dichloropropane				28			28
1,3,5-Trimethylbenzene				47			47
1,3-Dichloropropane				28			28
1-Methyl-4-isopropylbenzene				26			26
2,2-Dichloropropane				28			28
2-Chlorotoluene				28			28
2-Ethyl-1-hexanol				4			4
4-Chlorotoluene				28			28
Acetone				49			49
Acrylonitrile				6			6
Benzene				51			51
Bromobenzene				28			28
Bromochloromethane				28			28
Bromodichloromethane				28			28
Bromoform				28			28
Bromomethane				28			28
BTEX				33			33
Carbon disulfide				24			24
Carbon tetrachloride				28			28
Chlorobenzene				31			31
Chlorodibromomethane				28			28

Table 2.2-6. Summary of Stormwater Sample Counts in the RI Data Set.

	Stormwater[a]				Stormwater Outfall Sediment Trap		
Analyte	**LWG**	**GE**	**Port of Portland Terminal 4**	**Additional Data from Other Parties**	**LWG**	**Port of Portland Terminal 4**	**Grand Total**
Chloroethane				45			45
Chloroform				29			29
Chloromethane				28			28
cis-1,2-Dichloroethene				31			31
cis-1,3-Dichloropropene				28			28
Dichlorodifluoromethane				28			28
Ethylbenzene				51			51
Ethylene dibromide				31			31
Isobutyl alcohol				6			6
Isopropylbenzene				48			48
m,p-Xylene				27			27
Methyl iodide				4			4
Methyl isobutyl ketone				28			28
Methyl n-butyl ketone				28			28
Methyl tert-butyl ether				19			19
Methylene bromide				28			28
Methylene chloride				28			28
Methylethyl ketone				45			45
Methylisopropylbenzene				2			2
n-Butylbenzene				28			28
n-Propylbenzene				39			39
o-Xylene				27			27
Sec-butylbenzene				40			40
Styrene				27			27
tert-Butylbenzene				28			28
Tetrachloroethene				30			30
Toluene				52			52
trans-1,2-Dichloroethene				31			31
trans-1,3-Dichloropropene				28			28
Trichloroethene				31			31
Trichlorofluoromethane				28			28
Vinyl chloride				31			31
Xylene				50			50
Petroleum							
Diesel-Range Hydrocarbons		8		98		8	114
Diesel-Range Hydrocarbons (dissolved)		8		1			9
Gasoline-Range Hydrocarbons				60		8	68
Heavy oil				7			7
Heavy-Oil Range Hydrocarbons				91			91
Heavy-Oil Range Hydrocarbons (dissolved)				1			1
Oil And Grease				43			43
Residual-Range Hydrocarbons				11		8	19
Total Petroleum Hydrocarbons			30	75		8	113
Total Petroleum Hydrocarbons (dissolved)				1			1
Grand Total	27,810	3,487	3,923	10,983	8,471	623	55,297

Notes:

[a] GE and Terminal 4 stormwater data are considered part of the LWG's complete stormwater data set. Other stormwater data are available to confirm loading calculations in the fate and transport model. Sediment trap data collected by other parties are not included in Section 5.

BTEX - benzene, toluene, ethylbenzene, and total xylene
GE - General Electric
LWG - Lower Willamette Group
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
RI - remedial investigation

Table 2.2-7. Summary of Transition Zone Water Sample Counts in the RI Data Set.

	LWG					Other Parties			
	≤38 cm BML			> 38 cm BML		≤38 cm BML	> 38 cm BML		
	Push Probe [a]		Small Volume Peeper	Push Probe [a]		Push Probe [a]	Push Probe [a]		
Analyte	**filtered**	**unfiltered**	**unfiltered**	**filtered**	**unfiltered**	**unfiltered**	**unfiltered**	**Unknown**	**Grand Total**
Conventionals									
Alkalinity	13	65	36	8	31			13	166
Calcium carbonate							76		76
Carbon dioxide						1	77		78
Chloride	13	65	36	8	31		76	13	242
Conductivity		51		7	26	41	97		222
Cyanide		11	10		3	13	11	13	61
Cyanide amenable to chlorination								13	13
Dissolved organic carbon								13	13
Dissolved oxygen						40	97		137
Ethane						1	77		78
Ethylene						1	77		78
Free cyanide								13	13
Methane						1	77		78
Nitrate							76		76
Nitrite							76		76
Oxidation-Reduction Potential		44			18	41	97		200
Perchlorate	5	17	12	1	7				42
pH	13	67	36	8	32	41	97		294
Phosphorus							74		74
Sulfate	13	65	36	8	31		76	13	242
Sulfide							76	13	89
Temperature						41	97		138
Total dissolved solids		50			19				69
Total organic carbon							76	13	89
Total suspended solids							55		55
Turbidity		51			18		36		105
Metals									
Aluminum	57	60	35	12	24				188
Antimony	57	60	35	12	24	13	11		212
Arsenic	60	64	39	19	31	13	11		237
Barium	57	60	35	12	24				188
Beryllium	57	60	35	12	24				188
Cadmium	57	60	35	12	24				188
Calcium	69	67	43	20	26			18	243
Chromium	62	65	39	13	25	13	11		228
Cobalt						13	11		24
Copper	50	53	39	19	25	13	11		210
Iron	57	60	35	12	24	13	15	18	234
Lead	60	64	39	19	31	13	11		237
Magnesium	69	67	43	20	26	13	11	18	267
Manganese	69	69	43	20	32	13	15	18	279
Mercury	57	60	35	12	24				188
Nickel	57	60	35	12	24	13	11		212
Potassium	69	67	43	20	26			18	243
Selenium	57	60	35	12	24	13	11		212
Silver	57	60	35	12	24	13	11		212
Sodium	69	67	43	20	26			18	243
Thallium	57	60	35	12	24				188
Titanium						13	11		24
Vanadium						13	11		24
Zinc	60	64	39	19	31	13	11		237
PCDD/Fs									
1,2,3,4,6,7,8-Heptachlorodibenzofuran	3	3							6
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	3	3							6
1,2,3,4,7,8,9-Heptachlorodibenzofuran	3	3							6
1,2,3,4,7,8-Hexachlorodibenzofuran	3	3							6
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3	3							6
1,2,3,6,7,8-Hexachlorodibenzofuran	3	3							6
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3	3							6
1,2,3,7,8,9-Hexachlorodibenzofuran	3	3							6
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3	3							6
1,2,3,7,8-Pentachlorodibenzofuran	3	3							6
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	3	3							6
2,3,4,6,7,8-Hexachlorodibenzofuran	3	3							6
2,3,4,7,8-Pentachlorodibenzofuran	3	3							6
2,3,7,8-Tetrachlorodibenzofuran	3	3							6
2,3,7,8-Tetrachlorodibenzo-p-dioxin	3	3							6
Dioxin/furan TCDD toxicity equivalent (ND = 0)	3	3							6
Total TCDD toxicity equivalent (ND = 0)	3	3							6

Table 2.2-7. Summary of Transition Zone Water Sample Counts in the RI Data Set.

	LWG					Other Parties			
	≤ 38 cm BML			> 38 cm BML		≤ 38 cm BML	> 38 cm BML		
	Push Probe [a]		Small Volume Peeper	Push Probe [a]		Push Probe [a]	Push Probe [a]		
Analyte	filtered	unfiltered	unfiltered	filtered	unfiltered	unfiltered	unfiltered	Unknown	Grand Total
PCDD/F Homologs									
Heptachlorodibenzofuran homologs	3	3							6
Heptachlorodibenzo-p-dioxin homologs	3	3							6
Hexachlorodibenzofuran homologs	3	3							6
Hexachlorodibenzo-p-dioxin homologs	3	3							6
Octachlorodibenzofuran	3	3							6
Octachlorodibenzo-p-dioxin	3	3							6
Pentachlorodibenzofuran homologs	3	3							6
Pentachlorodibenzo-p-dioxin homologs	3	3							6
Tetrachlorodibenzofuran homologs	3	3							6
Tetrachlorodibenzo-p-dioxin homologs	3	3							6
Total PCDD/F	3	3							6
Pesticides									
2,4'-DDD	4	6	4	1	4				19
2,4'-DDE	4	6	4	1	4				19
2,4'-DDT	4	6	4	1	4				19
4,4'-DDD	8	10	8	1	4				31
4,4'-DDE	8	10	8	1	4				31
4,4'-DDT	8	10	8	1	4				31
Total of 2,4' and 4,4'-DDD	8	10	8	1	4				31
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	8	10	8	1	4				31
Total of 2,4' and 4,4'-DDE	8	10	8	1	4				31
Total of 2,4' and 4,4'-DDT	8	10	8	1	4				31
Total of 4,4'-DDD, -DDE, -DDT	8	10	8	1	4				31
Herbicides									
2,4,5-T	6	7	2	1	2				18
2,4-D	6	7	2	1	2				18
2,4-DB			2						2
Dalapon			2						2
Dicamba			2						2
Dichloroprop	6	7	2	1	2				18
Dinoseb			2						2
MCPA			2						2
MCPP			2						2
Silvex	6	7	2	1	2				18
Polycyclic Aromatic Hydrocarbons									
2-Methylnaphthalene	39	42	24	11	17		11	13	157
Acenaphthene	39	42	24	11	17	13	11	13	170
Acenaphthylene	39	42	24	11	17	13	11	13	170
Anthracene	39	42	24	11	17	13	11	13	170
Benzo(a)anthracene	39	42	24	11	17	13	11	13	170
Benzo(a)pyrene	39	42	24	11	17	13	11	13	170
Benzo(b)fluoranthene	39	42	24	11	17	13	11	13	170
Benzo(g,h,i)perylene	39	42	24	11	17	13	11	13	170
Benzo(k)fluoranthene	39	42	24	11	17	13	11	13	170
Chrysene	39	42	24	11	17	13	11	13	170
Dibenzo(a,h)anthracene	39	42	24	11	17	13	11	13	170
Fluoranthene	39	42	24	11	17	13	11	13	170
Fluorene	39	42	24	11	17	13	11	13	170
High Molecular Weight PAH	39	42	24	11	17	13	11	13	170
Indeno(1,2,3-cd)pyrene	39	42	24	11	17	13	11	13	170
Low Molecular Weight PAH	39	42	24	11	17	13	11	13	170
Naphthalene	39	70	43	11	32	41	115	18	369
Phenanthrene	39	42	24	11	17	13	11	13	170
Pyrene	39	42	24	11	17	13	11	13	170
Total cPAHs	39	42	24	11	17	13	11	13	170
Total PAHs	39	41	24	11	17	13	11	13	169
Phthalates									
Bis(2-ethylhexyl) phthalate							11		11
Butylbenzyl phthalate							11		11
Dibutyl phthalate							11		11
Diethyl phthalate							11		11
Dimethyl phthalate							11		11
Di-n-octyl phthalate							11		11
Semivolatile Organic Compounds									
1,2,4-Trichlorobenzene		62	39		31	41	115	18	306
1,2-Dichlorobenzene		62	39		31	41	115	18	306
1,3-Dichlorobenzene		62	39		31	41	115	18	306
1,4-Dichlorobenzene		62	39		27	41	115	18	302

Table 2.2-7. Summary of Transition Zone Water Sample Counts in the RI Data Set.

	LWG					Other Parties			
	≤ 38 cm BML			> 38 cm BML		≤ 38 cm BML	> 38 cm BML		
	Push Probe [a]		Small Volume Peeper	Push Probe [a]		Push Probe [a]	Push Probe [a]		
Analyte	filtered	unfiltered	unfiltered	filtered	unfiltered	unfiltered	unfiltered	Unknown	Grand Total
2,4-Dinitrotoluene							11		11
2,6-Dinitrotoluene							11		11
2-Chloronaphthalene							11		11
2-Nitroaniline							11		11
3,3'-Dichlorobenzidine							11		11
3-Nitroaniline							11		11
4-Bromophenyl phenyl ether							11		11
4-Chloroaniline							11		11
4-Chlorophenyl phenyl ether							11		11
4-Nitroaniline							11		11
Benzoic acid							11		11
Benzyl alcohol							11		11
Bis(2-chloroethoxy) methane							11		11
Bis(2-chloroethyl) ether							11		11
Bis(2-chloroisopropyl) ether							11		11
Carbazole							11		11
Dibenzofuran	39	42	24	11	17		11	13	157
Hexachlorobenzene							11		11
Hexachlorobutadiene		62	39		31	41	115	18	306
Hexachlorocyclopentadiene							11		11
Hexachloroethane							11		11
Isophorone							11		11
Nitrobenzene							11		11
N-Nitrosodimethylamine							11		11
N-Nitrosodiphenylamine							11		11
N-Nitrosodipropylamine							11		11
Pyridine							11		11
Phenols									
2,4,5-Trichlorophenol							11		11
2,4,6-Trichlorophenol							11		11
2,4-Dichlorophenol							11		11
2,4-Dimethylphenol							11		11
2,4-Dinitrophenol							11		11
2-Chlorophenol							11		11
2-Methylphenol							11		11
2-Nitrophenol							11		11
3- and 4-Methylphenol Coelution							11		11
4,6-Dinitro-2-methylphenol							11		11
4-Chloro-3-methylphenol							11		11
4-Nitrophenol							11		11
Pentachlorophenol							11		11
Phenol							11		11
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane		70	39		31	41	113	18	312
1,1,1-Trichloroethane		70	39		31	41	113	18	312
1,1,2,2-Tetrachloroethane		70	39		31	41	113	18	312
1,1,2-Trichloroethane		70	39		31	41	113	18	312
1,1-Dichloroethane		70	39		31	41	113	18	312
1,1-Dichloroethene		70	39		31	41	113	18	312
1,1-Dichloropropene						41	113		154
1,2,3-Trichlorobenzene						41	113		154
1,2,3-Trichloropropane		70	39		31	41	113	18	312
1,2,4-Trimethylbenzene						41	113		154
1,2-Dibromo-3-chloropropane						41	113		154
1,2-Dichloroethane		70	39		31	41	113	18	312
1,2-Dichloropropane		70	39		31	41	113	18	312
1,3,5-Trimethylbenzene						41	113		154
1,3-Dichloropropane						41	113		154
1,4-Dichloro-trans-2-butene		70	39		31			18	158
1,4-Difluorobenzene		8			4				12
1-Methyl-4-isopropylbenzene						41	113		154
2,2-Dichloropropane						41	113		154
2-Chloroethyl vinyl ether		70	39		31			18	158
2-Chlorotoluene						41	113		154
4-Chlorotoluene						41	113		154
Acetone		70	39		31	41	113	18	312
Acrolein		70	39		31			18	158
Acrylonitrile		70	39		31	41	113	18	312
Benzene		70	43		31	41	113	18	316
Bromobenzene						41	113		154

Table 2.2-7. Summary of Transition Zone Water Sample Counts in the RI Data Set.

	LWG					Other Parties			
	≤38 cm BML			> 38 cm BML		≤38 cm BML	> 38 cm BML		
	Push Probe [a]		Small Volume Peeper	Push Probe [a]		Push Probe [a]	Push Probe [a]		
Analyte	filtered	unfiltered	unfiltered	filtered	unfiltered	unfiltered	unfiltered	Unknown	Grand Total
Bromochloromethane		70	39		31	41	113	18	312
Bromodichloromethane		70	39		31	41	113	18	312
Bromoform		70	39		31	41	113	18	312
Bromomethane		70	39		31	41	113	18	312
BTEX		70	43		31	41	113	18	316
Carbon disulfide		70	39		31	41	113	18	312
Carbon tetrachloride		70	39		31	41	113	18	312
Chlorobenzene		70	39		31	41	113	18	312
Chlorodibromomethane		70	39		31	41	113	18	312
Chloroethane		70	39		31	41	113	18	312
Chloroform		70	39		31	41	113	18	312
Chloromethane		70	39		31	41	113	18	312
cis-1,2-Dichloroethene		62	35		24	41	113		275
cis-1,3-Dichloropropene		70	39		31	41	113	18	312
Dichlorodifluoromethane		70	39		31	41	113	18	312
Ethylbenzene		70	43		31	41	113	18	316
Ethylene dibromide		70	39		31	41	113	18	312
Isopropylbenzene		70	39		31	41	113	18	312
m,p-Xylene		70	43		31	41	113	18	316
Methyl iodide		70	39		31			18	158
Methyl isobutyl ketone		70	39		31	41	113	18	312
Methyl n-butyl ketone		70	39		31	41	113	18	312
Methyl tert-butyl ether		70	39		31	41	113	18	312
Methylene bromide		70	39		31	41	113	18	312
Methylene chloride		70	39		31	41	113	18	312
Methylethyl ketone		70	39		31	41	113	18	312
n-Butylbenzene						41	113		154
n-Propylbenzene						41	113		154
o-Xylene		70	43		31	41	113	18	316
Sec-butylbenzene						41	113		154
Styrene		70	39		31	41	113	18	312
tert-Butylbenzene						41	113		154
Tetrachloroethene		70	39		31	41	113	18	312
Toluene		70	43		31	41	113	18	316
trans-1,2-Dichloroethene		70	39		31	41	113	18	312
trans-1,3-Dichloropropene		70	39		31	41	113	18	312
Trichloroethene		70	39		31	41	113	18	312
Trichlorofluoromethane		70	39		31	41	113	18	312
Vinyl acetate		70	39		31			18	158
Vinyl chloride		70	39		31	41	113	18	312
Xylene		70	43		31	41	113	18	316
Petroleum									
Diesel-Range Hydrocarbons	36	38	21	12	17		11		135
Gasoline-Range Hydrocarbons		39	24		18				81
Lube Oil							11		11
Residual-Range Hydrocarbons	36	38	21	12	17				124
Total Petroleum Hydrocarbons	36	38	21	12	17				124
Grand Total	2,471	7,057	3,938	654	3,029	3,451	10,118	1,524	32,242

Notes:

[a] Push probes were collected using Trident® samplers.

BML - below mudline
BTEX - benzene, toluene, ethylbenzene, and total xylene
PAH - polycyclic aromatic hydrocarbon
PCDD/Fs - dioxins/furans
SVOC - semivolatile organic compound
VOC - volatile organic compound

Table 2.2-8. Biota Sample and Analysis Summary for the RI Data Set.

			Number of Samples										
Species	**Tissue Type**	**Task Description**	**Conven-tionals**	**Metals**	**Butyltins**	**Aroclors**	**PCB Congeners**	**PBDEs**	**PCDD/Fs**	**PCDD/F Homologs**	**Pesticides**	**PAHs**	**SVOCs**
Black crappie	Fillet	Round 1 tissue samples	4	4		4					4		4
Black crappie	Fillet without skin	Round 1 tissue samples		4									
Black crappie	Whole body	Round 1 tissue samples	4	4		4	4		4	4	4		4
Brown bullhead	Fillet without skin	Round 1 tissue samples	6	12		6					6	6	6
Brown bullhead	Whole body	Round 1 tissue samples	9	9		9	9		9	9	9	9	9
Carp	Fillet	Round 3B biota	9	9	9		9		9	9	9	9	9
Carp	Fillet	Round 1 tissue samples	6	6		6					6		6
Carp	Fillet without skin	Round 1 tissue samples		6									
Carp	Whole body	Round 1 tissue samples	6	6		6	6		6	6	6	6	6
Carp	Whole body	Round 1A tissue samples		1									
Carp	Whole body (calculated)	Round 3B biota	9	9	9		9		9	9	9	9	9
Chinook (adult)	Fillet	ODHS/EPA/ATSDR Fish Contaminant Study (ODHS et al. 2003)	3	3		3	3	3	3	3	3	3	3
Chinook (adult)	Fillet without skin	ODHS/EPA/ATSDR Fish Contaminant Study (ODHS et al. 2003)		3			3	3	3	3			
Chinook (adult)	Whole body	ODHS/EPA/ATSDR Fish Contaminant Study (ODHS et al. 2003)	4	4		4	4	4	4	4	4	4	4
Chinook (juvenile)	Stomach contents	Round 2A tissue, juvenile chinook					6		6		6	6	6
Chinook (juvenile)	Whole body	Round 2A tissue, juvenile chinook	12	12	11		12		12	12	12	12	12
Chinook (juvenile)	Whole body	Round 1A tissue samples	7	7		7					7	7	7
Clam	Body without shell	Round 2A benthic tissue	33	28	25		31		32	29	31	29	32
Clam	Body without shell	Round 3B biota	10	10	10		10		10	10	10	10	10
Clam	Body without shell	Round 1 tissue samples	3	3	2	3					3	3	3
Clam	Depurated w/o shell	Round 3B biota	5	5	4		5		5	5	5	5	5
Crayfish	Whole body	Round 3B biota	9	9	9		9		9	9	9	9	9
Crayfish	Whole body	Round 1 tissue samples	27	27		27	10		10	10	27	27	27
Lab clam	Body without shell	Round 2A benthic tissue	39	39	39		39		39	39	39	39	39
Lab clam	Body without shell	2005 O&M Dredge Sediment Characterization (Tetra Tech 2006)	14	14	14	14	14		11		14	14	14
Lamprey, ammocoetes	Whole body	Round 2B tissue, lamprey	1				1		1	1	1		1
Lamprey, ammocoetes	Whole body	Round 3 lamprey tissue composites	6	5	1		6		6	6	6	4	6
Lamprey, macropthalmia	Whole body	Round 3 lamprey tissue composites	3	3			3		3	3	3	3	3
Largescale sucker	Whole body	Round 1 tissue samples	6	6		6					6	6	6
Lumbriculus variegatus	Whole body	Round 2A benthic tissue	39	39	39		39		39	39	39	39	39
Lumbriculus variegatus	Whole body	2005 O&M Dredge Sediment Characterization (Tetra Tech 2006)	14	14	14	14	14		11		14	14	14
Multiplate invertebrates	Whole body	Round 2A tissue, multiplate	2	2			7		7	7	7		7
Mussel	Body without shell	Round 2B tissue, freshwater mussel	7	7	7		7		7	7	7	7	7
Northern pikeminnow	Whole body	Round 1 tissue samples	6	6		6					6		6
Pacific lamprey	Whole body	ODHS/EPA/ATSDR Fish Contaminant Study (ODHS et al. 2003)	4	4		4	4	4	4	4	4	4	4
Peamouth	Whole body	Round 1 tissue samples	4	4		4					4		4
Sculpin	Whole body	Round 3B biota	16	16	16		16		16	16	16	16	16
Sculpin	Whole body	Round 1 tissue samples	26	27		26	9		9	9	26	26	26
Smallmouth bass	Fillet	Round 3B biota	18	18	18		18		18	18	18	18	18
Smallmouth bass	Fillet	Round 1 tissue samples	5	5		5					5		5
Smallmouth bass	Fillet without skin	Round 1 tissue samples		5									
Smallmouth bass	Whole body	Round 1 tissue samples	20	20		20	20		20	20	20	20	20
Smallmouth bass	Whole body (calculated)	Round 3B biota	18	18	18		18		18	18	18	18	18
Sturgeon	Fillet without skin	ODHS/EPA/ATSDR Fish Contaminant Study (ODHS et al. 2003)	5	5		5	5	5	5	5	5	5	5
Sturgeon (juvenile)	Stomach contents	Round 3A juvenile sturgeon	3	3			1		1		1	3	1
Sturgeon (juvenile)	Whole body	Round 3A juvenile sturgeon	15	15	15		15		15	15	15	15	15

Notes:

ATSDR - Agency for Toxic Substances and Disease Registry
EPA - U.S. Environmental Protection Agency
ODHS - Oregon Department of Human Services
PAH - polycyclic aromatic hydrocarbon
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
RI - remedial investigation
SVOC - semivolatile organic compound

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																														
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
Conventionals																															
Lipids	4		4	6	9	9	15		6		19	45	5	36	35	7	3	6	35		7	6	4	42	18	23		20	3	15
Total solids	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Metals																															
Aluminum	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Antimony	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Arsenic	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Barium																															
Beryllium																															
Cadmium	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Calcium																															
Chromium	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Cobalt																															
Copper	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Iron																															
Lead	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Magnesium																															
Manganese	4		4	6	9	9	15		6		7	13	5	36				6				6	4	42	18	23		20		
Mercury		4	4	6	9	9	9	6	7		19	38	4	36	35	4	2	6	34		7	6	4	43	18	18	5	20	3	15
Nickel	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Potassium																															
Selenium	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Silver	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Sodium																															
Thallium	4		4	6	9	9	15		6		7	13	5	36				6				6	4	42	18	23		20		
Vanadium																															
Zinc	4		4	6	9	9	15		6		19	41	5	36	35	5	3	6	35	2	7	6	4	42	18	23		20	3	15
Butyltins																															
Butyltin ion						9	9				11	37	4	9	35	1			35		7			16	18	18				15
Dibutyltin ion						9	9				11	37	4	9	35	1			35		7			16	18	18				15
Tetrabutyltin						9	9				11	37	4	9	35	1			35		7			16	18	18				15
Tributyltin ion						9	9				11	37	4	9	35	1			35		7			16	18	18				15
PCB Aroclors																															
Aroclor 1016	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1221	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1232	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1242	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1248	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1254	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1260	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1262	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Aroclor 1268	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Total PCB Aroclors	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
PCB Congeners																															
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB001			2		2	9	9		5	6	12	36	5	19	33	7	3		32	7	7			23	18	18		10	1	15
PCB002			2		2	9	9		5	6	12	38	5	19	34	7	3		32	7	7			23	18	18		10	1	15
PCB003			2		2	9	9		5	6	12	38	5	19	34	7	3		32	7	7			23	18	18		10	1	15
PCB004			4		9	9	9		6	6	12	38	5	19	35	7	3		34	7	7			25	18	18		20	1	15
PCB005			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB006			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB007			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB008			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB009			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB010			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB011			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB012 & 013			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB014			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB015			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB016			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB017			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB018																															
PCB018 & 030			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB019			4		9	9	9		6	6	12	40	5	19	35	7	3		34	7	7			25	18	18		20	1	15
PCB020 & 028			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB021 & 033			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB022			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB023			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB024			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB025			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB026 & 029			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB027			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																														
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
PCB028																															
PCB031			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB032			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB033																															
PCB034			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB035			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB036			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB037			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB038			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB039			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB040 & 041 & 071			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB042			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB043			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB044																															
PCB044 & 047 & 065			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB045 & 051			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB046			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB048			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB049																															
PCB049 & 069			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB050 & 053			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB052			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB054			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB055			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB056			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB057			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB058			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB059 & 062 & 075			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB060			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB061 & 070 & 074 & 076			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB063			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB064			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB066			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB067			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB068			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB070																															
PCB072			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB073			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB074																															
PCB077			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB078			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB079			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB080			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB081			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB082			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB083 & 099			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB084			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB085 & 116 & 117			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB086 & 087 & 097 & 108 & 119 & 125			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB087																															
PCB088 & 091			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB089			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB090																															
PCB090 & 101 & 113			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB092			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB093 & 095 & 098 & 100 & 102			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB094			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB095																															
PCB096			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB097																															
PCB099																															
PCB101																															
PCB103			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB104			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB105			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB106			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB107 & 124			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB109			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB110																															
PCB110 & 115			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB111			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB112			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																														
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
PCB114			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB118			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB119																															
PCB120			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB121			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB122			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB123			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB126			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB127			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB128																															
PCB128 & 166			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB129 & 138 & 160 & 163			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB130			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB131			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB132			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB133			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB134 & 143			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB135 & 151 & 154			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB136			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB137			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB138																															
PCB139 & 140			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB141			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB142			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB144			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB145			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB146			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB147 & 149			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB148			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB149																															
PCB150			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB151																															
PCB152			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB153																															
PCB153 & 168			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB155			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB156			4		9				6					10										9				20		
PCB156 & 157						9	9			6	12	41	5	9	35	7	3		35	7	7			16	18	18			1	15
PCB157			4		9				6					10										9				20		
PCB158			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB159			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB161			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB162			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB164			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB165			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB166																															
PCB167			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB168																															
PCB169			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB170			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB171 & 173			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB172			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB174			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB175			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB176			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB177			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB178			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB179			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB180																															
PCB180 & 193			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB181			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB182			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB183																															
PCB183 & 185			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB184			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB186			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB187			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB188			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB189			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB190			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB191			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB192			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set

	LWG																														
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
PCB194			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB195			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB196			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB197 & 200			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB198 & 199			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB201			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB202			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB203			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB204			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB205			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB206			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB207			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB208			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCB209			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Total PCB Congeners			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PBDE Congeners																															
PBDE001																															
PBDE002																															
PBDE003																															
PBDE007																															
PBDE008 & PBDE011																															
PBDE010																															
PBDE012																															
PBDE012 & 013																															
PBDE013																															
PBDE015																															
PBDE017																															
PBDE017 & 025																															
PBDE025																															
PBDE028 & PBDE033																															
PBDE030																															
PBDE032																															
PBDE035																															
PBDE037																															
PBDE047																															
PBDE049																															
PBDE051																															
PBDE066																															
PBDE071																															
PBDE075																															
PBDE077																															
PBDE079																															
PBDE085																															
PBDE099																															
PBDE100																															
PBDE105																															
PBDE116																															
PBDE119																															
PBDE119 & 120																															
PBDE126																															
PBDE128																															
PBDE138 & PBDE166																															
PBDE140																															
PBDE153																															
PBDE154																															
PBDE155																															
PBDE181																															
PBDE183																															
PBDE190																															
PBDE203																															
PBDE206																															
PBDE207																															
PBDE208																															
PBDE209																															
PCB Homologs																															
Dichlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Heptachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Hexachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Monochlorobiphenyl homologs			2		2	9	9		5	6	12	38	5	19	35	6	3		32	7	7			23	18	18		10	1	15
Nonachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Octachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Pentachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																														
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
Tetrachlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
Trichlorobiphenyl homologs			4		9	9	9		6	6	12	41	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCDD/Fs																															
1,2,3,4,6,7,8-Heptachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,4,7,8,9-Heptachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,4,7,8-Hexachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,6,7,8-Hexachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,7,8,9-Hexachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,7,8-Pentachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
1,2,3,7,8-Pentachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
2,3,4,6,7,8-Hexachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
2,3,4,7,8-Pentachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
2,3,7,8-Tetrachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
2,3,7,8-Tetrachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Dioxin/furan TCDD toxicity equivalent (ND = 0)			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Total TCDD toxicity equivalent (ND = 0)			4		9	9	9		6	6	12	42	5	19	35	7	3		35	7	7			25	18	18		20	1	15
PCDD/F Homologs																															
Heptachlorodibenzofuran homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Heptachlorodibenzo-p-dioxin homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Hexachlorodibenzofuran homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Hexachlorodibenzo-p-dioxin homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Octachlorodibenzofuran			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Octachlorodibenzo-p-dioxin			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Pentachlorodibenzofuran homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Pentachlorodibenzo-p-dioxin homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Tetrachlorodibenzofuran homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Tetrachlorodibenzo-p-dioxin homologs			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Total PCDD/F			4		9	9	9		6		12	39	5	19	35	7	3		35	7	7			25	18	18		20		15
Pesticides																															
2,4'-DDD	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
2,4'-DDE	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
2,4'-DDT	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
4,4'-DDD	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
4,4'-DDE	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
4,4'-DDT	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Aldrin	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
alpha-Endosulfan	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
alpha-Hexachlorocyclohexane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
beta-Endosulfan	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
beta-Hexachlorocyclohexane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	33	7	7	6	4	42	18	23		20	1	15
cis-Chlordane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
cis-Nonachlor	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
delta-Hexachlorocyclohexane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Dieldrin	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Endosulfan sulfate	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Endrin	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Endrin aldehyde	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Endrin ketone	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
gamma-Hexachlorocyclohexane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Heptachlor	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Heptachlor epoxide	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Methoxychlor	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Mirex	4		4	6	9		6		6		7	3		27				6				6	4	26		5		20		
Oxychlordane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total Chlordanes	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total Endosulfan	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total of 2,4' and 4,4'-DDD	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total of 2,4' and 4,4'-DDE	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total of 2,4' and 4,4'-DDT	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Total of 4,4'-DDD, -DDE, -DDT	4		4	6	9		6		6	6	19	34		27	35	7	3	6	35	7		6	4	26		5		20		
Toxaphene	4		4	6	9		6		6		19	3		27				6				6	4	26		5		20		
trans-Chlordane	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
trans-Nonachlor	4		4	6	9	9	15		6	6	19	44	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
PAHs																															
1-Methylnaphthalene						9	9					10	5											16	18	18				
2-Methylnaphthalene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Acenaphthene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																													
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
Acenaphthylene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Anthracene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Benzo(a)anthracene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Benzo(a)pyrene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Benzo(b)fluoranthene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Benzo(b+k)fluoranthene																														
Benzo(e)pyrene												10	5																	
Benzo(g,h,i)perylene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Benzo(j+k)fluoranthene										6																				
Benzo(k)fluoranthene				6	9	9	9		6		19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
C1-Chrysene												10	5																	
C1-Dibenzothiophene												10	5																	
C1-Fluoranthene/pyrene												10	5																	
C1-Fluorene												10	5																	
C1-Phenanthrene/anthracene												10	5																	
C2-Chrysene												10	5																	
C2-Dibenzothiophene												10	5																	
C2-Fluoranthene/pyrene												10	5																	
C2-Fluorene												10	5																	
C2-Naphthalene												10	5																	
C2-Phenanthrene/anthracene												10	5																	
C3-Chrysene												10	5																	
C3-Dibenzothiophene												10	5																	
C3-Fluoranthene/pyrene												10	5																	
C3-Fluorene												10	5																	
C3-Naphthalene												10	5																	
C3-Phenanthrene/anthracene												10	5																	
C4-Chrysene												10	5																	
C4-Naphthalene												10	5																	
C4-Phenanthrene/anthracene												10	5																	
Chrysene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Dibenzo(a,h)anthracene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Dibenzothiophene						9	9					10	5											16	18	18				
Fluoranthene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Fluorene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
High Molecular Weight PAH				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Indeno(1,2,3-cd)pyrene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Low Molecular Weight PAH				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Naphthalene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Perylene												10	5																	
Phenanthrene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Pyrene				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Total cPAHs				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Total PAHs				6	9	9	9		6	6	19	42	5	36	35	4	3	6	35		7			42	18	18		20	3	15
Phthalates																														
Bis(2-ethylhexyl) phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Butylbenzyl phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Dibutyl phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Diethyl phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Dimethyl phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Di-n-octyl phthalate				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
SVOCs																														
1,2,4-Trichlorobenzene				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
1,2-Dichlorobenzene				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
1,2-Diphenylhydrazine				6	9				6		7	3		27				6						26				20		
1,3-Dichlorobenzene				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
1,4-Dichlorobenzene				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
2,4-Dinitrotoluene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,6-Dinitrotoluene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2-Chloronaphthalene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2-Nitroaniline				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
3,3'-Dichlorobenzidine				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
3-Nitroaniline				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Bromophenyl phenyl ether				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Chloroaniline				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Chlorophenyl phenyl ether				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Nitroaniline				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Aniline				6	9	9	9		5			10	4	36										16	18	18		20		
Azobenzene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Benzoic acid				6	9	9	9		6			10	4	36										16	18	18		20		
Benzyl alcohol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Bis(2-chloro-1-methylethyl) ether				6	9				6		7	3		27				6						26				20		

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	LWG																												
	Black crappie			Brown bullhead		Carp				Chinook, juvenile		Clam		Crayfish	Lab clam	Lamprey, ammocoetes	Lamprey, macropthalmia	Largescale sucker	*Lumbriculus variegatus*	Multiplate invertebrates	Mussel	Northern pikeminnow	Peamouth	Sculpin	Smallmouth bass				Sturgeon, juvenile	
Analyte	fillet	fillet without skin	whole body	fillet without skin	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body	body without shell	depurated w/o shell	whole body	body without shell	whole body	whole body	whole body	whole body	whole body	body without shell	whole body	whole body	whole body	body without fillet	fillet	fillet without skin	whole body	stomach contents	whole body
Bis(2-chloroethoxy) methane				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Bis(2-chloroethyl) ether				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Bis(2-chloroisopropyl) ether						9	9					10	4	9										16	18	18				
Carbazole				6	9				6		7	3		27				6						26				20		
Dibenzofuran				6	9	9	9		6		19	42	5	36	35			6	35					42	18	18		20		
Diphenyl																														
Hexachlorobenzene	4		4	6	9	9	15		6	6	19	45	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Hexachlorobutadiene	4		4	6	9	9	15		6	6	19	41	5	36	35	7	3	6	35	7	7	6	4	42	18	23		20	1	15
Hexachlorocyclopentadiene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Hexachloroethane	4		4	6	9	9	15		6		15	41	4	36	35	4	1	6	35		7	6	4	42	18	23		20		15
Isophorone				6	9	9	9		6			10	4	36										16	18	18		20		
Nitrobenzene				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
N-Nitrosodimethylamine				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
N-Nitrosodiphenylamine				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
N-Nitrosodipropylamine				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Retene																														
Phenols																														
2,3,4,5-Tetrachlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,3,4,6-Tetrachlorophenol						9	9					10	4	9										16	18	18				
2,3,5,6-Tetrachlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,4,5-Trichlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,4,6-Trichlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,4-Dichlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2,4-Dimethylphenol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
2,4-Dinitrophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2-Chlorophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
2-Methylphenol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
2-Nitrophenol				6	9	9	9		6			10	4	36										16	18	18		20		
4,6-Dinitro-2-methylphenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Chloro-3-methylphenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
4-Methylphenol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
4-Nitrophenol				6	9	9	9		6		7	13	4	36				6						42	18	18		20		
Pentachlorophenol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Phenol				6	9	9	9		6		15	41	4	36	35	4	1	6	35		7			42	18	18		20		15
Grand Total	252	4	1,044	822	2,996	2,943	3,321	6	2,012	1,362	4,359	12,682	1,689	8,614	10,181	1,861	821	798	10,168	1,655	2,023	384	256	10,474	5,886	6,201	5	6,680	310	4,335

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	**fillet**	**fillet without skin**	**whole body**	**body without shell**	**whole body**	**whole body**	**fillet without skin**	**Grand Total**
Conventionals								
Lipids	3		4	11	11	4	5	420
Total solids				11	11			400
Metals								
Aluminum	3		4			4	5	394
Antimony	3		4	11	11	4	5	416
Arsenic	3		4	11	11	4	5	416
Barium	3		4			4	5	16
Beryllium	3		4			4	5	16
Cadmium	3		4	11	11	4	5	416
Calcium	3		4			4	5	16
Chromium	3		4	11	11	4	5	416
Cobalt	3		4			4	5	16
Copper	3		4	11	11	4	5	416
Iron	3		4			4	5	16
Lead	3		4	11	11	4	5	416
Magnesium	3		4			4	5	16
Manganese	3		4			4	5	249
Mercury		3	4	11	11	4	5	409
Nickel	3		4	11	11	4	5	416
Potassium	3		4			4	5	16
Selenium	3		4			4	5	394
Silver	3		4	11	11	4	5	416
Sodium	3		4			4	5	16
Thallium	3		4			4	5	249
Vanadium	3		4			4	5	16
Zinc	3		4	11	11	4	5	416
Butyltins								
Butyltin ion				11	11			246
Dibutyltin ion				11	11			246
Tetrabutyltin				11	11			246
Tributyltin ion				11	11			246
PCB Aroclors								
Aroclor 1016	3		4	11	11	4	5	177
Aroclor 1221	3		4	11	11	4	5	177
Aroclor 1232	3		4	11	11	4	5	177
Aroclor 1242	3		4	11	11	4	5	177
Aroclor 1248	3		4	11	11	4	5	177
Aroclor 1254	3		4	11	11	4	5	177
Aroclor 1260	3		4	11	11	4	5	177
Aroclor 1262	3		4	11	11	4	5	177
Aroclor 1268	3		4	11	11	4	5	177
Total PCB Aroclors	3		4	11	11	4	5	177
PCB Congeners								
Dioxin-like PCB congener TCDD toxicity equivalent (ND = 0)	3	3	4	11	11	4	5	352
PCB001	3	3	4	11	11	4	5	320
PCB002	3	3	4			4	5	301
PCB003	3	3	4			4	5	301
PCB004	3	3	4			4	5	326
PCB005	3	3	4	11	11	4	5	352
PCB006	3	3	4			4	5	330
PCB007	3	3	4			4	5	330
PCB008	3	3	4	11	11	4	5	352
PCB009	3	3	4			4	5	330
PCB010	3	3	4			4	5	330
PCB011	3	3	4			4	5	330
PCB012 & 013	3	3	4			4	5	330
PCB014	3	3	4			4	5	330
PCB015	3	3	4			4	5	330
PCB016	3	3	4			4	5	330
PCB017	3	3	4			4	5	330
PCB018				11	11			22
PCB018 & 030	3	3	4			4	5	330
PCB019	3	3	4			4	5	328
PCB020 & 028	3	3	4			4	5	330
PCB021 & 033	3	3	4			4	5	330
PCB022	3	3	4			4	5	330
PCB023	3	3	4			4	5	330
PCB024	3	3	4			4	5	330
PCB025	3	3	4			4	5	330
PCB026 & 029	3	3	4			4	5	330
PCB027	3	3	4			4	5	330

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	fillet	fillet without skin	whole body	body without shell	whole body	whole body	fillet without skin	Grand Total
PCB028				11	11			22
PCB031	3	3	4	11	11	4	5	352
PCB032	3	3	4			4	5	330
PCB033				11	11			22
PCB034	3	3	4			4	5	330
PCB035	3	3	4			4	5	330
PCB036	3	3	4			4	5	330
PCB037	3	3	4	11	11	4	5	352
PCB038	3	3	4			4	5	330
PCB039	3	3	4			4	5	330
PCB040 & 041 & 071	3	3	4			4	5	330
PCB042	3	3	4			4	5	330
PCB043	3	3	4			4	5	330
PCB044				11	11			22
PCB044 & 047 & 065	3	3	4			4	5	330
PCB045 & 051	3	3	4			4	5	330
PCB046	3	3	4			4	5	330
PCB048	3	3	4			4	5	330
PCB049				11	11			22
PCB049 & 069	3	3	4			4	5	330
PCB050 & 053	3	3	4			4	5	330
PCB052	3	3	4	11	11	4	5	352
PCB054	3	3	4			4	5	330
PCB055	3	3	4			4	5	330
PCB056	3	3	4	11	11	4	5	352
PCB057	3	3	4			4	5	330
PCB058	3	3	4			4	5	330
PCB059 & 062 & 075	3	3	4			4	5	330
PCB060	3	3	4	11	11	4	5	352
PCB061 & 070 & 074 & 076	3	3	4			4	5	330
PCB063	3	3	4			4	5	330
PCB064	3	3	4			4	5	330
PCB066	3	3	4	11	11	4	5	352
PCB067	3	3	4			4	5	330
PCB068	3	3	4			4	5	330
PCB070				11	11			22
PCB072	3	3	4			4	5	330
PCB073	3	3	4			4	5	330
PCB074				11	11			22
PCB077	3	3	4	11	11	4	5	352
PCB078	3	3	4			4	5	330
PCB079	3	3	4			4	5	330
PCB080	3	3	4			4	5	330
PCB081	3	3	4	11	11	4	5	352
PCB082	3	3	4			4	5	330
PCB083 & 099	3	3	4			4	5	330
PCB084	3	3	4			4	5	330
PCB085 & 116 & 117	3	3	4			4	5	330
PCB086 & 087 & 097 & 108 & 119 & 125	3	3	4			4	5	330
PCB087				11	11			22
PCB088 & 091	3	3	4			4	5	330
PCB089	3	3	4			4	5	330
PCB090				11	11			22
PCB090 & 101 & 113	3	3	4			4	5	330
PCB092	3	3	4			4	5	330
PCB093 & 095 & 098 & 100 & 102	3	3	4			4	5	330
PCB094	3	3	4			4	5	330
PCB095				11	11			22
PCB096	3	3	4			4	5	330
PCB097				11	11			22
PCB099				11	11			22
PCB101				11	11			22
PCB103	3	3	4			4	5	330
PCB104	3	3	4			4	5	330
PCB105	3	3	4	11	11	4	5	352
PCB106	3	3	4			4	5	330
PCB107 & 124	3	3	4			4	5	330
PCB109	3	3	4			4	5	330
PCB110				11	11			22
PCB110 & 115	3	3	4			4	5	330
PCB111	3	3	4			4	5	330
PCB112	3	3	4			4	5	330

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	**fillet**	**fillet without skin**	**whole body**	**body without shell**	**whole body**	**whole body**	**fillet without skin**	**Grand Total**
PCB114	3	3	4	11	11	4	5	352
PCB118	3	3	4	11	11	4	5	352
PCB119				11	11			22
PCB120	3	3	4			4	5	330
PCB121	3	3	4			4	5	330
PCB122	3	3	4			4	5	330
PCB123	3	3	4	11	11	4	5	352
PCB126	3	3	4	11	11	4	5	352
PCB127	3	3	4			4	5	330
PCB128				11	11			22
PCB128 & 166	3	3	4			4	5	330
PCB129 & 138 & 160 & 163	3	3	4			4	5	330
PCB130	3	3	4			4	5	330
PCB131	3	3	4			4	5	330
PCB132	3	3	4	11	11	4	5	352
PCB133	3	3	4			4	5	330
PCB134 & 143	3	3	4			4	5	330
PCB135 & 151 & 154	3	3	4			4	5	330
PCB136	3	3	4			4	5	330
PCB137	3	3	4			4	5	330
PCB138				11	11			22
PCB139 & 140	3	3	4			4	5	330
PCB141	3	3	4	11	11	4	5	352
PCB142	3	3	4			4	5	330
PCB144	3	3	4			4	5	330
PCB145	3	3	4			4	5	330
PCB146	3	3	4			4	5	330
PCB147 & 149	3	3	4			4	5	330
PCB148	3	3	4			4	5	330
PCB149				11	11			22
PCB150	3	3	4			4	5	330
PCB151				11	11			22
PCB152	3	3	4			4	5	330
PCB153				11	11			22
PCB153 & 168	3	3	4			4	5	330
PCB155	3	3	4			4	5	330
PCB156	3	3	4	11	11	4	5	99
PCB156 & 157								253
PCB157	3	3	4	11	11	4	5	99
PCB158	3	3	4	11	11	4	5	352
PCB159	3	3	4			4	5	330
PCB161	3	3	4			4	5	330
PCB162	3	3	4			4	5	330
PCB164	3	3	4			4	5	330
PCB165	3	3	4			4	5	330
PCB166				11	11			22
PCB167	3	3	4	11	11	4	5	352
PCB168				11	11			22
PCB169	3	3	4	11	11	4	5	352
PCB170	3	3	4	11	11	4	5	352
PCB171 & 173	3	3	4			4	5	330
PCB172	3	3	4			4	5	330
PCB174	3	3	4	11	11	4	5	352
PCB175	3	3	4			4	5	330
PCB176	3	3	4			4	5	330
PCB177	3	3	4	11	11	4	5	352
PCB178	3	3	4			4	5	330
PCB179	3	3	4			4	5	330
PCB180				11	11			22
PCB180 & 193	3	3	4			4	5	330
PCB181	3	3	4			4	5	330
PCB182	3	3	4			4	5	330
PCB183				11	11			22
PCB183 & 185	3	3	4			4	5	330
PCB184	3	3	4	11	11	4	5	352
PCB186	3	3	4			4	5	330
PCB187	3	3	4	11	11	4	5	352
PCB188	3	3	4			4	5	330
PCB189	3	3	4	11	11	4	5	352
PCB190	3	3	4			4	5	330
PCB191	3	3	4			4	5	330
PCB192	3	3	4			4	5	330

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	fillet	fillet without skin	whole body	body without shell	whole body	whole body	fillet without skin	Grand Total
PCB194	3	3	4	11	11	4	5	352
PCB195	3	3	4	11	11	4	5	352
PCB196	3	3	4			4	5	330
PCB197 & 200	3	3	4			4	5	330
PCB198 & 199	3	3	4			4	5	330
PCB201	3	3	4	11	11	4	5	352
PCB202	3	3	4			4	5	330
PCB203	3	3	4	11	11	4	5	352
PCB204	3	3	4			4	5	330
PCB205	3	3	4			4	5	330
PCB206	3	3	4	11	11	4	5	352
PCB207	3	3	4			4	5	330
PCB208	3	3	4			4	5	330
PCB209	3	3	4	11	11	4	5	352
Total PCB Congeners	3	3	4	11	11	4	5	352
PBDE Congeners								
PBDE001	3	3	4			3		13
PBDE002	3	3	4			3		13
PBDE003	3	3	4			3		13
PBDE007	3	3	4			3	1	14
PBDE008 & PBDE011	3	3	4			3	1	14
PBDE010	3	3	4			3	1	14
PBDE012	3	3	4			3		13
PBDE012 & 013							1	1
PBDE013	3	3	4			3		13
PBDE015	3	3	4			3	1	14
PBDE017	3	3	4			3		13
PBDE017 & 025						1	5	6
PBDE025	3	3	4			3		13
PBDE028 & PBDE033	3	3	4			4	5	19
PBDE030	3	3	4			4	5	19
PBDE032	3	3	4			4	5	19
PBDE035	3	3	4			4	5	19
PBDE037	3	3	4			4	5	19
PBDE047	3	3	4			4	5	19
PBDE049	3	3	4			4	5	19
PBDE051						1	5	6
PBDE066	3	3	4			4	5	19
PBDE071	3	3	4			4	5	19
PBDE075	3	3	4			4	5	19
PBDE077	3	3	4			4	5	19
PBDE079						1	5	6
PBDE085	3	3	4			4	5	19
PBDE099	3	3	4			4	5	19
PBDE100	3	3	4			4	5	19
PBDE105	3	3	4			4	5	19
PBDE116	3	3	4			4	5	19
PBDE119	3	3	4			3		13
PBDE119 & 120						1	5	6
PBDE126	3	3	4			4	5	19
PBDE128						1	5	6
PBDE138 & PBDE166	3	3	4			4	5	19
PBDE140	3	3	4			4	5	19
PBDE153	3	3	4			4	5	19
PBDE154	3	3	4			4	5	19
PBDE155	3	3	4			4	5	19
PBDE181	3	3	4			4	5	19
PBDE183	3	3	4			4	5	19
PBDE190	3	3	4			4	5	19
PBDE203						1	5	6
PBDE206	3	3	4			4	5	19
PBDE207	3	3	4			4	5	19
PBDE208	3	3	4			4	5	19
PBDE209	3	3	4			4	5	19
PCB Homologs								
Dichlorobiphenyl homologs	3	3	4			4	5	329
Heptachlorobiphenyl homologs	3	3	4			4	5	329
Hexachlorobiphenyl homologs	3	3	4			4	5	329
Monochlorobiphenyl homologs	3	3	4			4	5	300
Nonachlorobiphenyl homologs	3	3	4			4	5	329
Octachlorobiphenyl homologs	3	3	4			4	5	329
Pentachlorobiphenyl homologs	3	3	4			4	5	329

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	**fillet**	**fillet without skin**	**whole body**	**body without shell**	**whole body**	**whole body**	**fillet without skin**	**Grand Total**
Tetrachlorobiphenyl homologs	3	3	4			4	5	329
Trichlorobiphenyl homologs	3	3	4			4	5	329
PCDD/Fs								
1,2,3,4,6,7,8-Heptachlorodibenzofuran	3	3	4			4	5	321
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	3	3	4			4	5	321
1,2,3,4,7,8,9-Heptachlorodibenzofuran	3	3	4			4	5	321
1,2,3,4,7,8-Hexachlorodibenzofuran	3	3	4			4	5	321
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3	3	4			4	5	321
1,2,3,6,7,8-Hexachlorodibenzofuran	3	3	4			4	5	321
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3	3	4			4	5	321
1,2,3,7,8,9-Hexachlorodibenzofuran	3	3	4			4	5	321
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3	3	4			4	5	321
1,2,3,7,8-Pentachlorodibenzofuran	3	3	4			4	5	321
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	3	3	4			4	5	321
2,3,4,6,7,8-Hexachlorodibenzofuran	3	3	4			4	5	321
2,3,4,7,8-Pentachlorodibenzofuran	3	3	4			4	5	321
2,3,7,8-Tetrachlorodibenzofuran	3	3	4			4	5	321
2,3,7,8-Tetrachlorodibenzo-p-dioxin	3	3	4			4	5	321
Dioxin/furan TCDD toxicity equivalent (ND = 0)	3	3	4			4	5	321
Total TCDD toxicity equivalent (ND = 0)	3	3	4	11	11	4	5	353
PCDD/F Homologs								
Heptachlorodibenzofuran homologs	3	3	4			4	5	321
Heptachlorodibenzo-p-dioxin homologs	3	3	4			4	5	321
Hexachlorodibenzofuran homologs	3	3	4			4	5	321
Hexachlorodibenzo-p-dioxin homologs	3	3	4			4	5	321
Octachlorodibenzofuran	3	3	4			4	5	321
Octachlorodibenzo-p-dioxin	3	3	4			4	5	321
Pentachlorodibenzofuran homologs	3	3	4			4	5	321
Pentachlorodibenzo-p-dioxin homologs	3	3	4			4	5	321
Tetrachlorodibenzofuran homologs	3	3	4			4	5	321
Tetrachlorodibenzo-p-dioxin homologs	3	3	4			4	5	321
Total PCDD/F	3	3	4			4	5	321
Pesticides								
2,4'-DDD	3		4	11	11	4	5	430
2,4'-DDE	3		4	11	11	4	5	430
2,4'-DDT	3		4	11	11	4	5	430
4,4'-DDD	3		4	11	11	4	5	430
4,4'-DDE	3		4	11	11	4	5	430
4,4'-DDT	3		4	11	11	4	5	430
Aldrin	3		4	11	11	4	5	430
alpha-Endosulfan	3		4	11	11	4	5	430
alpha-Hexachlorocyclohexane	3		4	11	11	4	5	430
beta-Endosulfan	3		4	11	11	4	5	430
beta-Hexachlorocyclohexane	3		4	11	11	4	5	428
cis-Chlordane	3		4	11	11	4	5	430
cis-Nonachlor				11	11			414
delta-Hexachlorocyclohexane	3		4	11	11	4	5	430
Dieldrin	3		4	11	11	4	5	430
Endosulfan sulfate	3		4	11	11	4	5	430
Endrin	3		4	11	11	4	5	430
Endrin aldehyde	3		4	11	11	4	4	429
Endrin ketone	3		4	11	11	4	5	430
gamma-Hexachlorocyclohexane	3		4	11	11	4	5	430
Heptachlor	3		4	11	11	4	5	430
Heptachlor epoxide	3		4	11	11	4	5	430
Methoxychlor	3		4	11	11	4	5	430
Mirex				11	11			161
Oxychlordane				11	11			414
Total Chlordanes	3		4	11	11	4	5	430
Total Endosulfan	3		4	11	11	4	5	430
Total of 2,4' and 4,4'-DDD	3		4	11	11	4	5	430
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	3		4	11	11	4	5	430
Total of 2,4' and 4,4'-DDE	3		4	11	11	4	5	430
Total of 2,4' and 4,4'-DDT	3		4	11	11	4	5	430
Total of 4,4'-DDD, -DDE, -DDT	3		4	11	11	4	5	313
Toxaphene				11	11			173
trans-Chlordane	3		4	11	11	4	5	430
trans-Nonachlor				11	11			414
PAHs								
1-Methylnaphthalene	3		4			4	5	101
2-Methylnaphthalene	3		4	11	11	4	5	391
Acenaphthene	3		4	11	11	4	5	391

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	**fillet**	**fillet without skin**	**whole body**	**body without shell**	**whole body**	**whole body**	**fillet without skin**	**Grand Total**
Acenaphthylene	3		4	11	11	4	5	391
Anthracene	3		4	11	11	4	5	391
Benzo(a)anthracene	3		4	11	11	4	5	391
Benzo(a)pyrene	3		4	11	11	4	5	391
Benzo(b)fluoranthene	3		4	11	11	4	5	391
Benzo(b+k)fluoranthene	3		4			4	5	16
Benzo(e)pyrene								15
Benzo(g,h,i)perylene	3		4	11	11	4	5	391
Benzo(j+k)fluoranthene								6
Benzo(k)fluoranthene	3		4	11	11	4	5	385
C1-Chrysene								15
C1-Dibenzothiophene								15
C1-Fluoranthene/pyrene								15
C1-Fluorene								15
C1-Phenanthrene/anthracene								15
C2-Chrysene								15
C2-Dibenzothiophene								15
C2-Fluoranthene/pyrene								15
C2-Fluorene								15
C2-Naphthalene								15
C2-Phenanthrene/anthracene								15
C3-Chrysene								15
C3-Dibenzothiophene								15
C3-Fluoranthene/pyrene								15
C3-Fluorene								15
C3-Naphthalene								15
C3-Phenanthrene/anthracene								15
C4-Chrysene								15
C4-Naphthalene								15
C4-Phenanthrene/anthracene								15
Chrysene	3		4	11	11	4	5	391
Dibenzo(a,h)anthracene	3		4	11	11	4	5	391
Dibenzothiophene								85
Fluoranthene	3		4	11	11	4	5	391
Fluorene	3		4	11	11	4	5	391
High Molecular Weight PAH	3		4	11	11	4	5	391
Indeno(1,2,3-cd)pyrene	3		4	11	11	4	5	391
Low Molecular Weight PAH	3		4	11	11	4	5	391
Naphthalene	3		4	11	11	4	5	391
Perylene								15
Phenanthrene	3		4	11	11	4	5	391
Pyrene	3		4	11	11	4	5	391
Total cPAHs	3		4	11	11	4	5	391
Total PAHs	3		4	11	11	4	5	391
Phthalates								
Bis(2-ethylhexyl) phthalate				11	11			358
Butylbenzyl phthalate				11	11			358
Dibutyl phthalate				11	11			358
Diethyl phthalate				11	11			358
Dimethyl phthalate				11	11			358
Di-n-octyl phthalate				11	11			358
SVOCs								
1,2,4-Trichlorobenzene	3		4	11	11	4	5	374
1,2-Dichlorobenzene	3		4	11	11	4	5	374
1,2-Diphenylhydrazine				10	10			130
1,3-Dichlorobenzene	3		4	11	11	4	5	374
1,4-Dichlorobenzene	3		4	11	11	4	5	374
2,4-Dinitrotoluene	3		4	11	11	4	5	241
2,6-Dinitrotoluene	3		4	11	11	4	5	241
2-Chloronaphthalene	3		4	11	11	4	5	241
2-Nitroaniline				11	11			225
3,3'-Dichlorobenzidine				11	11			225
3-Nitroaniline				11	11			225
4-Bromophenyl phenyl ether	3		4	11	11	4	5	241
4-Chloroaniline				11	11			225
4-Chlorophenyl phenyl ether	3		4	11	11	4	5	241
4-Nitroaniline				11	11			225
Aniline				11	11			182
Azobenzene				1	1			205
Benzoic acid				11	11			183
Benzyl alcohol				11	11			358
Bis(2-chloro-1-methylethyl) ether								110

Table 2.2-9. Summary of Biota Sample Counts in RI Data Set.

	Non-LWG							
	Chinook, adult			Lab clam	*Lumbriculus variegatus*	Lamprey, adult	Sturgeon, adult	
Analyte	**fillet**	**fillet without skin**	**whole body**	**body without shell**	**whole body**	**whole body**	**fillet without skin**	**Grand Total**
Bis(2-chloroethoxy) methane	3		4	11	11	4	5	241
Bis(2-chloroethyl) ether	3		4	11	11	4	5	241
Bis(2-chloroisopropyl) ether	3		4	11	11	4	5	131
Carbazole	3		4	11	11	4	5	148
Dibenzofuran	3		4	11	11	4	5	353
Diphenyl	3		4			4	5	16
Hexachlorobenzene	3		4	11	11	4	5	431
Hexachlorobutadiene	3		4	11	11	4	5	427
Hexachlorocyclopentadiene				11	11			225
Hexachloroethane	3		4	11	11	4	5	403
Isophorone				11	11			183
Nitrobenzene				11	11			225
N-Nitrosodimethylamine				11	11			225
N-Nitrosodiphenylamine	3		4	11	11	4	5	374
N-Nitrosodipropylamine				11	11			225
Retene	3		4			4	5	16
Phenols								
2,3,4,5-Tetrachlorophenol				11	11			225
2,3,4,6-Tetrachlorophenol				11	11			115
2,3,5,6-Tetrachlorophenol				11	11			225
2,4,5-Trichlorophenol	2		4	11	11	2	5	238
2,4,6-Trichlorophenol	2		4	11	11	2	5	238
2,4-Dichlorophenol	2		4	11	11	2	5	238
2,4-Dimethylphenol	2		4	11	11	3	5	372
2,4-Dinitrophenol				11	11			225
2-Chlorophenol	2		4	11	11	2	5	238
2-Methylphenol				11	11			358
2-Nitrophenol	2		4	11	11	2	5	196
4,6-Dinitro-2-methylphenol				11	11			225
4-Chloro-3-methylphenol				11	11			225
4-Methylphenol				11	11			358
4-Nitrophenol				11	11			225
Pentachlorophenol				11	11			358
Phenol	2		4	11	11	2	5	371
Grand Total	1,052	723	1,416	2,189	2,189	1,397	1,744	114,845

Notes:

LWG - Lower Willamette Group
PAH - polycyclic aromatic hydrocarbon
PBDE - polybrominated diphenyl ether
PCB - polychlorinated biphenyl
PCDD/Fs - dioxins/furans
SVOC - semivolatile organic compound

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Black crappie	Fillet	LWG01FZ0306TSBCFLC10	5
Black crappie	Fillet	LWG01FZ0306TSBCFLC20	5
Black crappie	Fillet	LWG01FZ0609TSBCFLC10	5
Black crappie	Fillet	LWG01FZ0609TSBCFLC20	5
Black crappie	Fillet without skin	LWG01FZ0306TSBCFSC10	5
Black crappie	Fillet without skin	LWG01FZ0306TSBCFSC20	5
Black crappie	Fillet without skin	LWG01FZ0609TSBCFSC10	5
Black crappie	Fillet without skin	LWG01FZ0609TSBCFSC20	5
Black crappie	Whole body	LWG01FZ0306TSBCWBC10	5
Black crappie	Whole body	LWG01FZ0306TSBCWBC20	5
Black crappie	Whole body	LWG01FZ0609TSBCWBC10	5
Black crappie	Whole body	LWG01FZ0609TSBCWBC20	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFLC10	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFLC20	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFLC30	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFSC10	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFSC20	5
Brown bullhead	Fillet without skin	LWG01FZ0306TSBBFSC30	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFLC10	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFLC20	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFLC30	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFSC10	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFSC20	5
Brown bullhead	Fillet without skin	LWG01FZ0609TSBBFSC30	5
Brown bullhead	Whole body	LWG0120R001TSBBWBC10	5
Brown bullhead	Whole body	LWG0120R001TSBBWBC20	5
Brown bullhead	Whole body	LWG0128R001TSBBWBC00	5
Brown bullhead	Whole body	LWG01FZ0306TSBBWBC10	5
Brown bullhead	Whole body	LWG01FZ0306TSBBWBC20	5
Brown bullhead	Whole body	LWG01FZ0306TSBBWBC30	5
Brown bullhead	Whole body	LWG01FZ0609TSBBWBC10	5
Brown bullhead	Whole body	LWG01FZ0609TSBBWBC20	5
Brown bullhead	Whole body	LWG01FZ0609TSBBWBC30	5
Carp	Body without fillet	LW3-CP0004-C10B	5
Carp	Body without fillet	LW3-CP0004-C20B	5
Carp	Body without fillet	LW3-CP0004-C30B	5
Carp	Body without fillet	LW3-CP0408-C10B	5
Carp	Body without fillet	LW3-CP0408-C20B	5
Carp	Body without fillet	LW3-CP0408-C30B	5
Carp	Body without fillet	LW3-CP0812-C11B	5
Carp	Body without fillet	LW3-CP0812-C20B	5
Carp	Body without fillet	LW3-CP0812-C30B	5
Carp	Fillet	LW3-CP0004-C10F	5
Carp	Fillet	LW3-CP0004-C20F	5
Carp	Fillet	LW3-CP0004-C30F	5
Carp	Fillet	LW3-CP0408-C10F	5
Carp	Fillet	LW3-CP0408-C20F	5
Carp	Fillet	LW3-CP0408-C30F	5
Carp	Fillet	LW3-CP0812-C11F	5
Carp	Fillet	LW3-CP0812-C20F	5
Carp	Fillet	LW3-CP0812-C30F	5
Carp	Fillet	LWG01FZ0306TSCPFLC10	5
Carp	Fillet	LWG01FZ0306TSCPFLC20	5
Carp	Fillet	LWG01FZ0306TSCPFLC30	5
Carp	Fillet	LWG01FZ0609TSCPFLC10	5
Carp	Fillet	LWG01FZ0609TSCPFLC20	5
Carp	Fillet	LWG01FZ0609TSCPFLC30	5
Carp	Fillet without skin	LWG01FZ0306TSCPFSC10	5
Carp	Fillet without skin	LWG01FZ0306TSCPFSC20	5
Carp	Fillet without skin	LWG01FZ0306TSCPFSC30	5
Carp	Fillet without skin	LWG01FZ0609TSCPFSC10	5

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Carp	Fillet without skin	LWG01FZ0609TSCPFSC20	5
Carp	Fillet without skin	LWG01FZ0609TSCPFSC30	5
Carp	Whole body	LWG01FZ0306TSCPWBC10	5
Carp	Whole body	LWG01FZ0306TSCPWBC20	5
Carp	Whole body	LWG01FZ0306TSCPWBC30	5
Carp	Whole body	LWG01FZ0609TSCPWBC10	5
Carp	Whole body	LWG01FZ0609TSCPWBC20	5
Carp	Whole body	LWG01FZ0609TSCPWBC30	5
Carp	Whole body	LWG1AFZ0609TSCPWB	1
Chinook, adult	Fillet	WLTASE03CFH03254200	3
Chinook, adult	Fillet	WLTASE03CFH03254201	3
Chinook, adult	Fillet	WLTASE03CFH03254202	3
Chinook, adult	Fillet without skin	WLTASE03CFH03254210	3
Chinook, adult	Fillet without skin	WLTASE03CFH03254211	3
Chinook, adult	Fillet without skin	WLTASE03CFH03254212	3
Chinook, adult	Whole body	WLTASE03CFH03254220	3
Chinook, adult	Whole body	WLTASE03CFH03254221	3
Chinook, adult	Whole body	WLTASE03CFH03254222	3
Chinook, adult	Whole body	WLTASE03CFH03254223	3
Chinook, juvenile	Stomach contents	LW2-T01 SC	90
Chinook, juvenile	Stomach contents	LW2-T01-NOAA SC	40
Chinook, juvenile	Stomach contents	LW2-T02 SC	90
Chinook, juvenile	Stomach contents	LW2-T02-NOAA SC	42
Chinook, juvenile	Stomach contents	LW2-T03 SC	72
Chinook, juvenile	Stomach contents	LW2-T04 SC	90
Chinook, juvenile	Whole body	LW2-T01-REP1	30
Chinook, juvenile	Whole body	LW2-T01-REP2	30
Chinook, juvenile	Whole body	LW2-T01-REP3	30
Chinook, juvenile	Whole body	LW2-T02-REP1	30
Chinook, juvenile	Whole body	LW2-T02-REP2	30
Chinook, juvenile	Whole body	LW2-T02-REP3	30
Chinook, juvenile	Whole body	LW2-T03-REP1	24
Chinook, juvenile	Whole body	LW2-T03-REP2	21
Chinook, juvenile	Whole body	LW2-T03-REP3	27
Chinook, juvenile	Whole body	LW2-T04-REP1	30
Chinook, juvenile	Whole body	LW2-T04-REP2	30
Chinook, juvenile	Whole body	LW2-T04-REP3	30
Chinook, juvenile	Whole body	LWG1A02R102TSSCWBC00	15
Chinook, juvenile	Whole body	LWG1A02R112TSSCWBC00	14
Chinook, juvenile	Whole body	LWG1A02R113TSSCWBC00	15
Chinook, juvenile	Whole body	LWG1A03R118TSSCWBC00	11
Chinook, juvenile	Whole body	LWG1A03R125TSSCWBC00	13
Chinook, juvenile	Whole body	LWG1A04R126TSSCWBC00	12
Chinook, juvenile	Whole body	LWG1A26R111TSSCWBC00	12
Clam	Body without shell	LW2-BTFC001	106
Clam	Body without shell	LW2-BTFC002	96
Clam	Body without shell	LW2-BTFC003	71
Clam	Body without shell	LW2-BTFC004	102
Clam	Body without shell	LW2-BTFC005	56
Clam	Body without shell	LW2-BTFC006 Rep 1	171
Clam	Body without shell	LW2-BTFC006 Rep 2	171
Clam	Body without shell	LW2-BTFC007	39
Clam	Body without shell	LW2-BTFC008	62
Clam	Body without shell	LW2-BTFC009	63
Clam	Body without shell	LW2-BTFC010	108
Clam	Body without shell	LW2-BTFC011	32
Clam	Body without shell	LW2-BTFC012	50
Clam	Body without shell	LW2-BTFC013	89
Clam	Body without shell	LW2-BTFC014	36
Clam	Body without shell	LW2-BTFC015	32
Clam	Body without shell	LW2-BTFC016	34

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Clam	Body without shell	LW2-BTFC017	37
Clam	Body without shell	LW2-BTFC018	16
Clam	Body without shell	LW2-BTFC019	41
Clam	Body without shell	LW2-BTFC020	52
Clam	Body without shell	LW2-BTFC021	37
Clam	Body without shell	LW2-BTFC022	49
Clam	Body without shell	LW2-BTFC023	35
Clam	Body without shell	LW2-BTFC024	110
Clam	Body without shell	LW2-BTFC025	22
Clam	Body without shell	LW2-BTFC026	50
Clam	Body without shell	LW2-BTFC027 Rep 1	75
Clam	Body without shell	LW2-BTFC027 Rep 2	75
Clam	Body without shell	LW2-BTFC028	42
Clam	Body without shell	LW2-BTFC029	10
Clam	Body without shell	LW2-BTFC030	69
Clam	Body without shell	LW2-BTFC031	41
Clam	Body without shell	LW2-BTFC032	5
Clam	Body without shell	LW2-BTFC033	14
Clam	Body without shell	LW3-CA01E-C01	Unknown
Clam	Body without shell	LW3-CA02W-C00	Unknown
Clam	Body without shell	LW3-CA03W-C00	Unknown
Clam	Body without shell	LW3-CA04W-C00	Unknown
Clam	Body without shell	LW3-CA05E-C00	Unknown
Clam	Body without shell	LW3-CA05W-C00	Unknown
Clam	Body without shell	LW3-CA10W-C00	Unknown
Clam	Body without shell	LW3-CA11E-C00	Unknown
Clam	Body without shell	LW3-CA12E-C00	Unknown
Clam	Body without shell	LW3-CA12W-C00	Unknown
Clam	Body without shell	LWG0106R002TSCAWBC00	Unknown
Clam	Body without shell	LWG0107R003TSCAWBC00	Unknown
Clam	Body without shell	LWG0107R006TSCAWBC00	Unknown
Clam	Depurated w/o shell	LW3-CA01E-C00D	Unknown
Clam	Depurated w/o shell	LW3-CA02W-C00D	Unknown
Clam	Depurated w/o shell	LW3-CA10W-C00D	Unknown
Clam	Depurated w/o shell	LW3-CA11E-C00D	Unknown
Clam	Depurated w/o shell	LW3-CA12E-C00D	Unknown
Crayfish	Whole body	LW3-CR01E-Alt-C00	7
Crayfish	Whole body	LW3-CR01W-C00	8
Crayfish	Whole body	LW3-CR05W-C00	6
Crayfish	Whole body	LW3-CR06W-C00	7
Crayfish	Whole body	LW3-CR08W-C00	10
Crayfish	Whole body	LW3-CR10W-C00	9
Crayfish	Whole body	LW3-CR11E-C01	8
Crayfish	Whole body	LW3-CR12E-C00	8
Crayfish	Whole body	LW3-CR12W-C00	9
Crayfish	Whole body	LWG0102R001TSCRWBC00	8
Crayfish	Whole body	LWG0102R015TSCRWBC00	8
Crayfish	Whole body	LWG0103R001TSCRWBC00	8
Crayfish	Whole body	LWG0103R002TSCRWBC00	9
Crayfish	Whole body	LWG0103R003TSCRWBC00	8
Crayfish	Whole body	LWG0103R004TSCRWBC00	8
Crayfish	Whole body	LWG0103R005TSCRWBC00	9
Crayfish	Whole body	LWG0103R032TSCRWBC00	9
Crayfish	Whole body	LWG0104R002TSCRWBC00	9
Crayfish	Whole body	LWG0104R003TSCRWBC00	8
Crayfish	Whole body	LWG0104R004TSCRWBC10	9
Crayfish	Whole body	LWG0104R004TSCRWBC20	10
Crayfish	Whole body	LWG0105R001TSCRWBC00	8
Crayfish	Whole body	LWG0105R003TSCRWBC00	8
Crayfish	Whole body	LWG0106R001TSCRWBC00	11
Crayfish	Whole body	LWG0106R004TSCRWBC10	9

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Crayfish	Whole body	LWG0106R004TSCRWBC20	8
Crayfish	Whole body	LWG0106R031TSCRWBC00	8
Crayfish	Whole body	LWG0107R003TSCRWBC00	9
Crayfish	Whole body	LWG0107R004TSCRWBC00	9
Crayfish	Whole body	LWG0107R006TSCRWBC00	8
Crayfish	Whole body	LWG0108R001TSCRWBC00	9
Crayfish	Whole body	LWG0108R002TSCRWBC00	9
Crayfish	Whole body	LWG0108R003TSCRWBC00	8
Crayfish	Whole body	LWG0109R001TSCRWBC10	8
Crayfish	Whole body	LWG0109R001TSCRWBC20	9
Crayfish	Whole body	LWG0109R002TSCRWBC00	8
Lab clam	Body without shell	LW2-BTLC001	183
Lab clam	Body without shell	LW2-BTLC002	183
Lab clam	Body without shell	LW2-BTLC003	183
Lab clam	Body without shell	LW2-BTLC004	183
Lab clam	Body without shell	LW2-BTLC005	183
Lab clam	Body without shell	LW2-BTLC006-1	183
Lab clam	Body without shell	LW2-BTLC006-2	183
Lab clam	Body without shell	LW2-BTLC007	177
Lab clam	Body without shell	LW2-BTLC008	177
Lab clam	Body without shell	LW2-BTLC009	183
Lab clam	Body without shell	LW2-BTLC010	183
Lab clam	Body without shell	LW2-BTLC011	183
Lab clam	Body without shell	LW2-BTLC012	183
Lab clam	Body without shell	LW2-BTLC013	177
Lab clam	Body without shell	LW2-BTLC014	183
Lab clam	Body without shell	LW2-BTLC015	183
Lab clam	Body without shell	LW2-BTLC016	183
Lab clam	Body without shell	LW2-BTLC017	177
Lab clam	Body without shell	LW2-BTLC018	183
Lab clam	Body without shell	LW2-BTLC019	183
Lab clam	Body without shell	LW2-BTLC020	177
Lab clam	Body without shell	LW2-BTLC021	177
Lab clam	Body without shell	LW2-BTLC022	177
Lab clam	Body without shell	LW2-BTLC023	183
Lab clam	Body without shell	LW2-BTLC024	177
Lab clam	Body without shell	LW2-BTLC025	177
Lab clam	Body without shell	LW2-BTLC026	177
Lab clam	Body without shell	LW2-BTLC027-1	177
Lab clam	Body without shell	LW2-BTLC027-2	177
Lab clam	Body without shell	LW2-BTLC028	177
Lab clam	Body without shell	LW2-BTLC029	177
Lab clam	Body without shell	LW2-BTLC030	177
Lab clam	Body without shell	LW2-BTLC031	177
Lab clam	Body without shell	LW2-BTLC032	177
Lab clam	Body without shell	LW2-BTLC033	183
Lab clam	Body without shell	LW2-BTLCCTRL 011906	177
Lab clam	Body without shell	LW2-BTLCCTRL 022406	183
Lab clam	Body without shell	LW2-BTLCTZ 012706	183
Lab clam	Body without shell	LW2-BTLCTZ 122205	177
Lab clam	Body without shell	WLCDRD050178G	Unknown
Lab clam	Body without shell	WLCDRD050184G	Unknown
Lab clam	Body without shell	WLCDRD05CtrlCf	Unknown
Lab clam	Body without shell	WLCDRD05Day0Cf	Unknown
Lab clam	Body without shell	WLCDRD05WRVC011Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC028Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC029Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC043Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC046Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC057Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC066Clam	Unknown

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Lab clam	Body without shell	WLCDRD05WRVC072Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC108Clam	Unknown
Lab clam	Body without shell	WLCDRD05WRVC118Clam	Unknown
Lamprey, adult	Whole body	WLTASE03WF03214300	30
Lamprey, adult	Whole body	WLTASE03WF03214301	30
Lamprey, adult	Whole body	WLTASE03WF03214302	30
Lamprey, adult	Whole body	WLTASE03WF03214303	30
Lamprey, ammonocoetes	Whole body	LW2-BTFLamp Comp	10
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp1	7
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp2	28
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp3	19
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp4	49
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp5-1	44
Lamprey, ammonocoetes	Whole body	LW3-LTA-Comp5-2	44
Lamprey, macropthalmia	Whole body	LW3-LTM-Comp1	6
Lamprey, macropthalmia	Whole body	LW3-LTM-Comp2	6
Lamprey, macropthalmia	Whole body	LW3-LTM-Comp3	9
Largescale sucker	Whole body	LWG0103R014TSLSWBC10	5
Largescale sucker	Whole body	LWG0103R014TSLSWBC20	4
Largescale sucker	Whole body	LWG0105R006TSLSWBC00	4
Largescale sucker	Whole body	LWG0107R009TSLSWBC00	6
Largescale sucker	Whole body	LWG0108R010TSLSWBC00	6
Largescale sucker	Whole body	LWG0109R006TSLSWBC00	6
Largescale sucker	Whole body	LWG01FZ0306TSLSWBC10	1
Largescale sucker	Whole body	LWG01FZ0306TSLSWBC20	2
Lumbriculus variegatus	Whole body	LW2-BTLW001	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW002	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW003	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW004	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW005	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW006-1	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW006-2	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW007	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW008	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW009	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW010	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW011	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW012	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW013	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW014	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW015	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW016	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW017	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW018	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW019	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW020	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW021	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW022	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW023	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW024	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW025	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW026	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW027-1	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW027-2	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW028	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW029	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW030	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW031	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW032	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLW033	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLWCTRL 011106	Unknown

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Lumbriculus variegatus	Whole body	LW2-BTLWCTRL 030106	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLWTZ 020106	Unknown
Lumbriculus variegatus	Whole body	LW2-BTLWTZ 121405	Unknown
Lumbriculus variegatus	Whole body	WLCDRD050176G	Unknown
Lumbriculus variegatus	Whole body	WLCDRD050187G	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05CtrlLv	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05Day0Lv	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC011Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC028Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC029Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC043Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC046Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC057Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC066Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC072Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC108Worm	Unknown
Lumbriculus variegatus	Whole body	WLCDRD05WRVC118Worm	Unknown
Multiplate invertebrates	Whole body	LW2-MIT001	Unknown
Multiplate invertebrates	Whole body	LW2-MIT002	Unknown
Multiplate invertebrates	Whole body	LW2-MIT003/005/006	Unknown
Multiplate invertebrates	Whole body	LW2-MIT004	Unknown
Multiplate invertebrates	Whole body	LW2-MIT007	Unknown
Multiplate invertebrates	Whole body	LW2-MIT008/010	Unknown
Multiplate invertebrates	Whole body	LW2-MIT009	Unknown
Northern pikeminnow	Whole body	LWG0103R014TSNPWBC10	5
Northern pikeminnow	Whole body	LWG0103R014TSNPWBC20	5
Northern pikeminnow	Whole body	LWG0105R006TSNPWBC00	5
Northern pikeminnow	Whole body	LWG0107R009TSNPWBC00	5
Northern pikeminnow	Whole body	LWG0108R010TSNPWBC00	3
Northern pikeminnow	Whole body	LWG0109R006TSNPWBC00	4
Peamouth	Whole body	LWG0103R014TSPMWBC00	5
Peamouth	Whole body	LWG0105R006TSPMWBC00	5
Peamouth	Whole body	LWG0107R009TSPMWBC00	4
Peamouth	Whole body	LWG0108R010TSPMWBC00	5
Peamouth	Whole body	LWG0109R006TSPMWBC00	5
Sculpin	Whole body	LW3-SP01E-C00	8
Sculpin	Whole body	LW3-SP01W-C00	12
Sculpin	Whole body	LW3-SP03E-C00	7
Sculpin	Whole body	LW3-SP04W-C00	9
Sculpin	Whole body	LW3-SP05E-C00	10
Sculpin	Whole body	LW3-SP06W-C00	20
Sculpin	Whole body	LW3-SP07E-C00	11
Sculpin	Whole body	LW3-SP07W-C00	10
Sculpin	Whole body	LW3-SP08E-C00	20
Sculpin	Whole body	LW3-SP08W-C00	10
Sculpin	Whole body	LW3-SP09W-C00	10
Sculpin	Whole body	LW3-SP10E-C00	11
Sculpin	Whole body	LW3-SP10W-C00	8
Sculpin	Whole body	LW3-SP11E-C00	12
Sculpin	Whole body	LW3-SP12E-C00	10
Sculpin	Whole body	LW3-SP12W-ALT-C01	32
Sculpin	Whole body	LWG0102R001TSSPWBC00	12
Sculpin	Whole body	LWG0102R001TSSPWBC10	12
Sculpin	Whole body	LWG0102R015TSSPWBC00	17
Sculpin	Whole body	LWG0103R001TSSPWBC00	17
Sculpin	Whole body	LWG0103R002TSSPWBC10	21
Sculpin	Whole body	LWG0103R002TSSPWBC20	18
Sculpin	Whole body	LWG0103R004TSSPWBC10	19
Sculpin	Whole body	LWG0103R004TSSPWBC20	20
Sculpin	Whole body	LWG0103R005TSSPWBC00	13
Sculpin	Whole body	LWG0103R032TSSPWBC00	24

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Sculpin	Whole body	LWG0103R034TSSPWBC00	19
Sculpin	Whole body	LWG0104R002TSSPWBC00	22
Sculpin	Whole body	LWG0104R003TSSPWBC00	20
Sculpin	Whole body	LWG0104R004TSSPWBC00	18
Sculpin	Whole body	LWG0105R001TSSPWBC00	21
Sculpin	Whole body	LWG0105R020TSSPWBC00	23
Sculpin	Whole body	LWG0106R001TSSPWBC00	17
Sculpin	Whole body	LWG0106R002TSSPWBC10	19
Sculpin	Whole body	LWG0106R002TSSPWBC20	19
Sculpin	Whole body	LWG0106R004TSSPWBC00	22
Sculpin	Whole body	LWG0107R003TSSPWBC00	16
Sculpin	Whole body	LWG0107R006TSSPWBC00	15
Sculpin	Whole body	LWG0108R001TSSPWBC00	19
Sculpin	Whole body	LWG0108R002TSSPWBC00	21
Sculpin	Whole body	LWG0108R003TSSPWBC00	18
Sculpin	Whole body	LWG0109R001TSSPWBC00	20
Sculpin	Whole body	LWG0109R002TSSPWBC00	19
Smallmouth bass	Body without fillet	LW3-SB010E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB010W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB011E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB011W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB02E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB03E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB03W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB04E-C01B	5
Smallmouth bass	Body without fillet	LW3-SB04W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB05W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB06E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB06W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB07E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB07W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB08E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB08W-C00B	5
Smallmouth bass	Body without fillet	LW3-SB09E-C00B	5
Smallmouth bass	Body without fillet	LW3-SB09W-C00B	5
Smallmouth bass	Fillet	LW3-SB010E-C00F	5
Smallmouth bass	Fillet	LW3-SB010W-C00F	5
Smallmouth bass	Fillet	LW3-SB011E-C00F	5
Smallmouth bass	Fillet	LW3-SB011W-C00F	5
Smallmouth bass	Fillet	LW3-SB02E-C00F	5
Smallmouth bass	Fillet	LW3-SB03E-C00F	5
Smallmouth bass	Fillet	LW3-SB03W-C00F	5
Smallmouth bass	Fillet	LW3-SB04E-C01F	5
Smallmouth bass	Fillet	LW3-SB04W-C00F	5
Smallmouth bass	Fillet	LW3-SB05W-C00F	5
Smallmouth bass	Fillet	LW3-SB06E-C00F	5
Smallmouth bass	Fillet	LW3-SB06W-C00F	5
Smallmouth bass	Fillet	LW3-SB07E-C00F	5
Smallmouth bass	Fillet	LW3-SB07W-C00F	5
Smallmouth bass	Fillet	LW3-SB08E-C00F	5
Smallmouth bass	Fillet	LW3-SB08W-C00F	5
Smallmouth bass	Fillet	LW3-SB09E-C00F	5
Smallmouth bass	Fillet	LW3-SB09W-C00F	5
Smallmouth bass	Fillet	LWG0103R014TSSBFLC00	5
Smallmouth bass	Fillet	LWG0105R006TSSBFLC00	5
Smallmouth bass	Fillet	LWG0106R024TSSBFLC00	3
Smallmouth bass	Fillet	LWG0108R032TSSBFLC00	5
Smallmouth bass	Fillet	LWG0109R006TSSBFLC00	5
Smallmouth bass	Fillet without skin	LWG0103R014TSSBFSC00	5
Smallmouth bass	Fillet without skin	LWG0105R006TSSBFSC00	5
Smallmouth bass	Fillet without skin	LWG0106R024TSSBFSC00	3

Table 2.2-10. Number of Individual Fish or Invertebrates per Sample in the RI Data Set.

Species	Tissue	Sample	Number of Individuals per Composite
Smallmouth bass	Fillet without skin	LWG0108R032TSSBFSC00	5
Smallmouth bass	Fillet without skin	LWG0109R006TSSBFSC00	5
Smallmouth bass	Whole body	LWG0103R014TSSBWBC00	5
Smallmouth bass	Whole body	LWG0104R023TSSBWBC10	5
Smallmouth bass	Whole body	LWG0104R023TSSBWBC20	5
Smallmouth bass	Whole body	LWG0104R023TSSBWBC30	5
Smallmouth bass	Whole body	LWG0105R006TSSBWBC00	5
Smallmouth bass	Whole body	LWG0106R024TSSBWBC00	1
Smallmouth bass	Whole body	LWG0107R009TSSBWBC10	5
Smallmouth bass	Whole body	LWG0107R009TSSBWBC20	5
Smallmouth bass	Whole body	LWG0107R009TSSBWBC30	5
Smallmouth bass	Whole body	LWG0108R010TSSBWBC10	4
Smallmouth bass	Whole body	LWG0108R010TSSBWBC20	5
Smallmouth bass	Whole body	LWG0108R010TSSBWBC30	5
Smallmouth bass	Whole body	LWG0108R032TSSBWBC00	5
Smallmouth bass	Whole body	LWG0109R006TSSBWBC00	2
Smallmouth bass	Whole body	LWG0120R001TSSBWBC10	5
Smallmouth bass	Whole body	LWG0120R001TSSBWBC20	5
Smallmouth bass	Whole body	LWG0120R001TSSBWBC30	5
Smallmouth bass	Whole body	LWG0128R001TSSBWBC10	5
Smallmouth bass	Whole body	LWG0128R001TSSBWBC20	5
Smallmouth bass	Whole body	LWG0128R001TSSBWBC30	5
Sturgeon (adult)	Fillet without skin	WLTASE03ISA03334750	1
Sturgeon (adult)	Fillet without skin	WLTASE03ISA03334751	1
Sturgeon (adult)	Fillet without skin	WLTASE03ISA03354100	1
Sturgeon (adult)	Fillet without skin	WLTASE03ISA03354101	1
Sturgeon (adult)	Fillet without skin	WLTASE03ISA03354102	1
Sturgeon (juvenile)	Stomach contents	LW3-SG001005-COMP	2
Sturgeon (juvenile)	Stomach contents	LW3-SG003-01	1
Sturgeon (juvenile)	Stomach contents	LW3-SG004-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB001-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB001-02	1
Sturgeon (juvenile)	Whole body	LW3-STWB001-03	1
Sturgeon (juvenile)	Whole body	LW3-STWB002-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB002-02	1
Sturgeon (juvenile)	Whole body	LW3-STWB002-03	1
Sturgeon (juvenile)	Whole body	LW3-STWB003-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB003-02	1
Sturgeon (juvenile)	Whole body	LW3-STWB003-03	1
Sturgeon (juvenile)	Whole body	LW3-STWB004-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB004-02	1
Sturgeon (juvenile)	Whole body	LW3-STWB004-03	1
Sturgeon (juvenile)	Whole body	LW3-STWB005-01	1
Sturgeon (juvenile)	Whole body	LW3-STWB005-02	1
Sturgeon (juvenile)	Whole body	LW3-STWB005-03	1

3.0 CURRENT ENVIRONMENTAL SETTING

This section describes the current natural and human-altered environmental setting of the Portland Harbor Superfund Site, including land use, regional geology and hydrogeology, surface water hydrology, the in-water physical system (which includes bathymetry, physical sediment characteristics, and hydrodynamics and sediment transport), habitat, and human access and use. Historical land use and activities on the Willamette River are discussed in Section 4.0. In addition to providing context to the RI sampling and analysis, the factors presented in this section and in Section 4 are considered in the refinement of the Study Area-wide CSM, which is discussed in Section 10.

Section 3 focuses primarily on the physical setting of the Study Area (RM 1.9 to 11.8). However, the LWR and physical features of the Willamette River and basin from Willamette Falls (RM 26) to the Columbia River (RM 0), as well as the upstream portion of Multnomah Channel, are discussed as needed to place the Study Area's physical characteristics into a regional context.

The Willamette River drains the Willamette Basin, which lies between the Cascade Range and the Coast Range and extends from headwater streams in the mountains southwest of Eugene to the confluence with the Columbia River. The portion of the river from Willamette Falls to the Columbia River is considered the LWR (see Map 1.2-1). Multnomah Channel is a tributary channel of the LWR that begins at RM 3.1 and flows approximately 21 miles to its confluence with the Columbia River.

The upstream reaches of the Willamette River above Willamette Falls constitute a meandering and, in some cases, braided river channel. Upstream flooding is largely controlled by 13 major tributary reservoirs (Uhrich and Wentz 1999). In the LWR, especially in the vicinity of Portland Harbor, the channel banks have been stabilized by the placement of riprap, and construction of seawalls, bulkheads, etc. These measures have created a much more stable channel in the LWR.

The portion of the river where the federal navigation channel is maintained at -40 ft Columbia River Datum (CRD) defines Portland Harbor and extends upstream from the Columbia River to RM 11.7 (Broadway Bridge; see Map 1.2-1 and Section 3.3.1). From 1973 through 2007, average annual mean flow in the Willamette River was approximately 33,000 cubic feet per second (cfs) at the Morrison Bridge (near RM 12.8) in Portland.[1]

3.1 CURRENT LAND AND HARBOR USE

This section provides an overview of Portland Harbor's current waterfront land and harbor use. Over the past 100 years, major physical alterations have modified the river hydrodynamics and changed the configuration of the river. Map 3.1-1 shows the

[1] Data obtained from the USGS Water Resources web site (http://waterdata.usgs.gov/or/nwis/sw).

channel reconfiguration and dredging history from 1888 to 2001. The LWR is currently highly urbanized and industrialized. Some remnant natural areas remain and support habitat for aquatic and terrestrial wildlife. A description of the industrial and marine development in the harbor is presented in Section 4.1-1.

3.1.1 Current Land Use

Portland Harbor is located within a broader region characterized by commercial, residential, recreational, and agricultural uses. A portion of the land adjacent to Portland Harbor is located within the Guild's Lake Industrial Sanctuary Plan area (from the St. Johns Bridge at RM 5.8 to 10.7, along the west shore). Land use along the Willamette River within the harbor includes marine terminals, various manufacturing facilities, and commercial operations, as well as public facilities, parks, and open spaces. A description of the industrial and marine development in the harbor is presented in Section 4.1-1.

Maps 3.1-2a–e illustrate current land use zoning within the LWR and upper Multnomah Channel and show sites located within Study Area drainage basins. Site parcels and sites inventoried in DEQ's Environmental Cleanup Site Inventory (ECSI) database are identified on the maps. Waterfront properties are also labeled. Current and previous facility names for these sites are listed in Table 3.1-1.

The shoreline has had significant physical modifications, including structures built to stabilize the riverbanks for development, as shown on the aerial photographs in Maps 3.1-3a–t. Riprap is the most common bank-stabilization measure, although upland bulkheads and rubble piles are also used. Seawalls are constructed primarily of treated timbers or concrete to control periodic flooding. Scattered natural areas also are found along the shoreline (Maps 3.1-3a–t).

The current overwater structures, such as wharfs, piers, floating docks, and pilings, were built largely to accommodate or support shipping traffic. These structures along the shoreline are clearly visible in the aerial photographs provided in Maps 3.1-3a–t. Numerous public and private outfalls, including stormwater and combined sewer overflow (CSO) outfalls, enter both shores of Portland Harbor, and are described further in Section 3.1.4.

The remainder of Section 3.1 presents a history of the channel authorization and dredge and sediment cap activities within the Study Area and a summary of conveyance systems and outfalls.

3.1.2 Navigational Channel Authorization History

Congress authorized the LWR federal navigation project through the Rivers and Harbors Act in June 1878. Its purpose was to deepen and maintain parts of the Columbia and Willamette rivers to a 20-ft minimum depth. The channel for both rivers has been deepened at various intervals since that time. Most significantly, the

authorizations affecting the LWR depth occurred as follows: -25 ft CRD in 1899, -30 ft CRD in 1912, -35 ft CRD between 1930 and 1935, and, finally, -40 ft CRD in 1962.

The current project authorization, as modified by Congress in 1962, encompasses 11.7 miles of the Willamette River in Portland and 103.5 miles of the Columbia River below Vancouver, Washington. Work on the authorized -40-ft-deep CRD channel from Portland and Vancouver to the Pacific was completed in 1976. The Willamette River channel from the Broadway Bridge (RM 11.7) to the mouth (RM 0) varies in width from 600 to 1,900 ft, with an average width of approximately 1,700 ft.

3.1.3 Dredging and Capping Activities

This section presents Portland Harbor dredging and capping activities since 1997. This date corresponds to the oldest data used in the presentation and evaluation of analytical data in this report. This section also notes ongoing and upcoming dredging projects in Portland Harbor.

In certain areas of Portland Harbor, periodic dredging is necessary to maintain the authorized depth of the navigation channel, as well as to maintain operational depths at docks and wharfs. Major changes in the river's bathymetry from 1888 to 2001 are depicted on Map 3.1-1. This map shows how the original shoreline was altered and filled, where material was excavated to create new uplands, and how most of the original channel has been deepened by at least 10 to 20 ft to reach the authorized federal navigation channel depth of -40 ft CRD. Historically, periodic dredging was needed to maintain this depth in two major shoaling areas, between RM 8 and 10, particularly in the western half of the channel, and from RM 2 to 2.5 in the eastern portion of the channel. The navigation channel has not been dredged since January 1997, although dredging at various docking facilities has occurred on an as-needed basis (Map 3.1-4). Currently, maintenance dredging has been suspended until issues are resolved regarding dredging within the boundaries of the Portland Harbor Superfund Site. The lack of maintenance dredging over the past 10 years has resulted in significant shoaling of the channel. Many areas of the channel are now less than 40 ft deep, which is a significant navigation hazard to large cargo ships that require a minimum draft of 40 ft. The USACE identified a critical area of shoaling in the river that needs immediate attention (i.e., Post Office Bar at RM 2), and proposed to conduct an interim dredging action (Portland Harbor Community Advisory Group 2008, pers. comm.); however, the USACE was again unable to gain approval to perform the work during 2009, mainly due to the Superfund issues. It is now unclear when this dredging will take place.

Dredging projects undertaken since 1997 by the Port of Portland, USACE, the City of Portland, and private parties are listed in Table 3.1-2. This table is an update of a similar compilation provided in the Programmatic Work Plan (Integral et al. 2004) and the Round 2 Report. The dredging projects that are italicized in the table indicate recent projects for which a USACE public notice has been issued, but specific information about dredging dates and amounts was not available in time for this report. Note that

the issuance of a permit does not mean that the project was implemented or that the volume of dredged material indicated in the table was dredged. Furthermore, the table does not distinguish between single events and multi-year permits. Map 3.1-4 shows the locations of dredging and capping operations between RM 1 and 11.8, since the most recent USACE-sponsored dredging of the federal navigation channel in January 1997.

Since 1997, the Port of Portland has performed maintenance dredging at its marine Terminals 2, 4, and 5 (see Table 3.1-2). Maintenance dredging has also been performed by Schnitzer Steel Industries, Inc. (Schnitzer berths in International Terminal Slip, RM 4), Chevron (Willbridge Terminal, RM 7.5), the City of Portland (Portland Fire Bureau Station 6 Dock, RM 9.7), the former Goldendale Aluminum Company (Goldendale Aluminum facility dock, RM 10), and Cargill (Irving Elevator Terminal, RM 11.6). The City of Portland project also included cap placement, as noted below. Brief descriptions of these dredging projects are described below.

- Schnitzer performed maintenance dredging of its berths located inside the International Terminal Slip in 2004 under two separate permits. Approximately 77,000 yd^3 of material was dredged from Berths 1, 2, and 3 under Permit #199100099. Maximum target dredge depths were -42, -38, or -24 ft CRD, depending on the location within the slip. Outside the slip, Schnitzer dredged approximately 61,000 yd^3 of material from Berths 4 (to -42 ft CRD) and 5 (to -36 ft CRD) under Permit #199200812. The permits for both projects allow for biannual maintenance dredging through January 31, 2009 (USACE 2004a,b).
- In 2001, Chevron Products removed approximately 15,000 yd^3 of material from both sides of its pier at Willbridge Terminal. The dredging was performed under a maintenance dredging permit issued in 1997. Sediments were removed to a target dredge depth of -40 ft CRD (PNG 2001).
- The former Goldendale Aluminum Company conducted maintenance dredging at its dock in 2000. Dredging volumes were not provided, but material was removed to -38 ft CRD (CH2M Hill 2000).
- The City of Portland performed maintenance dredging of the Portland Fire Bureau Station 6 Dock in 2005. The area approaching the dock was dredged to -12 ft CRD, and the area adjacent to the dock was dredged to -10 ft CRD. Altogether, 4,130 yd^3 of dredged material was removed. In accordance with the permit, both areas were capped to bring the bottom grade to between -10 and -11 ft CRD. Approximately 1,190 yd^3 of capping material was used (CH2M Hill 2005).
- Cargill performed maintenance dredging at the Irving Elevator Terminal in 2001. Approximately 5,000 yd^3 of material was removed to a permitted depth of -40 ft CRD (Harding ESE 2001).

- The dock area offshore of Glacier NW (RM 11.3) was dredged between 2004 and 2006, but no as-built drawings are available to determine the volume removed and the exact footprint.

Maintenance dredging is planned for several areas in Portland Harbor. Upcoming multiyear maintenance dredging projects include work by the Port of Portland at Terminal 2 (Berths 205, 206), Terminal 4, and Terminal 5 (Berths 501, 503). Maintenance dredging is also planned for the dock areas offshore of Cargill and Gunderson and at Willbridge.

Dredging and/or capping have also been completed or are in process as part of remedial actions at selected Portland Harbor locations. Interim removal action activities at Terminal 4 are underway and are scheduled to occur in two phases. The first phase, which was completed in the fall of 2008, included dredging of approximately 13,000 yd^3 of contaminated sediment and placement in an offsite disposal facility, isolating contaminated sediment in the back of Slip 3 with a cap made of an organoclay-sand mix, and re-contouring the slope of the bank along Wheeler Bay and planting native vegetation to minimize erosion and improve stability. The second phase of the Terminal 4 project includes dredging, capping, monitoring natural recovery, and constructing a confined disposal facility to hold dredged sediment. Exact dates for the second phase have yet to be determined (Port of Portland 2008).

Two in-river sediment capping projects (M&B and Gasco) have taken place since 2003. M&B was a remedial action project following a ROD, and Gasco was an interim removal action. Both projects are described below.

Sediment cap construction activities at M&B, a former wood treating facility, were completed in September 2005. (Subsequent modifications to the cap were performed in October 2005 and July 2007.) The cap's shoreward boundary extends from the south end of the property north into Willamette Cove (RM 6.8). Its offshore boundary extends up to approximately 700 ft from the shoreline. In Willamette Cove, the cap extends offshore up to approximately 600 ft. Approximately 23 acres of contaminated sediments were capped with 2 ft of sand. More highly contaminated areas were capped with 5 ft of sand. In addition, multiple areas of the cap overlying seeps were constructed with a total of 600 tons of organoclay, a bentonite or hectorite clay altered to be hydrophobic. The cap design incorporated different types of armoring (i.e., articulating concrete block mats and rock) in the nearshore areas to reduce erosion (DEQ 2005).

In 2005, pursuant to an EPA Administrative Order, approximately 15,300 yd^3 of tar and tar-contaminated sediment were removed by dredging from the riverbank and nearshore area adjacent to the Gasco facility and disposed of at the Chemical Waste Management landfill in Arlington, Oregon. After the removal action, an organoclay mat was placed along an upper-elevation band of the shoreline dredge-cut. This mat was secured with placement of cap sand and quarry spalls over the clay mat. The remainder of the removal area (0.4 acres) received 1 ft of cap sand and 0.5 ft of erosion protection gravel.

In addition, 2.3 acres of the area surrounding the removal area received 0.5 ft of "fringe cap" sand material. The removal action also created a depression into which potential seepage could be captured and localized for future response. Construction activities took place between August and October 2005 (Parametrix 2006).

3.1.4 Outfalls and Conveyance Systems

This section focuses on the current physical characteristics of outfalls and conveyance systems in the LWR in the Study Area; Section 4 addresses historical conveyance systems as a pathway for contaminant release to the LWR. Information presented in this section is primarily from the Programmatic Work Plan (Integral et al. 2004) and the *Programmatic Source Control Remedial Investigation Work Plan for the City of Portland Outfalls Project* (CH2M Hill 2004), as well as additional LWG analyses.

Figure 3.1-1 shows the hydroboundary, the approximate overall area draining stormwater to the Study Area. The delineation of the overall drainage basin area between RM 1 and 11.8 was provided by the City of Portland (City of Portland 2006a,c).

3.1.4.1 Outfalls

Within the Study Area, outfalls have been installed by a variety of entities, including private landowners, the Port of Portland, the State of Oregon, and the City of Portland. Most of the outfalls currently convey primarily stormwater, although historically some also conveyed industrial and sanitary discharges.

Some outfalls also currently convey nonstormwater discharges. Some nonstormwater discharges, such as noncontact cooling water, must be permitted while other nonstormwater discharges, such as landscape irrigation, are exempt under federal regulation. As discussed below in Section 3.1.4.2, some outfalls include a CSO component as well.

The City of Portland identified over 400 potential public and private outfalls along both shores of the Study Area (City of Portland 2006a,c). Using site-specific information and field reconnaissance, the LWG independently verified these outfalls and researched areas that potentially had additional outfalls. Incorporating results of the field reconnaissance, a total of 436 total outfalls were identified; of these approximately 313 are active, 44 are inactive, 30 are abandoned, 15 have been removed, 27 are unknown outfalls, and 7 were determined to not be outfalls (Integral 2008a).

The types of outfalls are defined below:

- **Active** = outfall is currently in use
- **Inactive** = outfall pipe exists, and is not filled, plugged, or disconnected, but discharge is presently not occurring

- **Abandoned** = outfall pipe exists but it is filled, plugged or disconnected, and discharge is not occurring
- **Removed** = outfall pipe has been removed
- **Unknown** = despite best efforts, the status of some outfalls cannot be determined.

Attributes for some outfalls in the data set remain flagged despite repeated attempts by LWG to verify during field work or due to conflicting information from the facility and the City.

The location and status of the outfalls within the Study Area are shown on Maps 3.1-5a–m. Note that roof drains and dock drains are depicted with different symbols on the map.

Discharges to the river are regulated by a variety of permits, including the National Pollutant Discharge Elimination System (NPDES) general stormwater permits (1200-Z); the City of Portland, Port of Portland, and Multnomah County Municipal Separate Storm Sewer System (MS4) discharge permits; the City of Portland wastewater discharge permit that includes combined sewer overflows and sewer system overflows; individual stormwater permits; and multiple general industrial stormwater permits. The Oregon Department of Transportation (ODOT) also has its own MS4 discharge permit for runoff from state highways. These permits are described further in Section 4.4.1.4.

3.1.4.2 Conveyance Systems

There are three general types of conveyance systems in the Study Area, as shown in Figure 3.1-2: 1) separated systems, 2) combined systems that discharge to the Columbia Boulevard Wastewater Treatment Plant (CBWTP), and 3) combined systems with overflow diverters. Separated systems have stormwater-only lines that discharge to the river and sanitary-only lines that discharge to the treatment plant. In combined systems, the stormwater and sanitary lines join and flow in a combined line. Most of the Study Area is served by separate storm lines and separate sanitary sewers. Only a limited portion of the area is served by the combined system and not all of the combined system has the ability to overflow to the river (see Section 4.1.2.2). Stormwater and combined systems are further described below.

The sanitary conveyance systems do not discharge to the river unless there is a total pump station failure. The sanitary pump stations have emergency overflow lines that connect to existing CSO and stormwater outfalls; a pump station discharge would be called a sanitary sewer overflow (SSO). SSOs are infrequent: since 1996, when the City developed a tracking database, there have been no recorded SSOs within the Portland Harbor. The locations of the SSO points are described in Section 4.

3.1.4.2.1 Stormwater Systems

Stormwater enters the river via stormwater conveyances, overland flow, and infiltration to groundwater. Stormwater conveyance systems typically consist of ditches, swales, storm drains, inlets, and catch basins connected to the outfall through pipes or lines.

Overland flow of stormwater occurs at some locations immediately adjacent to the river. In many of these areas, the extent to which rainwater falling on pervious ground near the river shoreline results in runoff versus infiltration into the ground is unknown. In some impervious shoreline areas, stormwater appears to be transported to the river via overland flow, with little chance for infiltration into the ground. A preliminary assessment of outfall drainage basins conducted for the Round 2 Report indicated that the area drained by overland flow appears to be relatively small compared to the area in which stormwater is discharged via outfalls. Given the difficulties of defining all stormwater conveyance drainage basins along the river, the proportion of overland flow to the river has not been further quantified for this RI.

Additionally, stormwater can enter the river indirectly via infiltration into pervious ground (or through dry wells, sumps, and other infiltration facilities), where it is then mixed with groundwater and discharged to the river as groundwater. Groundwater discharges are further discussed in Section 3.2 and Section 4.

Most of the stormwater from the west side of the river drains from Forest Park, an area which consists mostly of undeveloped parkland. Streams from Forest Park generally enter underground pipes at the base of the West Hills, near U.S. Highway 30. At this point, the highway stormwater drainage often enters these same conveyance systems. On the east side of the river, there are few open channel drainages, and most of the stormwater is discharged via conveyance systems. Most properties adjacent to the river on both sides do not discharge through shared conveyance systems but directly discharge to the river via their own stormwater conveyance systems and outfalls or overland flow.

Just under half of the stormwater drainage to the Study Area is through shared conveyance systems; open space comprises about 60 percent of these basins. These systems are further discussed in Section 4.4.1.3 and include shared conveyance systems owned by the City, by Burgard Industrial Park, and by ODOT; multiparty outfalls with unknown ownership; and Saltzman Creek.

In some locations, stormwater is captured by the City of Portland combined conveyance systems and is routed to CBWTP.

Section 4.4.1 further discusses the stormwater basins and the types of stormwater discharges, including a map showing a categorization of the different drainage types within the Study Area (i.e., shared conveyances, direct discharge, no discharge, and uncertain drainage).

3.1.4.3 Combined Sewer Systems

This section focuses on the current City of Portland CSO system. Sanitary interceptor lines run south to north through the main trunk lines, paralleling the riverbanks. Interceptors are large lines that collect sanitary and combined flows and direct them to the treatment plant. Some combined lines have diverters that allow excess flow to discharge to the LWR during heavy storms for a portion of the rainfall event; this is called a CSO. The diverters are designed to protect the interceptor from excess stormwater inflow by diverting the peak portions of the flow. Combined systems without CSO diverters direct all sanitary and stormwater flow to the treatment plant.

The City of Portland is now 18 years into a 20-year CSO abatement program. An abatement is defined as including both full and partial separation techniques. The location and status of CSO outfalls, including a summary of abatements completed and planned within the Study Area (City of Portland 2008a), is provided in the Table 3.1-3 and shown in Map 3.1-5a–m. The abatements listed include the following:

- Controlled to 3-year summer/4-per-winter storms, which means that the system is designed to meet the Amended Final Stipulated Order (AFSO) standard to reduce the number of overflows to the Willamette River to an average of one per every three summers and four per each winter
- Sealed off, which means that no sewage discharge can occur.

A previously combined system that has been fully separated sends sanitary wastewater to the CBWTP and stormwater to the LWR through separate conveyance systems. The stormwater may be diverted to a different outfall, or it may use the former CSO outfall. In the case of the latter, the CSO outfall becomes a Municipal Separate Storm Sewer System (MS4) outfall. Table 3.1-3 identifies which situation applies to each fully separated outfall. A partially separated CSO system conveys the combined sanitary and industrial wastewater and significantly reduced stormwater to the CBWTP except during extreme wet weather events when a portion of the combined flow overflows to the Willamette River due to capacity limitations.

Table 3.1-3 also shows the combined or CSO outfalls that were either converted to stormwater-only outfalls or abandoned before the City's 20-year abatement program was initiated.

3.2 HYDROGEOLOGY

The current understanding of the generalized hydrogeology of the Study Area is presented in this section. The detailed hydrogeology of the upland areas on both sides of the river varies by location. This generalized discussion is intended to describe the important basic hydrogeologic units and their properties and groundwater flow within the Study Area and is not representative of any one particular location. An upland groundwater data review that summarizes hydrogeologic information and groundwater

quality data from specific upland sites in the vicinity of the Study Area has been completed by LWG (GSI 2003a).

3.2.1 Geologic Setting

The Study Area is located along the southwestern edge of a large geologic structure known as the Portland Basin. The Portland Basin is a bowl-like structure bounded by folded and faulted uplands. These northwest-trending structural zones are interpreted as dextral wrench faults that delineate the Portland pull-apart basin (Beeson et al. 1985; Yelen and Patton 1991).

The basin has been filled with up to 1,400 ft of alluvial and glacio-fluvial flood deposits since the middle Miocene (approximately 12 million years ago). These sediments overlie older (Eocene and Miocene) rocks including the Columbia River Basalt Group (CRBG), Waverly Heights basalt, and older marine sediments. The older rocks are exposed where uplifting has occurred on the margins of the basin, including adjacent to the Study Area.

Because the Study Area is located at the edge of the basin, both the older rocks and overlying sediments are present near the surface and play a significant role in defining interactions between groundwater and the river. The geologic units found in the vicinity of the Study Area are illustrated in Figure 3.2-1 and briefly described below, from youngest to oldest (Beeson et al. 1991; Swanson et al. 1993):

- **Recent Anthropomorphic Fill.** Anthropomorphic fill blankets much of the lowland area next to the river and is predominantly dredged river sediment, including fine sand and silty sand. Hydraulic dredge fill was used to fill portions of the flood plain, such as Doane Lake, Guild's Lake, Kittridge Lake, Mocks Bottom, Rivergate, and a number of sloughs and low-lying areas. The fill also was used to connect Swan Island to the east shore of the Willamette River, and to elevate or extend the bank along significant lengths of both sides of the riverfront by filling behind artificial and natural silt and clay flood levee dike structures. Rocks, gravel, sand, and silt also were used to fill low-lying upland and bank areas. The thickness of this unit ranges from 0 to 20 or more feet. The permeability of this unit, where composed of clean dredge fill sand, is higher than the natural fine-grained alluvium. The presence of silt fill or a silty matrix in the sand fill generally reduces the permeability of the unit significantly.
- **Fine-grained Pleistocene Flood Deposits and Recent Alluvium (Undifferentiated).** This unit includes fine-grained facies of the Pleistocene Flood Deposits, as well as recent alluvium deposited by the present Willamette River. This unit generally consists of silt, clay, silty sand, and fine-to-medium sand that borders and underlies the present floodplain of the river (Beeson et al. 1991). The lower portions of this unit and where it forms the large bluffs bordering the east side of the river likely consist of the fine-grained facies of the

flood deposits, whereas the upper portions near the river are likely more recent alluvium. The upper fine-grained portion of the unit has likely been reworked and deposited by the present Willamette River. The sands of this unit may be indistinguishable from overlying dredge fill in some places (Landau 2002a). The thickness of this unit ranges from 20 to over 100 ft. The permeability of the clay, silt, and silty sand of this unit is generally relatively low, whereas the portions of the unit consisting of clean sands may have a relatively higher permeability. This unit forms part of the Unconsolidated Sedimentary Aquifer regional hydrostratigraphic unit proposed by Swanson et al. (1993).

- **Coarse-grained Pleistocene Flood Deposits (Gravels).** The gravels include fluvial deposits from the Pleistocene Missoula floods. The deposits fill deep channels that were incised into the Troutdale Formation and CRBG during the floods. The unit consists of uncemented sand, gravel, and cobbles with boulders in places. This unit is generally between 10 and 200 ft thick in the vicinity of the Study Area and underlies fine-grained flood deposits and recent alluvium under much of the Study Area. The Willamette River subsequently incised the flood deposits in places. The rise in sea level from the end of the Pleistocene to the present resulted in the filling of the incised channel by finer-grained flood and recent alluvial facies to form the current floodplain channel of the river.
- **Upper Troutdale Formation.** The upper Troutdale Formation in the vicinity of the LWR includes cemented and uncemented alluvial sand, gravel, and cobbles deposited by the ancestral Willamette and Columbia rivers. The Troutdale Formation comprises the Troutdale Gravel Aquifer hydrostratigraphic unit. This unit is present in some places on the west side of the Study Area to thicknesses of 100 ft and is present along the entire length of the east side of the Study Area at thicknesses of up to 200 ft (Swanson et al. 1993).
- **Lower Troutdale Formation/Sandy River Mudstone.** The Sandy River Mudstone (SRM) is a fine-grained equivalent of the lower Troutdale Formation that overlies the CRBG in the center of the basin and at the margins of the basin away from the axis of the Columbia River. The lower Troutdale Formation/SRM is present in places under the LWR (Swanson et al. 1993) and borders the Portland Hills, but is not considered a significant hydrogeologic unit within the Study Area. The lower Troutdale Formation/SRM consists mostly of silt and clay with lenses of sand and gravel and tends toward fine-grained (low permeability) textures at the basin margins (Swanson et al. 1993).
- **Columbia River Basalt Group.** The CRBG consists of a thick sequence of Miocene basalt flows dating from between 17 and 6 million years ago (mya), but the CRBG flows that underlie much of the Portland Basin entered the area between 16.5 mya and 12 mya. Basalt flows of the CRBG were folded and faulted during the uplift of the Tualatin Mountains, concurrent with eruption and emplacement of younger flows present in the Portland Basin (Beeson et al. 1991). The CRBG is present at the surface or at relatively shallow depths along the west side of the Study Area and may be in direct contact with the river in

places. The top of the unit drops off below ground surface (bgs) over a relatively short distance and is 400 or more ft bgs on the east side of the Study Area. The thickness of the CRBG in the vicinity of the Study Area is estimated to be approximately 600 ft (Beeson et al. 1991).

3.2.2 Hydrogeologic Units

The geologic units described above can be grouped into Study Area-wide hydrogeologic units on the basis of having generally similar hydrogeologic characteristics. Important hydrogeologic characteristics include the position of the groundwater surface relative to each hydrogeologic unit, the physical relationship between each hydrogeologic unit and the river, and physical characteristics of each hydrogeologic unit, such as permeability, heterogeneity, and anisotropy.

These hydrogeological units are described from uppermost to lowermost in the following sections.

3.2.2.1 Fill, Fine-grained Facies of Flood Deposits, and Recent Alluvium (FFA)

The FFA unit is composed of the fill, the combined fine-grained facies of the Pleistocene flood deposits, and the recent alluvium geologic units described by Beeson et al. (1991) and in Section 3.2.1. This unit, which encompasses a broad range of soil textures and hydraulic characteristics, blankets much of the lowland area next to the river and includes much of the material abutting the river. The unit consists of the fine sand and silty sand dredge fill overlying recent and Pleistocene silt and clay overbank sediments, which are interbedded with lenses and layers of fine to coarse sand. As discussed in Section 3.2.1, the dredge fill was placed behind low-permeability, artificial and natural flood levee dike structures in some locations. The thickness of this unit can be up to 150 ft, but it typically ranges between 30 and 100 ft.

The FFA hydrogeologic unit is the primary unit of importance in defining the interactions between upland groundwater and the river because of the following characteristics of the unit:

- The unit forms most of the river channel within the Study Area as well as the surrounding upland areas and, therefore, controls groundwater interactions with the river
- Most groundwater chemical plumes present in the upland areas occur within strata of this unit.

The distribution of textures and thus groundwater flow properties of the unit vary both vertically and horizontally by location along the Study Area. Silt, clay, and silty sand are present adjacent to the river at a majority of locations where the unit is observed near low river stage levels. Boring logs at sites north of RM 4 on the east side of the river indicate that a greater portion of the unit north of RM 4 and at depths below low river stage levels consists of sand layers. Comparison of hydraulic conductivity values

for different textures within the FFA unit listed below illustrates the importance of the channel sand lenses and layers in focusing groundwater fluxes to the river at any particular location where present within this unit:

- Silt/clay: 0.005 to 2 ft per day
- Silty sand: 0.1 to 2 ft per day
- Sand: 0.5 to 30 ft per day.

The typical measured hydraulic conductivities in the silt/clay facies of the FFA indicate that groundwater fluxes from these sediments within the Study Area are generally low. Identification of only a few seeps present in silt/clay during the seep reconnaissance survey (GSI 2003b) is consistent with this conclusion. Conversely, groundwater fluxes from the uplands to the river within the FFA are expected to be greater in those areas where more permeable sand zones are present.

3.2.2.2 Coarse-grained Flood Deposits and Upper Troutdale Formation (CGF)

The CGF unit combines the unconsolidated coarse-facies flood deposits, including sands, gravels and cobbles, with the underlying uncemented and cemented gravels and cobbles of the upper Troutdale Formation. The flood gravels that compose the upper portion of this unit typically occupy scour channel surfaces on older units (e.g., the CRBG). Anthropomorphic fill; silt, clay, and sand of the flood deposits; and alluvium mostly cover the CGF, except in places on the highland bluffs on the east side of the river where the unit may be exposed.

The CGF unit is adjacent to and underlies much of the Study Area to thicknesses exceeding 200 ft. The overall thickness of the unit is more typically in the range of 100 ft. However, the unit is missing in places, including on the west side of the river towards the south end of the Study Area and directly under the river at RM 7. The top of the CGF unit is present at elevations of 0 ft to over -100 ft mean sea level (MSL). The unit is present at relatively shallow depths adjacent to the west side of the river in the vicinity of the Doane Lake area and may be in contact with river sediments. The hydraulic conductivity of this unit measured in the vicinity of the Doane Lake area ranges from 3 ft per day to greater than 40 ft per day (AMEC 2001).

Because this unit has a relatively higher hydraulic conductivity than the overlying FFA unit, groundwater may flow more readily through this unit to deeper units where downward gradients are present and where the unit is present adjacent to the river, allowing deeper groundwater to more readily discharge to the river. Higher fluxes to the river within the CGF unit may increase downward gradients and thus increase groundwater and contaminant plume movement in the FFA unit. The effect of the CGF unit on groundwater flow in the FFA is a factor in the selection of characterization methods. Locations where the CGF unit may exert a stronger influence on deeper groundwater flow to the river, and thus vertical gradients in the FFA, include the Doane

Lake area, the southern edge of the Study Area, and on the east side of the river in the vicinity of the International Terminal.

3.2.2.3 Lower Troutdale Formation/Sandy River Mudstone

This hydrogeologic unit is present in some places under the west side of the Study Area and is present under the entire length of the east side of the Study Area. The unit is predominantly silt and clay where explored in the vicinity of the Study Area, and thus the permeability of the unit is low. Where present, the unit overlies the CRBG below depths of -100 to -150 ft MSL and tends to pinch out on the west side and towards the southern end of the Study Area where the CRBG is present at shallower depths. The unit typically is separated from the river by at least 100 to 200 ft of alluvium and deposits of the upper Troutdale Formation. Based on the hydrogeologic characteristics of this unit and the depth relative to the river, it is not considered to contribute significantly to surface water/groundwater interactions within the Study Area.

3.2.2.4 Columbia River Basalt Group

The CRBG consists of a concordant sequence of basalt lava flows. Groundwater flow in the CRBG is focused along the higher permeability interflow zones and in some areas of fracture-enhanced permeability (e.g., faults). Hydraulic conductivities measured in individual basalt interflow zones in the vicinity of the Study Area range from 1.5 to 10.9 ft per day (AMEC 2001). Hydraulic conductivities measured in CRBG basalt flow interiors at Hanford, Washington, range from 1×10^{-4} to 1×10^{-7} ft per day (Strait and Mercer 1986), illustrating that the basalt interflow zones (flow top and bottom collectively) are the primary groundwater flow pathways in the CRBG.

The CRBG is present at relatively shallow depths along portions of the west side of the Study Area and may be in direct contact with the river in places. The top of the unit is irregular on the west side of the Study Area with channels from scouring by flood events and the ancestral Willamette River. The top of the unit on the west side of the Study Area is between elevation 0 ft and -50 ft MSL north of RM 9, except for an ancestral channel in the vicinity of Doane Lake (Figure 3.2-1). The top of the CRBG slopes down to an elevation of -250 ft MSL or more across the river on the east side of the Study Area. The relief of the unit across the Study Area appears to be due to structural downwarping towards the center of the basin, and may be accentuated by normal faulting postulated along both sides of the Study Area (Beeson et al. 1991; Beeson 2003, pers. comm.). The overall significance of the CRBG with regard to groundwater/surface water interactions within the Study Area is not well characterized; however, the CRBG is considered to be most relevant to groundwater interactions with the river on the west side of the river downstream of about RM 9 because of its proximity to the river.

3.2.3 Groundwater Flow

Up to three general groundwater flow systems of interest are recognized along the Study Area: a shallow (shallow FFA), an intermediate (deep FFA), and a deep (CGF

and CRBG) system. A deeper, regional flow system also is present, which includes the CRBG, where it is deep below the river (on the east side of the river), and lower Troutdale Formation/SRM. This deeper, regional flow system is not considered to be important in understanding the interactions between upland groundwater and the river that are relevant to this RI/FS.

At a local level, these divisions between flow systems are likely indistinct in places along the Study Area. Additionally, some investigations have identified further flow system refinements or divisions based on the local hydrogeology. However, the general flow systems described above appear to apply for the majority of the Study Area and provide a general model from which variations can be evaluated on a local scale. Figure 3.2-2 presents the generalized conceptual picture of groundwater flow through these flow systems. This figure supports the following discussions of groundwater flow systems.

3.2.3.1 Shallow Flow System

The shallow, unconfined, groundwater flow system along the margins of the Study Area consists mostly of fill and alluvial silt and clay deposits and some medium- to coarse-grained channel sand of the shallow FFA that blankets the lowlands next to the river, as shown in the generalized conceptual image on Figure 3.2-2. At many locations, the shallow flow system is hosted within the lower portion of fine dredge-fill sand and underlying silty sand and silt. The shallow system is recharged by direct precipitation and infiltration, infiltration from the hills on the west side of the Study Area, and exchange with several surface water bodies along the Study Area (e.g., Doane Lake). Groundwater in this system is unconfined. Groundwater level data in the upland areas indicate that there is a downward gradient toward deeper units from the shallow system. Groundwater levels and fluxes in the shallow system are affected by seasonal river stage changes, as well as by diurnal tidal influences. The degree of tidal influence decreases with increasing distance from the river and shallower groundwater depths. Groundwater gradients within the shallow system are generally steep immediately adjacent to the river and flatten out away from the river bank. The shallow flow system discharges to the river as surface seeps and subsurface discharge, generally in nearshore areas.

The presence of low-permeability features, such as silt and clay dikes constructed to retain hydraulically emplaced dredge fill, cutoff walls, and retaining walls, may act to impede groundwater flow locally in the shallow system, resulting in higher groundwater levels and steep shallow groundwater gradients near the shore. The presence of preferential pathways (human-made and natural) in the shallow FFA can be a significant, albeit localized, influence on the discharge of groundwater to the river.

3.2.3.2 Intermediate Flow System

The intermediate flow system occurs within thicker sequences of the fine-grained alluvial sediments of the FFA. Groundwater in the intermediate system generally discharges to the Willamette River below the river surface to deeper portions of the

river (Figure 3.2-2), with discharge focused at the locations where more permeable strata (typically sand) may intersect the river. Horizontal hydraulic gradients within the intermediate flow system tend to be flatter near the river than observed in the shallow system, and thus high river stages and tidal changes may exert a greater influence on fluxes from the intermediate system to the river by further flattening or perhaps reversing the gradient locally.

3.2.3.3 Deep Flow System

The deep flow system occurs within the CGF and basalt interflow zones of the CRBG, where the CRBG is present near the surface on the west side of the river. Downstream of about RM 9 on the west side of the river, residual basalt gravels immediately overlying the CBRG have been identified as important hydrogeologic features and potential conduits for groundwater contaminant transport. Groundwater in the deep system discharges to the Willamette River only in deeper portions of the river, with discharges focused at the locations where the gravels and/or basalt interflow zones are near or intersect the river sediments (Figure 3.2-2).

The CRBG does not play a role in the deep flow system on the east side of the river, because it occurs at substantially greater depth due to structural downwarping and associated normal faulting. Deep groundwater flow in the east side of the river occurs in the CGF, which is generally highly transmissive; however, gradients may be relatively low. Seasonal gradient reversals are known to occur during periods of high river stages. Where near the river, the connection, and thus response, to river stage changes is expected to be great.

3.2.4 Processes Governing Discharge of Groundwater to the Study Area

Generally, groundwater flow adjacent to the Study Area is toward the river. In the absence of preferential pathways, groundwater flow to the sediments and river will be diffuse along the length of the interface of each flow system with the river. However, permeability contrasts of several orders of magnitude can be expected in the FFA where alluvial processes create lenses and channels of sand within or surrounding finer-grained materials. The result of these permeability contrasts is that groundwater discharge will tend to be heavily influenced by the location and geometry of higher permeability layers (e.g., sands) in relation to the river.

Discharge from the shallow water-table groundwater system tends to be focused at or below the river/shore interface. Low river stages expose zones of focused discharge as seeps along the bank where the shallow groundwater surface intersects the ground surface. Preferential pathways, including coarse backfill (e.g., around utilities), historic stream channels, or sand/gravel layers focus groundwater flow, particularly where they occur in predominantly fine-grained sediment sequences in the shallow groundwater system. The groundwater flow regimes of all of the flow systems show seasonal patterns related to seasonal river stage and precipitation variations.

The gradient and the resultant flux from these systems vary with seasonal river stage changes. Diurnal tidal stage changes also result in temporary gradient and thus flow changes, particularly where the degree of connection between the river and adjacent aquifer is greater. Groundwater discharge through the river sediments to surface water is controlled by: 1) the permeability contrast between the sediments and underlying aquifer, and 2) the difference between the hydraulic head in groundwater at the aquifer/sediment interface and the river stage, which determines hydraulic gradient.

Direct measurements of groundwater seepage rates to the river were taken during the LWG Round 2 investigation and during the offshore investigation performed by Gasco (Anchor et al. 2007). Locations of these measurements are discussed in Appendix C2. Measurements were taken in nearshore areas as well as farther offshore, including several locations within the navigational channel. In all, 77 ultrasonic seepage meter measurements were taken (70 LWG measurements and 7 non-LWG measurements), primarily during the season of presumed maximum groundwater flux (high upland groundwater levels and low river stage). Daily average measurements ranged from -18.2 cm/day (recharge) to 14.2 cm/day (discharge to the river), with an average of 1.5 cm/day. These measurements were taken in areas of suspected higher groundwater flux, as part of the investigations of upland plume discharges. As such, these values are expected to be higher than the average flux rate for the entire channel. In general, the highest seepage rates were observed in sandy areas, and the lower values were observed in less conductive clay zones, as expected.

In addition to the empirical seepage measurements, Appendix E presents a calculated estimate of groundwater discharge to the river based on Darcy's Law (which describes flow rates through permeable media) and observed upland groundwater hydraulic conductivity values. This calculation estimated groundwater discharge to the Study Area to be between 4.5 and 10.9 cfs, with an average of 7.3 cfs. This average corresponds to a seepage discharge rate of 0.1 ft/day (3.0 cm/day) across the entire channel surface of the Study Area, which is almost 10 miles long.

3.2.5 Groundwater/Surface Water Transition Zone

The groundwater/surface water transition zone represents a region beneath the bottom of a surface water body, where conditions change from a groundwater-dominated to surface-water-dominated system within the substrate. It is a region that includes both the interface between groundwater and surface water, as well as the broader region in the substrate (and, on occasion, up into the surface-water body) where groundwater and surface water mix. The transition zone is the interval where both groundwater and surface water comprise some percentage of the water occupying pore space in the sediments. The physical and chemical properties of water within the transition zone reflect the effects of mixing between groundwater and surface water that occurs within the sediments, as well as biological and geochemical processes occurring within the sediment matrix and pore water. The transition zone is the location where chemical and biological transformation processes occur that affect the properties of chemicals that

may be present in pore water and sediment, and it encompasses the sediment biologically active zone where benthic infaunal ecological receptors may reside.

The thickness of the transition zone is temporally and spatially variable due to changes in gradients between the surface water and groundwater, sediment texture and stratigraphy, and hydraulic conductivity. In general, areas with steeper groundwater gradients toward the river and/or lower sediment hydraulic conductivities are expected to exhibit thinner mixing zones (absent biological activity or other disturbances), with less diurnal response to tidal fluctuations.

3.3 HYDROLOGY

River stage and currents in the LWR and Portland Harbor are influenced by hydrologic conditions in both the Willamette and Columbia rivers, and are further affected by the operations of federal and non-federal dams along these two rivers. River stage refers to the height of the river measured relative to a specific elevation or "datum." A variety of vertical datums are used in the Portland Harbor region, and these are discussed below.

3.3.1 Regional Datums

Current or historical bathymetric and topographic data may be referenced to a variety of vertical datums in Portland Harbor. The bathymetric data collected as a part of this RI/FS are presented relative to the North American Vertical Datum of 1988 (NAVD88). This vertical datum is the national standard geodetic reference for heights and was selected for this project because it is a level datum and is easy to use with global positioning systems (GPS). NAVD88 is a fixed datum derived from local mean sea level observations at Father Point/Rimouski, Quebec, Canada. NAVD88 replaced NGVD29/47 as the national standard geodetic reference for heights.

The National Geodetic Vertical Datum of 1929 through the Pacific Northwest Supplemental Adjustment of 1947 (NGVD29/47) is a fixed datum adopted and adjusted in 1947 as a national standard geodetic reference for heights prior to June 24, 1993 and is now considered superseded by NAVD88. NGVD29 is sometimes referred to as Sea Level Datum of 1929 or as MSL on some early issues of USGS topographic quads. NGVD29 was originally derived from observations at 26 long-term tide stations in the U.S. and Canada. Data referencing MSL as the vertical datum in the Portland Harbor is technically based on NGVD29/47.

The CRD is used as the nautical chart datum for the LWR. CRD is a reference plane established by the USACE in 1912 by observing low water elevations at various points along the Columbia and Willamette rivers (USACE 1966). Consequently, the CRD is not a fixed/level datum but slopes upward as one moves upstream. The CRD is used upstream of RM 24 on the Columbia to the Bonneville Dam and on the Willamette River to Willamette Falls. Mariners can obtain the depth on a chart and apply tide or river-level gauge readings, relative to CRD, to compute actual water depth at the time of

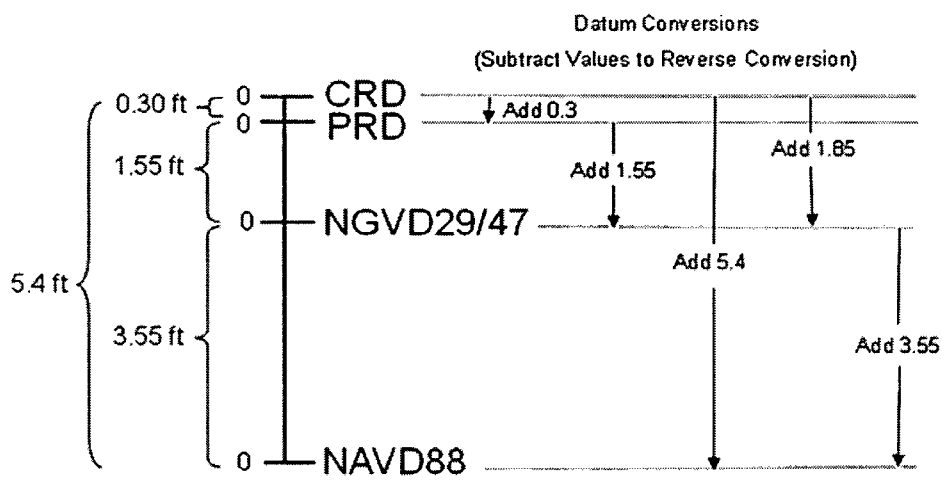
sailing. Low water values are used for navigation charting to provide conservative depth values in the event accurate tide data are not available to the mariner.

NAVD88, NGVD29/47, and CRD are the major datums used on maps and charts of Portland Harbor. In the lower Willamette, elevations reported relative to the CRD are approximately 5 ft less than NAVD88 elevations (e.g., the -15 ft NAVD88 contour on LWG bathymetry maps equates to a -20 ft CRD elevation).

Water level (river stage) data measured by the Morrison Bridge gauge (RM 12.8) are recorded as the Portland River Datum (PRD) and are 1.55 ft above NGVD29/47 (USACE 1991). The CRD is 1.85 ft above NGVD29/47 at the Morrison Bridge. On December 27, 2001, David Evans and Associates, Inc. (DEA) confirmed the relationship between this gauge and the CRD by running a differential leveling circuit from a nearby control monument used in the control network for the Willamette multibeam surveys. This survey confirmed that the Morrison Street staff gauge reports water levels 0.30 ft above CRD, as defined by the USACE (1991).

The river stages discussed below in Section 3.3.2 are the directly measured Morrison Bridge gauge levels and are therefore reported as PRD elevations in feet. To convert from PRD to CRD, subtract 0.3 ft from the reported river level.

The datum relationships discussed for Portland Harbor above are illustrated below:



Relative Height of Datums (at RM 12.8, not to scale)

3.3.2 Regional Surface Water Hydrology

The Columbia River drains a large segment of the northwestern United States and parts of western Canada. The Columbia basin is so large that isolated events such as localized rainstorms may have little or no effect on river flow. In its natural state, high flows on the Columbia River are most influenced by snow melt, which takes place

during the spring months. This results in high water typically occurring in late May or early June, followed by receding water levels until the rains begin in late fall.

Lowest water on the Columbia River typically occurs in October or early November, reflecting a lack of precipitation and snowmelt in the basin during the summer months. With the onset of winter rains and snow, runoff will vary during the winter months, until the spring snowmelt leads to the high water period.

The Willamette River is a major tributary of the Columbia River and flows into the river at Columbia River Mile 103. Lowest water in the Willamette, as in the Columbia, typically occurs between September and early November prior to the initiation of the winter rains. Unlike the Columbia River, however, Willamette River flows generally increase in response to regional storms due to the comparatively small size of the basin. Record winter floods (e.g., 1964 and 1996) occurred when periods of heavy snowfall at lower elevations were followed by warming periods and heavy rains, resulting in rapid increases in runoff.

The effect of the multipurpose dams on the Columbia River and its tributaries has generally been to reduce the spring high water flows with retention and storage of the water through the system-wide management of reservoir pool levels at each dam. Beginning in late summer, stored water is released, which increase flows above the naturally occurring low-flow hydrograph. By winter, these reservoirs have been drawn down, and the storage capacity is used to take the peak off of winter flows and to optimize the generation of electricity.

There are 13 federal reservoirs on the Willamette River and its tributaries, having a combined storage capacity of over 1.6 million acre-ft. These reservoirs reduce the river flow during the winter snow and rain events by storing water (Table 3.3-1). With each major storm, water is retained and then released at the end of the storm to dampen hydrographic peaks and valleys. During persistent rainy periods and/or during exceptionally large precipitation events, the storage capacity may be exceeded, and additional flow entering the system leads to flooding, as occurred in 1964 and 1996. During these flood events, water flow in the river can be up to 50 times greater than the flow during low-water periods. Late in the winter, after the likelihood of a major flooding event has passed, the reservoirs are filled to capacity. These reservoirs are used for recreation during the summer and are drawn down in the fall to supplement natural low flows and to provide storage capacity in preparation for the flood season.

Water levels and currents in the LWR can be influenced by the Columbia River in several ways. The most apparent influence occurs during spring when high flows from the Columbia River act as a hydraulic dam to Willamette River, resulting in rises in the Willamette River stage. The Columbia River flow drops as the summer progresses, and this effect is diminished. During the winter, high seasonal flows on the Willamette River can be allowed to pass through to the Columbia River, which may have

diminished flows due to retention at dams. This mechanism was used in the 1996 flood to lower the flood stage levels of the Willamette River in Portland.

Tidal action also compounds the hydrology and interplay of the two rivers, and affects the Willamette River upstream as far as Portland Harbor and beyond. Tides along the North American West Coast are mixed semidiurnal (two unequal high tides and two unequal low tides daily), with an average tidal range of approximately 8 ft in the Pacific Ocean. The high (i.e., flood) tide can influence Willamette River levels by up to 3 ft in Portland Harbor when the river is at a low stage. These tidal fluctuations can result in short-term flow reversals (i.e., upstream flow) in Portland Harbor during times of low river stage combined with large flood tides; this effect was measured in May 2003 as part of the bathymetry survey effort using an acoustic Doppler current meter (DEA 2003). As river stage rises, the tidal effect is gradually dampened and disappears at river levels around 10 ft CRD.

3.3.2.1 Willamette River Stages and Discharges

Figure 3.3-1 shows a plot of the mean daily river stage data from October 1, 1972 through March 31, 2008 at the Morrison Bridge in Portland near RM 12.8 (reported in feet PRD, USGS gauge #14211720).[2] Mean historical daily discharge (cfs) calculations from this gauge are shown in Figure 3.3-2, and Figure 3.3-3 presents the annual average discharges by water year[3] over the period of record. Flow data from October 1972 to September 1994 were computed by the USGS using an acoustic velocity meter (Lee 2002, pers. comm.). Most data after September 1994 are USGS estimates based on measurements from regional stations (Miller 2006, pers. comm.).

The seasonal cycle of water levels on the Willamette River is illustrated in Figure 3.3-1. Annual low water levels occur during the regional dry season from August to November. Winter (November to March) river stage is relatively high but variable due to short-term changes in precipitation levels in the Willamette Basin. Finally, a distinct and persistent period of relatively high water levels occurs from late May through June when Willamette River flow into the Columbia is slowed by high-water stage/flow in the Columbia River during the spring freshet in the much larger Columbia River Basin, as described above. The two highest peaks in the daily mean discharge record occurred in the winters of 1996 and 1997, when peak flows reached 420,000 cfs on February 9, 1996 and 293,000 cfs on January 2, 1997 (Figure 3.3-2).

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[2] Data obtained from Regulation and Water Quality Section Web site (http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?k=id:PRTO+record://PRTO/HG//1DAY/MEAN/) and the USGS National Water Information System Web site (http://waterdata.usgs.gov/or/nwis/uv?14211720). Where USGS data are available, they replaced USACE data for compiling the graphs shown in this section. The USACE site notes that these "data have not been verified and may contain bad and/or missing data and are only provisional and subject to revision and significant change." The data are used here only to illustrate long-term relative trends in the Willamette River stage at Portland. No data are available for 1991 and 1992.

[3] A water year extends from October 1 to September 30 (e.g., October 1, 1972 to September 30, 1973 comprises the 1973 water year).

For the water years 1973 through 2007—a 35-year period of record—the mean annual daily discharge was between 20,000 and 30,000 cfs during 14 years of this period (Figure 3.3-3). Annual mean daily flows were above 30,000 cfs during 19 years, with seven of those years above 40,000 cfs, and three in excess of 50,000 cfs. Only two water years (1977 and 2001) had average daily flows between 10,000 and 20,000 cfs.

Figure 3.3-4 presents the frequency (number of days per year) distribution of daily mean discharge values from the October 1, 1972 through March 31, 2008 data set. Flow on the Willamette River is most often between 10,000 and 30,000 cfs. Approximately 75 percent of the time flows are less than about 40,000 cfs, and exceed 90,000 cfs less than 10 percent of the time.

Figures 3.3-5a–h show river stage data through each of the RI years (i.e., 2001–March 31, 2008). For comparison, the graphs also include a plot of average annual river stage values based on the entire period of record (October 1972–March 2008), and plots of the values within one and two standard deviations from the average (representing approximately 68 percent and 95 percent of the recorded values, respectively). The LWR flood stage (18.3 ft PRD [18 ft CRD]) was not reached during the RI period.

Figures 3.3-6a–h present plots of river discharge data through each of the RI years (2001–March 31, 2008), with plots of the average daily discharge (October 1, 1972–March 31, 2008) and values within one and two standard deviations from the average shown for comparison. LWR discharge rates during the RI years followed a typical seasonal pattern and, as with river stage levels, have generally been within the range of typical discharges on record. Early 2001 and early 2005 were relatively low-flow winter/spring periods and early and late 2006 had relatively high flows compared with the long-term averages.

3.3.3 Hydrodynamics

Recent investigations of the hydrodynamics of the LWR, Study Area, and Multnomah Channel are summarized in this section. Both empirical information (flow measurements) and HST modeling have been conducted as part of this RI to support the understanding of the physical system and hydrodynamics. Additional work will be conducted as part of the FS. The primary objective of these efforts for the RI was to gain a sufficient understanding of the physical system to support the RI site characterization, the BHHRA, the BERA, site-wide fate and transport modeling, and the development and comparative evaluation of remedial alternatives for the FS. A central issue for this large river system was the evaluation of sediment stability throughout the Study Area (i.e., where and to what depth in the sediment column are sediments stable and unstable over time under a range of hydrologic conditions, including rare flood events).

3.3.3.1 Flows in the Study Area

Flows were measured directly at multiple locations in the LWR using an ADCP during three of the four time-series bathymetric surveys which were conducted to measure

riverbed elevation changes over time (see Section 3.4.2). The ADCP data provided snapshot observations of flows in the Study Area across a range of flow and tidal conditions (DEA 2002, 2003, 2004). The empirical flow data also supported the development and calibration of a hydrodynamic model developed for this RI/FS (WEST and Integral 2005). The revised Phase 2 HST model (WEST and Tetra Tech 2009) was used here to develop vector plots of current velocities throughout the Study Area during both mid-ebb and mid-flood tides for both high- and low-river-flow periods (Figures 3.3-7a through 3.3-10c). Vector plots were also generated that show current velocities during maximum flood tide coupled with low river flow (Figures 3.3-11a–h) for the entire LWR (to assess the maximum extent of upstream flow reversals) and during high flows in both the Willamette and Columbia rivers (Figures 3.3-12a–h). The model output shows that currents generally flow downstream during four of the six flow-tide combinations. Reverse or upstream flows occur when river flow is low and the tide is in flood.

In general, flow in many of the relatively shallow nearshore embayments and slips is characterized by eddies and/or inshore flow, except on ebbing tides during low-flow periods, when downstream or offshore flow directions are dominant. As expected, higher current speeds occur in the deeper portions of the river channel, and lower speeds occur in the shallow nearshore areas, regardless of flow direction. Flow in Multnomah Channel is in a downstream direction under all flow/tide combinations modeled.

Based on this hydrodynamic model output, at the maximum flood tide during the low-flow period, reversed flows extend upstream to approximately RM 15, where upstream flow velocities are minimal, approximately 0.2 ft per second in the channel (Figures 3.3-11a–h), and are very low upstream of RM 15 to about RM 18.

During high flows on the Willamette and comparable flows on the Columbia (Figures 3.3-12a–h), flow is consistently downstream on the LWR, and the model predicts that there is an apparent eddy effect (reduced circular flows) where the Willamette River flows into the Columbia River.

3.3.3.2 Flows to Multnomah Channel

The flow data collected during the ADCP surveys in April 2002, May 2003, and January 2004, and summarized in the Round 1 Site Characterization Summary Report (Integral 2004) suggested that LWR discharge through Multnomah Channel could be significant, ranging from 25 to 50 percent of the discharge volume of the Willamette during the "snap-shot" ADCP measurement periods. The percentage of Willamette River flow through Multnomah Channel is a function of the relative flow regimes in the Willamette and Columbia rivers, as well as tidal stage.

To investigate Multnomah Channel flows on a more continuous temporal basis, the CE-QUAL-W2 hydrodynamic model of the Columbia River/Willamette River System developed by Portland State University was used to model daily average flows in the

system over a nearly four-year period from January 1999 through December 2002. The results of this study were discussed in the Round 3A Upstream & Downstream Sediment FSP (Integral 2006c) and are briefly summarized here and in Figure 3.3-13.

Figure 3.3-13 shows the flows (daily average cubic meters per second) for the Willamette and Columbia rivers and the modeled flows for the Multnomah Channel over the 1,400+ day (approximately 4-year) model run. The figure also shows the fraction of the total Willamette River flow through Multnomah Channel (black line). "Fraction" values greater than 1 indicate that flow down Multnomah Channel exceeds the Willamette River flow upstream of Multnomah Channel (i.e., at these times, Multnomah Channel flows are a mixture of Willamette River water and inflow from the Columbia River).

The modeling effort identified three distinct river flow combinations and evaluated the proportion of discharge carried by Multnomah Channel:

1. **Low flows in both the Columbia River and Willamette River**—When flows are relatively low in both the Willamette and Columbia rivers, about 50 to 60 percent of the Willamette flow goes down Multnomah Channel.
2. **Low flow in the Columbia River and high flow in the Willamette River**—When relatively high flows in the Willamette River are concurrent with relatively low flows in the Columbia River, the proportion of Willamette River flow carried by Multnomah Channel decreases to about 25 to 30 percent of the total Willamette River flow.
3. **High flow in the Columbia River and low flow in the Willamette River**—When Columbia River flows are high and Willamette River flows are low, the increased river stage at the Columbia/Willamette confluence forces much of the Willamette River flow down Multnomah Channel. At certain low-flow Willamette periods (summer/early fall), all of the Willamette River flow, in terms of daily average volumes, plus some flow from the Columbia River, goes down Multnomah Channel. This last condition occurs about 25 percent of the time over the period modeled (January 1999 to December 2002).

No clear periods of concurrent high flows in both the Willamette River and Multnomah Channel were identified within the nearly four-year model simulation period. Averaged over the study period, flows in Multnomah Channel represent about 60 percent of the Willamette River flow upstream of Multnomah Channel. It should be kept in mind that some of the Multnomah Channel flow is Columbia River water, but the relative volumes of Willamette River versus Columbia River water flowing down Multnomah Channel cannot be determined from these modeling results.

3.4 RIVERBED CHARACTERISTICS AND DYNAMICS

Several types of investigations have been conducted as part of the RI to characterize the physical nature of bedded sediments and their potential for movement within and

through the LWR due to natural or anthropogenic forces. The results of the early physical system studies (STA, SPI, and time-series bathymetry surveys) conducted from 2000 to 2004 have been documented previously in individual technical reports and were summarized in the Programmatic Work Plan (Integral et al. 2004). These data were used to develop the initial physical CSM for the LWR presented in the Programmatic Work Plan, and this CSM helped direct the extensive sediment (and other media) chemical sampling efforts that were conducted throughout the harbor and the LWR from 2004 to 2008.

As noted above, in conjunction with the collection of empirical information on physical site characteristics, a numerical HST model was developed (Integral 2006b; Integral and WEST 2005; WEST 2004, 2005, 2006b; WEST and Integral 2005; WEST and Tetra Tech 2009). The primary RI objective of this modeling effort was to predict the potential impact of extreme (flood) events on site sediments, particularly the potential for buried contaminated sediments to be re-exposed. A secondary objective was to provide physical surface water and sediment flux data for the fate and transport modeling being conducted as part of the FS.

The sections that follow provide an overview of the major physical system site information, including sediment characteristics, bathymetric trends, site-specific data collected to support the HST model, a summary of the key HST model outputs, and finally, a description of the major sediment transport regimes based on this body of empirical and modeling information. This description represents a refinement of the physical CSM presented in the Programmatic Work Plan and Round 2 Report.

3.4.1 Physical Characteristics of Sediments

Physical sediment sample texture data (grain size, specific gravity, total solids) and TOC have been collected as part of all sediment sampling for the RI. Sediment texture data are also available from non-LWG sampling efforts conducted in the LWR.

3.4.1.1 Sediment Texture

The grain-size data measured in surface sediment samples in the nature and extent database were used to generate contour maps of surface sediment grain size (as percent fines) and TOC (percent) in the Study Area in Maps 3.4-1 and 3.4-2. In the absence of anthropogenic activities that affect sediment textures, the physical characteristics of surface-bedded sediment are general indicators of the energy regime of the riverbed at that location. Typically, fine-grained sediments (silts, clays) dominate in relatively low-energy environments where current velocities are low enough to allow fine particles to settle out of the water column and remain deposited, whereas coarse sediments (sands, gravels) are indicative of higher-energy environments where fines are kept in suspension in the water column and/or winnowed out of previously deposited material and transported away during transitory high-energy events (e.g., floods or anthropogenic disturbances, such as prop wash, dredging, etc.).

Starting at the upstream end of the Study Area (RM 11.8), Map 3.4-1 shows that coarse-grained surface deposits (i.e., 0–20 percent fines) are predominant from upstream of the Study Area downstream to RM 11, especially along the western half of the river. The river gradually widens from RM 11 to 10, and this area is a mosaic of mostly sandy (21–40 percent fines) and mixed (41–60 percent fines) textures, and deeper holes and nearshore areas and embayments dominated by fines (61–100 percent fines).

The river widens markedly from RM 10 to 7, and surface sediments are dominated by fines, with the exception of some nearshore bank areas and some discontinuous areas along the western edge of the navigation channel. The finest texture sediments (81–100 percent fines) are widespread from RM 9 to 7, including locations within Willbridge Terminal, in the downstream lee of Swan Island (Portland Shipyard), and in Swan Island Lagoon.

From about RM 7 to 5, the river and navigation channel narrows again, and this reach is dominated by sands with relatively small subareas (e.g., within Willamette Cove and western nearshore around RM 6) that are dominated by fines characteristic of lower energy environments. Much of the remainder of the Study Area and beyond, to about RM 1.5, is dominated by fines, with a texture of 61–80 percent fines dominant upstream of Multnomah Channel (RM 3–5) and 81–100 percent fines widespread downstream of Multnomah Channel (RM 1.5–3). Conversely, the relatively shallow and narrow Multnomah Channel is dominated by sands, as is a portion of the Study Area upstream and immediately adjacent to the Multnomah Channel entrance extending to the east bank. This is the largest area in the LWR between RM 1.5 and 5 that is not dominated by fines.

As expected, the TOC content of the surface sediments (Map 3.4-2) generally mirrors the sediment grain-size distribution, with higher TOC content collocated with the finer-grained deposits. TOC levels generally range from 0.5 to approximately 3 percent, but a few isolated areas contain higher levels (6 to up to 27 percent); these are all downstream of RM 7 and include the head of Willamette Cove, an area west of the main channel from RM 6.2 to 6.4, a mid-channel area at RM 5.7, and a relatively large area east of the channel at RM 2.

Vertical gradients in grain size can be examined visually across the Study Area by comparing Map 3.4-1 (contoured surface grain size) with Map 3.4-3 (the grain-size contour of the shallow subsurface horizon). Overall, the surface and immediate subsurface sediment textures are consistent across the Study Area, suggesting that the energy regimes in the system are relatively stable over time. There is, however, a subtle but perceptible widespread shift from finer-grained surface sediments to a slightly coarser-grained subsurface layer (e.g., from 81–100 percent fines to 61–80 percent fines) across much of the site. This may reflect seasonal or inter-annual winnowing of the finer sediments from the sediment bed during higher flow periods and the subsequent long-term burial of the slightly coarser residual sediments. Finally, there are

three areas that show distinctly coarser surface sediments overlying finer material; these include the head of Swan Island Lagoon, the M&B/Willamette Cove area, and the area outside the entrance to Multnomah Channel, extending into the channel itself. Anthropogenic placement of fill and the recent sand cap appear to explain this pattern in Swan Island Lagoon and around M&B/Willamette Cove, respectively. The vertical shift to finer material at depth immediately adjacent to and within the mouth of the Multnomah Channel is not as apparent, but the "relict" muds may reflect the less dynamic sedimentary environment that existed in this portion of the river prior to the Portland Harbor navigation channel dredging and other land use modifications in the region (e.g., bank treatments).

3.4.2 Bathymetric Survey Data

Four major multibeam bathymetric surveys were conducted by the LWG to measure LWR riverbed elevation for the RI/FS: January 2002, July–September 2002, May 2003, and February 2004. A fifth, smaller survey focused in Multnomah Channel was conducted by the LWG in February 2007. The data were processed using a 1-m grid size to generate a digital terrain model, and the survey results were plotted in both 3-D color-graded (i.e., "hillshade") and contour formats. Except for the Multnomah Channel survey, the results of each survey were compared to those from preceding surveys to analyze net bed elevation changes and change trends over time. The results of the four major surveys and the time-series change analyses have been reported previously (Integral et al. 2004; Integral 2004b). The Multnomah Channel survey data are reported in the Round 3A Upstream and Downstream Data Report (Integral 2007d).

In addition, a multibeam survey of the LWR was conducted by NOAA in January 2009, and this survey data was obtained by the LWG and compared with the 2002 baseline data to produce a 7-year bathymetric change data set.[4] This new data set is presented and discussed below.

3.4.2.1 Bathymetry

Map 3.4-4 shows the most recent LWR riverbed and upper Multnomah Channel bathymetry data. This bathymetric survey in the LWR was conducted in January 2009 by NOAA and the data obtained by the LWG. The Multnomah Channel bathymetric survey was conducted in February 2007 as part of the Round 3A sampling effort. The primary goal of this survey was to obtain high resolution riverbed elevation data in the channel. Map 3.4-4 shows that most of the Study Area is from -30 to -50 ft CRD (-25 to -45 ft NAVD88) and is dominated by the -40 ft CRD authorized federal navigation channel, which runs from RM 0 (Columbia River) to RM 11.7 (Broadway Bridge) and extends nearly bank-to-bank from RM 4 to 6 and again from RM 8 to 11.7. Except along the western channel edge from RM 8 to 10 where extensive shoaling has occurred, these portions of the Study Area have very narrow and steeply sloped off-

[4] This 2009 survey was conducted by DEA under contract to NOAA. DEA was the contractor that conducted the Portland Harbor bathymetric surveys for the LWG, and the survey equipment, set-up, and data processing techniques used in 2009 were very similar and fully compatible with methods used previously.

channel areas. Broader off-channel areas with some shallow benches (-10 to -30 ft CRD) occur from RM 1 to 4 and RM 6 to 8. In addition, there are a number of off-channel areas, such as Swan Island Lagoon, Willbridge Terminal, Willamette Cove, and Terminal 4, that vary widely in depth as a function of their history and current land use (e.g., actively dredged berths). Finally, there are several deep areas in the harbor that extend from -60 to -80 ft CRD. These are borrow areas that were dredged to create the adjacent uplands; the two most extensive ones are in the western portion of the channel from RM 4.3 to 5 and RM 9.2 to 10. Map 3.1-3 shows the long-term bathymetric changes that occurred in the LWR between 1888 and 2001 and illustrates the large-scale deepened, diverted, and filled areas.

3.4.2.2 Riverbed Elevation Changes

Map 3.4-5 shows the net bathymetric change over the seven-year period between the first (January 2002) survey and the January 2009 survey in the LWR. The elevation change maps were created by overlaying the 1-m cells from each survey and subtracting the January 2009 data from the January 2002 data (the depth values are generally negative numbers, e.g., -15 ft NAVD88) to generate a direction and magnitude of change for each cell. The vertical resolution of the multibeam survey overlay was ±0.25 ft (approximately 7.6 cm), so cell comparisons that show positive or negative changes less than or equal to 0.25 ft represent no discernable change in riverbed elevation.[5] On Map 3.4-5, positive elevation changes (shallower in 2009 compared to 2002) indicate shoaling, and negative elevation changes (deeper in 2009 compared to 2002) indicate deepening. The no-change areas are shaded gray, while shoaling areas (positive change) are shown in yellow to orange shades, and areas that deepened (negative change) are shown in blue shades.

Previous evaluations of the time-series bathymetric change data between each survey period from 2002 to 2004 (i.e., 2002 to 2003, 2003 to 2004, and 2002 to 2004) showed generally consistent results and are discussed in the context of the LWR physical system in the Programmatic Work Plan (Integral et al. 2004; Integral 2006f). Key observations and conclusions from those evaluations are listed below:

- Over the 25-month period of observation, only 10 percent of the riverbed exhibited net bathymetric changes (erosion or accretion) greater than 1 ft (30 cm), but relatively small-scale scour or accretion from 0.25 ft (8 cm; the limit of resolution) to 1 ft (30 cm) in extent was widespread.
- The reaches between RM 5 and 7 and RM 10 and 11.8, where the river is relatively narrow, are dominated by areas of small-scale net erosion, as is the western off-channel area from RM 0 to 3 (outside bend of the LWR as it turns toward the Columbia).

[5] The survey vertical accuracy specification of ≤0.5 ft was exceeded for both individual surveys (DEA 2002, DEA 2004). An analysis of bathymetric change data indicated that the vertical resolution of the survey overlay was ±0.25 ft for approximately 80 percent of the channel data. Therefore, this interval was used as the no-change category (Integral and DEA 2004).

- Wide areas of deposition occur in the channel and along channel margins in the broader sections of the river (RM 1.5 to 3 [eastern margin], RM 4 to 5, and RM 7 to 10). The downstream and upstream areas mentioned in the previous sentence are known to be long-term sediment accumulation areas based on historical dredging records.
- Signs of in-filling are apparent in formerly dredged borrow areas (e.g., RM 5.2, RM 9 to 10, and RM 10.5 to 11.9).
- Many deepening areas are closely associated with berthing areas, slips, and pier structures (e.g., Terminal 4, Portland Shipyard, Willbridge Terminal), likely the result of anthropogenic factors (e.g., prop wash from ships, dredging).
- Map 3.4-5 shows the net bathymetric change from 2002 to 2009 from the Columbia River (RM 0) to the upper end of Ross Island (RM 15.3) and includes a winter (late 2005-2006) with a prolonged period of relatively high flows approaching 200,000 cfs. Spatial patterns noted above for the Study Area hold for the 2002 to 2009 time period also for this larger reach. Over this longer time-frame, the extent of sediment accumulation in shoaling areas increased, with 22 percent of the riverbed surveyed showing accretion exceeding 1 ft (30 cm). Erosion exceeding 1 ft is noted in only 6 percent of the riverbed (including dredged areas). Nearly three-quarters of the surveyed area (72 percent) shows positive or negative elevation changes of less than 1 ft (30 cm). More importantly, and as noted above, the locations subject to scour, accretion, or no change within the Study Area remain consistent with those inferred from the two-year data set over this longer timeframe.

3.4.2.3 Sediment Erodibility Measurements

Sediment erosion rates and critical erosion shear stress values for LWR sediment were measured directly as part of the HST model data collection effort conducted in the spring of 2006 (Integral 2006b). This study involved the collection of 17 cores from locations throughout the Study Area selected to represent a range of bottom conditions in terms of sediment texture and local hydrodynamic conditions. The primary use of these data was to support the sediment transport modeling effort, and these data and their incorporation into the HST model are detailed by WEST and Tetra Tech (2009). These data are discussed here for their empirical value as a measure of riverbed erodibility of surface sediments across the Study Area in late March 2006.

The sediment cores were subjected to various flows using a Sedflume system to produce a range of shear stresses (a force applied parallel or tangentially to a surface; from 0.1 Newtons [N]/m^2 to 10 N/m^2) to the sediment surface. Resulting critical erosion flow velocities and erosion rates were measured at approximately 5-cm intervals to depths of approximately 25 cm. Physical properties of bulk density and grain-size distributions were also analyzed at approximately 5-cm intervals. Erosion rates per shear stress applied varied depending on sediment grain size, bulk density, and sediment depth. A summary of the number of applications per shear stress value and

range of observed erosion rates (in cm/s, depth of sediment eroded per unit time) on all Sedflume cores is presented in the following table.

Shear Stress (N/m^2)	Measurements Count	Erosion Rate (cm/s) Min	Max
0.1	16	0	0.0003
0.2	23	0	0.0003
0.4	55	0	0.001
0.8	74	0	0.04
1.6	76	0.0002	0.1
3.2	76	0.0003	0.3
6.4	60	0.007	0.4
10	2	0.02	0.04

Critical erosion velocity shear stress values (defined in the Sedflume method as the shear stress at which erosion occurs at 10^{-4} cm/s; Sea Engineering 2006) were calculated at approximately 5-cm intervals. Median grain size (d50) values for the sediment intervals ranged from 9.7 µm (medium silt) to 401 µm (medium sand), and critical shear stresses (T_{cr}) were calculated to range from 0.06 N/m^2 to 1.28 N/m^2. These data summarized by core depth interval are tabulated below.

Sample Depth Category	d50 (µm) Min	Max	T_{cr} (N/m^2) Min	Max
0–5 cm	9.7	401	0.06	0.64
5–10 cm	12	367	0.32	1.28
10–15 cm	10	378	0.22	1.28
15–20 cm	7.8	384	0.26	1.28
20–25 cm	10.9	357	0.24	1.28

The Phase 1 Hydrodynamic model (WEST and Integral 2005) was used to predict bed shear stresses that would occur in the LWR under typical low-flow (e.g., 40,000 cfs) and relatively infrequent high-flow (e.g., 160,000 cfs) conditions (Map 3.4-6).[6] Under the low-flow conditions, bed shear values are predicted to remain below 0.4 N/m^2 throughout most of the channel and below 0.1 N/m^2 in the nearshore areas. Slightly higher shear stresses (up to 0.7 N/m^2) are predicted for the channel near RM 11 and for the head of Multnomah Channel. As a first-order approximation, these data indicate that significant sediment bed movement or resuspension due to natural hydrodynamic forces does not occur under the typical flow conditions that take place over much of the year (i.e., less than 50,000 cfs) in the LWR.

[6] Mean daily flows of approximately 160,000 cfs or more were recorded on 119 days (0.9 percent) over the 30-year period of record and on 14 days (0.5 percent) over the RI water years 2001 through March 31, 2008. Mean daily flows of 40,000 cfs or less were recorded on 9,374 days (74 percent) over the period of record and on 2,031 days (77 percent) over the RI water years 2001 through March 31, 2008.

Under the relatively rare high-flow conditions, the predicted bed shear values remain low in most nearshore areas, slips, and embayments but are much higher, as well as more variable, in the channel. The predicted bed shear values in the main channel range from 0.614 N/m^2 between RM 2 and 2.3 to the maximum value of 19.7 N/m^2, which occurs in the channel at approximately RM 10.3. The highest values (>5.0 N/m^2) occur in both the nearshore and channel areas in the more constricted reaches (e.g., between RM 10 and 11, and again between RM 5 and 7; Map 3.4-6). The predicted high-flow bed shear values in the channel approach or exceed the highest critical shear stress calculated from the Sedflume study (1.28 N/m^2) throughout much of the Study Area, indicating that sediment transport is likely to occur throughout much of the channel during this flow condition.

3.4.2.4 Suspended Sediment

Suspended sediment loads and dynamics are an important component of the LWR physical system, and total suspended solids (TSS) data have been collected both as part of the surface water characterization and hydrodynamic model data collection efforts. Suspended solids data were collected in November 2004, March 2005, and July 2005 as part of the Round 2A surface water characterization effort, and during sampling conducted from November 2005 to April 2006 to directly support the hydrodynamic modeling effort (Table 3.4-1). The Round 2A surface water data, collected during the fall of 2004, winter of 2005, and summer of 2005, were reported previously in the Round 2A Surface Water Site Characterization Data Report (Integral 2006g). The results of conventional parameter analyses (TSS and TOC) from the November 2005 to April 2006 surface water sampling efforts (summarized in Table 3.4-2), and recently provided TSS data from the City of Portland, are presented in this section. Section 5.3.4 provides additional details on the RI suspended sediment sampling efforts and data compilation.

3.4.2.4.1 November 2005 to April 2006 LWG Sampling

Suspended solids concentrations were analyzed in a time series (November 2005 to April 2006) of vertically and horizontally integrated composite water samples from upriver of the Study Area, which were collected to verify the hydrodynamic model's suspended sediment/discharge rating curve, and from samples collected in April 2006 from points downstream of RM 11 and in Multnomah Channel, to support hydrodynamic model calibration (Integral 2006f).

The data from the sampling events are presented in Tables 3.4-2 and 3.4-3. TSS concentrations at the upriver stations ranged from 7 to 50 mg/L over the measurement period. Although the data set is relatively small, a plot of the upstream TSS data against the discharge hydrograph shows the expected pattern of higher concentrations on the rising limb of the hydrograph peak (i.e., 50 mg/L on December 22, 2005 at a discharge rate of 67,700 cfs) compared with the falling limb (i.e., 49 mg/L on January 19, 2006 at a discharge rate of 169,000 cfs; 39 mg/L on February 3, 2006 at 139,000 cfs; and 25 mg/L on February 7, 2006 at 108,000 cfs; Figure 3.4-1).

Available upriver TOC data (from March 3 and April 4, 2006 samples) show organic fractions of total solids in the water column remaining relatively consistent, ranging from 2.2 to 2.4 mg/L. In the same samples, TSS concentrations decrease from 21 to 22 mg/L at a flow of 41,500 cfs in March to 9 mg/L at a flow of 28,000 cfs in April, perhaps suggesting a higher inorganic suspended solids fraction with increased discharge. This would be expected; however, the particulate organic carbon (POC) was not directly measured.

Samples were collected twice per day in early April 2006 at stations in the Study Area and in Multnomah Channel, once on the rising tide and once on the falling tide. TSS concentrations in these samples ranged from 7 to 12 mg/L, and TOC concentrations ranged from 1.8 to 2.4 mg/L (Table 3.4-3). Because of the low variability of the results and limited number of data points, there is no clear pattern for the concentrations based on location or tidal phase; however, TOC values were slightly higher at the RM 11 and RM 6.3 stations than at the RM 2 and Multnomah Channel stations.

In situ suspended particle sizes were measured at HMV01 through HMV05 (RM 2, 6.3, 11, and 18) in early April 2006 using a laser *in situ* scattering and transmissometer (LISST) as part of the hydrodynamic model data needs collection (Integral 2006c). Particle size was measured in 0.5-m increments through the water column. The median grain-size measurements with depth at each station are plotted in Figure 3.4-2, and a summary of the grain-size ranges measured is tabulated below. As indicated by the data, particles primarily in the silt and fine-to-medium sand size ranges were in suspension, under a flow of approximately 30,000 cfs. The coarsest median grain sizes were found upstream of the harbor at station HMV05 (RM 18) where the river is relatively narrow.

		Maximum Grain Sizes per Station		
Location	**Station**	**d10(μm)**	**d50(μm)**	**d90(μm)**
RM 2 West Side	HMV01	4.28	25.76	204.36
RM 6.3 East Side	HMV02	4.1	40.66	274.53
RM 11 West Side	HMV03	3.32	35.28	242.34
RM 11 Mid-Channel	HMV04	2.98	32.11	242.91
RM 18 Mid-Channel	HMV05	3.78	79.3	383.11

Note:
d10, d50, d90 = diameter of the 10th, 50th, and 90th percentiles of the grain-size distribution.

3.4.2.4.2 Long-Term City Data

The City of Portland has provided TSS data collected from the Willamette River at locations between RM 1.1 and 20 from February 1992 to March 2008 (City of Portland 2008d). Data from the RI years (2001 to March 31, 2008) within the Study Area are available only from the City's RM 6.8 sampling location. These data are presented against the USGS discharge data for the 2001 through 2008 water years in Figures 3.4-3a–h. Figure 3.4-3i combines this long-term RM 6.8 TSS data set and plots suspended load versus discharge. This plot shows that there is a strong positive relationship between TSS and flow from discharges levels of 30,000 cfs and above

($r^2 = 0.81$); below that discharge level the measured TSS levels are not correlated with flow ($r^2 = 0.06$).

3.4.3 Hydrodynamic and Sediment Transport Modeling

As noted previously, a numerical HST modeling effort was conducted as part of the Portland Harbor RI to complement the empirical observations and gain a further understanding of physical system dynamics. A primary RI objective of this modeling was to predict the potential impact of extreme (flood) events on site sediment stability, particularly the potential for buried contaminated sediments to be re-exposed. Other objectives include understanding the complex hydrodynamics (i.e., the movement of surface water) of the LWR system (e.g., see Section 3.3.3) and providing preliminary surface water and sediment flux data to the fate and transport modeling effort being conducted for the FS over a range of flow regimes. The initial fate and transport modeling effort is detailed in Anchor et al. (2007).

Development of the HST model began in 2003, and the model has been through several development phases with EPA coordination and input. The HST modeling work is detailed in a series of documents (Integral 2006b; Integral and WEST 2005; WEST 2004, 2005, 2006b; WEST and Integral 2005), and the final revised Phase 2 HST modeling report has been provided under separate cover (WEST and Tetra Tech 2009). Key aspects of the model, important developmental milestones, site-specific data collected to improve model performance, and major model sediment transport outputs are summarized in the sections that follow. The revised Phase 2 HST model is being further refined in 2009 by the LWG to address difficulties encountered in the sediment transport calibration and to improve the ability of the model to support FS objectives. The refined model will be presented in the FS.

The LWR HST model uses the Environmental Fluid Dynamics Code (EFDC) and was developed by WEST Consultants, Inc. (Bellevue, Washington). EFDC is a public domain, multifunctional, surface water modeling system, which can include hydrodynamic, sediment-transport, and eutrophication components. EFDC has been used for more than 80 modeling studies of rivers, lakes, estuaries, coastal regions, and wetlands in the United States and abroad.

The EFDC model's sediment-transport component is capable of simulating the transport of multiple size classes of cohesive and non-cohesive sediment (Tetra Tech 2002). A sediment processes function library allows the model user to choose from a wide range of currently accepted parameterizations for settling, deposition, resuspension, and bedload transport. The sediment bed is represented by multiple layers and includes a number of armoring representations for noncohesive sediment and a mixed bed material finite-strain consolidation formulation for dynamic prediction of bed-layer thickness, void ratio, and pore water advection. The sediment-transport component can operate in a morphological mode, with full coupling between the hydrodynamic components, to represent dynamic evolution of bed topography. Water column/bed exchange processes

include particulate deposition and resuspension, pore water entrainment, and pore water advection and diffusion.

3.4.3.1 Phase 1 Modeling

Following EPA approval of the Modeling Approach Technical Memorandum (WEST 2004), Phase 1 of the modeling, including model setup, an analysis of model sensitivity, and initial model calibration and validation runs for both hydrodynamics and sediment transport were conducted (WEST and Integral 2005) and revised (WEST 2005). The Phase 1 revisions incorporated refinements identified in EPA's review of the initial Phase 1 results, as well as site-specific sediment data collected in Round 2 of the Portland Harbor RI/FS in the latter half of 2004. The primary objective of the Phase 1 modeling was to determine if a two-dimensional (2-D) model would be adequate for the site, in terms of addressing model objectives. Due to the relatively small tidal influence in the LWR and the general lack of a significant density structure (WEST 2004), Phase 1 concluded that a 2-D model was adequate. The secondary Phase 1 modeling objective was to gain an understanding of the site's physical processes and the impact of various model parameters on the model predictions. Based on the model sensitivity and performance analyses, additional potential site-specific data needs were identified.

Overall, the Phase 1 model effectively simulated the hydrodynamics. However, bed elevation changes were not well captured by the model at the target accuracy levels. As a result, a number of site-specific data needs related to improving the sediment transport performance of the model were identified and collected in 2006. The data needs collection effort for the model is described below.

3.4.3.2 Hydrodynamic/Sediment Transport Model Data Collection

The Phase 1 HST modeling effort identified a suite of site-specific data types that would potentially improve the performance of the sediment transport portion of the model, and thus the ability of the model to achieve the specific modeling objectives (WEST and Integral 2005). In general, these data needs were associated with the behavior of cohesive sediments in the system (e.g., settling velocities and erodibility). The hydromodeling data needs FSP (Integral and WEST 2005) included the following field sampling and laboratory analysis tasks:

- Measure TSS at an upstream location just below the confluence of the Willamette and Clackamas rivers across a range of flow conditions
- Measure TSS in the Study Area under both relatively low- and high-flow conditions across a tidal cycle
- Determine fine sediment settling velocity under both relatively low- and high-flow conditions in the Study Area and upstream of the Study Area using a transmissometer
- Determine erosion rates and critical erosion shear stress with depth in the sediment column from sediment cores collected throughout the Study Area (Sedflume system)

- Collect duplicate cores from the Sedflume sample locations for the laboratory analysis of bulk sediment properties (grain size, bulk density, and TOC) with depth in the sediment column
- If the proper hydrologic conditions are present (i.e., flows on the Willamette approach or exceed 100,000 cfs), perform a short-term, time-series bathymetric survey; TSS sampling; and fine-grained settling velocity measurements in the Study Area.

The FSP was implemented in April 2006. All target data sets were collected in accordance with the FSP with the exception of the short-term, high-flow bathymetric changes. These data could not be collected because a qualifying hydrologic event did not occur in the spring of 2006. The HST data collection effort and data sets are detailed in Integral (2006b) and the Round 2 Report (Integral et al. 2007).

These site-specific data were incorporated in the Phase 2 modeling effort, which is summarized below. The detailed Phase 2 modeling efforts are provided in WEST and Tetra Tech (2009).

3.4.3.3 Phase 2 Modeling

In Phase 2, the HST model was revised and recalibrated using the site-specific modeling data collected in 2006. The recalibration focused on identifying a combination of the reference critical shear stress for deposition, reference resuspension rate, reference critical shear stress for resuspension, and reference void ratio to minimize the differences (both statistically and graphically) between the measured and simulated bed change over the calibration period.

Compared to the revised Phase 1 results, the Phase 2 model showed significant improvement in the agreement between simulated and measured bed elevations by incorporating site-specific data. The model does a better job in the deeper portions of the river than the nearshore areas. This is expected as sediment transport in nearshore areas might also be affected by other factors (e.g., local flow features near structures and prop wash) that are not explicitly represented in the model. The revised Phase 2 calibration results are detailed in WEST and Tetra Tech (2009) and outputs from this version of the model are included in this Draft RI in conjunction with the extensive physical system empirical data set to inform the physical CSM for the LWR. The LWG is conducting significant revisions to some aspects of the HST model in 2009. Revised model outputs that affect the physical CSM descriptions included in this Draft RI Report will be addressed in a refinement of the CSM in the Final RI as warranted.

3.4.3.3.1 Phase 2 Model Application – Flood Simulation

The primary RI HST model application is the evaluation of the risk of contaminated subsurface sediment re-exposure due to a major flood event in the LWR (i.e., the future risk scenario).

The revised Phase 2 HST model was used to predict the bed elevation changes (i.e., the areas and magnitude of erosion and deposition in the Study Area) that would result from five different high-flow scenarios. These are described in Section 5.2 of the modeling report (WEST and Tetra Tech 2009). A range of high-flow simulations were run because bed response can be a function of the long-term hydrographic conditions that exist leading up to the flood event. Figure 3.4-4 shows the simulated hydrograph for the flood event that produced the largest overall riverbed elevation changes. Map 3.4-7 shows the maximum erosion levels predicted for each model cell as a result of this simulated high-flow event. This map includes model cells outside the river edge boundary that represent the predicted extent of upland flooding during the event. Note also that this map is a mosaic of maximum change per cell at any point during the simulation, and so shows the maximum extent of erosion for each cell regardless of backfilling that might occur on the falling limb of the hydrograph. Nonetheless, the total net change map (WEST and Tetra Tech 2009), which shows the riverbed elevation at the end of the simulated hydrograph period, is quite similar to the result shown in Map 3.4-7, suggesting that, in this case, large changes due to backfilling were not evident.

The flood event maximum bed change map (Map 3.4-7) shows that much of the harbor experiences relatively minimal change (≤30 cm of erosion or deposition). Fifty-three percent (1,224 of 2,291 cells) are predicted to either not change (382 cells show 0 change) or erode down to maximum depth of 30 cm. About 31 percent of the cells show a positive elevation change (accretion), indicating that the event is, as expected, generally erosional in its effect. This leaves approximately 16 percent of the harbor with erosion predicted to exceed the 30-cm project-defined surface sediment layer during the modeled flood event. This erosion of deeper, "subsurface" sediments (greater than 30 cm to 300+ cm) is localized in two distinct regions of the harbor (see the darker blue cells in Map 3.4-7):

- The navigation channel from RM 10 to 11.8
- The navigation channel from about RM 5 to 6.8.

These more deeply eroded areas correspond to areas that are predominantly sandy in texture and are also coherent with the areas that the empirical time-series bathymetry data show to be erosional (or non-depositional) under typical seasonal flows.

A third less deeply eroded area is predicted to occur from about RM 8.7 to RM 10 (contiguous with the deep erosion area that begins at RM 10) in the eastern portion of the channel. The predicted erosion here is in the 15- to 30-cm range. Much of this area is also predominantly sand (see Map 3.4-1). It should be noted that any predicted erosion (all cells in the blue shades on Map 3.4-7) brings deeper sediment into the 30-cm surface sediment layer defined for this RI. Examination of Map 3.4-7 shows scattered model cells where erosion between 7.5 and 15 cm is indicated (pale blue cells). The largest "concentration" of these relatively small-scale erosion cells occurs at the center of the channel between about RM 8.1 and 8.4.

3.5 SEDIMENT TRANSPORT REGIMES (PHYSICAL CONCEPTUAL SITE MODEL)

In the deeper, offshore areas of the harbor (i.e., the navigation channel and adjacent areas in the main stem of the LWR deeper than about -20 ft NAVD88, see Map 3.4-4), the movement of water and sediment appears to be controlled in large part by the physical shape of the river, both the cross-sectional area and anthropogenic alterations such as borrow pits, dredged areas, and structures (e.g., bridge footings). In the off-channel, nearshore areas, especially areas less than -20 ft (NAVD88) in depth, the sediment dynamics are potentially complicated by local riverbank morphology, changing water levels, bank treatments, and other anthropogenic factors such as prop wash. Map 3.5-1 shows several cross-sectional channel profiles from RM 1 to 13 and illustrates the variability of the river morphology through the Study Area. The cross-sectional profiles include both the 2002 (blue) and 2009 (red) bathymetry and show where relatively large-scale deposition (mostly) and erosion have occurred. Select sediment-profile images from the 2001 survey are included on Map 3.5-1 to show how river bed surface textures and sediment shear strength (as indicated by the depth of the SPI camera prism penetration; SEA 2002) vary in accordance with the river's cross-sectional area and depositional setting. Finally, the plan view 2002 to 2009 bathymetric change data (Map 3.4-5) is included as the background layer on Map 3.5-1.

Map 3.5-2 shows predicted (EFDC hydrodynamic model) bottom shear forces in the LWR from the RM 24 (the upstream end of the revised HST model domain) to the Columbia under a relatively high flow regime (160,000 cfs); this was the flow condition observed in the LWR in late January 2004 when the Columbia River was relatively low. This map shows the predicted bottom shear forces of the Study Area in relation to the bottom shear forces in the upriver reaches. With the exception of the area from approximately RM 15 to 17, Map 3.5-2 shows that narrower upriver areas from RM 12 to 24 experience much higher near-bottom shear forces than RM 12 to the Columbia (Portland Harbor).

The physical system data collected throughout the Portland Harbor RI, summarized in the preceding sections, support and expand upon the physical conceptual site model described previously for the LWR (Integral et al. 2004; Integral 2007a). Table 3.5-1 summaries some of the key hydrodynamic/sediment transport characteristics of the LWR by major reaches with a focus on the distinct variations observed in subsections of the Study Area. These data indicate that the hydrodynamic character and sediment transport regimes of the LWR may be broadly described in terms of the ten reaches discussed in the following subsections.

3.5.1 Upriver Reaches

There are two reaches upstream of the Study Area that are summarized in Table 3.5-1 and described below:

- Upriver Reach (RM 15.3 to 26)[7]
- Downtown Reach (RM 11.8 to 15.3).

3.5.1.1 Upriver (RM 15.3 to 26)

The upriver segment includes the stretch of the river from Willamette Falls to the upstream end of Ross Island (approximately RM 26 to 15.3). Here the river is relatively narrow and flows through suburban areas under largely natural conditions, with the exception of the control structure (USACE Locks) at the Willamette Falls (approximately RM 26). Much of the river bottom consists of exposed basalt bedrock (GeoSea Consulting 2001). Bed shear stresses through this area are generally high (averaging 5.8 N/m^2), with the highest shear stresses occurring in the bend between RM 23 and 24 (>40 N/m^2), Map 3.5-2. Sustained current speeds in this reach appear to prevent all but the coarsest material from settling in the main stem of the river. Some low to moderate shear stresses occur in the smaller bifurcated channels, embayments, and sheltered nearshore areas. The most extensive relatively low-energy area occurs at the downstream end of this reach from approximately RM 15 to 17 and includes the river channel that runs behind (east of) Ross Island; predicted shear stresses here range from 0.4 to 4 N/m^2. This portion of the LWR (including the downtown reach) appears to most closely match the physical conditions observed in much of the Study Area under this flow regime (Map 3.5-2).

3.5.1.2 Downtown Reach (RM 11.8 to 15.3)

The downtown segment of the LWR extends from the upstream end of Ross Island (RM 15.3) to the upstream end of the Study Area at RM 11.8. Like the upriver reach, this is also a relatively high-energy segment of the river, where the main channel of the river is narrow (average cross-sectional area estimated at 34,000 ft^2) with steep channel margins that are largely constrained by upland bulkheads along both riverbanks. The deepest areas of the channel are found on the outer edges of bends in the river below Ross Island, and in the dominant bifurcation channel west of Ross Island. The -40 ft CRD authorized federal navigation channel does not extend into this reach (Map 3.4-4). Relatively high bed shear stresses (averaging 3.4 N/m^2) occur in the main portions of the channel, while lower shear stresses occur in the channel east of Ross Island and in shallower nearshore areas associated with some bends in the river (Map 3.5-2).

The high-energy environment of the main channel is evidenced by the observed bed sediment, which consists primarily of gravels and sands (SEA 2002). Localized areas of exposed bedrock occur, particularly near bridges where scouring appears related to footing structures (GeoSea Consulting 2001). Fine-grained deposits are observed in some nearshore areas sheltered from the main flow of the river (SEA 2002). The 2002 to 2009 bathymetric change data show limited sediment accretion throughout this reach,

[7] The upstream end of the upriver reach is defined hydrodynamically by the Willamette Falls at RM 26. In Sections 5 and 7 of this RI, the upstream end of the upriver reach is extended to RM 28.4 in order to incorporate some surface sediment data collected upstream of the falls as part of EPA's 2007 Blue Heron & West Linn Paper Mill Site Investigations in the upriver/background data set.

particularly downstream of RM 14; areas showing no change and small-scale deepening (≤1 ft) are dominant (Integral 2004b).

3.5.2 RI Study Area

The Study Area extends from RM 1.9 to 11.8 and the LWR -40 ft CRD authorized federal navigation channel nearly overlaps it, extending upstream from the Columbia River to RM 11.7 (Broadway Bridge). The varying physical/hydrodynamic conditions observed and measured within the Study Area during the RI support its classification into the following six separate segments that share characteristics (Table 3.5-1):

- RM 10 to 11.8
- RM 9.2 to 10
- RM 6.9 to 9.2
- RM 5 to 6.9
- RM 3 to 5
- RM 1.9 to 3.

Map 3.5-3 juxtaposes on a single panel the contoured surface grain-size patterns, the measured bathymetric change from 2002 to 2009, and the HST-predicted maximum riverbed elevation changes following a major flood event for the Study Area. The overlap of certain elements of these features across the Study Area helps support the discussions provided below.

3.5.2.1 RM 11.8 to RM 10

The cross-sectional area of the river begins to increase in this segment as the river broadens in a downstream direction, but the hydrodynamic energy in this segment of the Study Area remains relatively high (Maps 3.5-1 and 3.5-2) and comparable to the upriver reaches (e.g., see high-flow bed shear values in Table 3.5-1). This is evidenced by the high potential bed shear stresses, particularly in the eastern portion of the main channel where the channel bank is steep (Map 3.4-4), and by the observed bed sediment texture, which is dominated by sand (Map 3.5-3). The lower bed shear stresses predicted to occur along the eastern channel flank at RM 11.5 at the Goldendale Aluminum facility (Map 3.5-2) is supported by the historical dredging that has been required to maintain that facility's docking berth (CH2M Hill 2001).

The off-channel, nearshore areas of this reach are narrow, and show a nearly equal proportion of small-scale deepening, shoaling, and no-change areas (Integral 2004). The channel through this reach has generally undergone minor net deepening over the study period (on the order of 30 cm [1 ft], or less), though small areas have deepened more substantially. Deposition on the order of several feet has occurred in the deep areas of previously dredged holes (borrow pits) on the western side of the channel (Map 3.5-3). These are the farthest-upstream areas of significant net deposition in the LWR surveyed bathymetrically (i.e., from the Columbia River to the upper end of Ross

Island) as part of the Portland Harbor RI/FS. Sand waves are evident migrating along the western portion of the channel between RM 11 and 11.7 (Map 3.4-5).

The flood scenario predicts extensive deep (>100 cm) erosion to the central portions of the navigation channel in this reach, with minor erosion near the channel edge and some deposition in several off-channel areas (Map 3.5-3).

3.5.2.2 RM 10 to 9.2

The river becomes predominantly depositional as it widens significantly around RM 10. The increase in cross-sectional area reduces flow velocities, as reflected by the lower predicted bed shear stresses (Table 3.5-1), particularly along the broad western flank of the channel (Map 3.4-6), and the widespread sediment accumulation measured in this area (Map 3.5-3). An extensive shoaling on the order of 60 to 150 cm (~2 to 5 ft) in extent is evident along the broad western flank of the channel here. Observed bed sediment textures reflect the cross-channel energy differences, with coarser-grained deposits dominating the eastern portion of the riverbed and finer-grained deposits occurring along the western portion (Map 3.5-3). The model predicts a narrow swath of deposition along the western channel edge during the flood event and erosion to depths exceeding 100 cm in the channel in the eastern portion of this reach; this large-scale erosion coincides with sandy areas where some small-scale scour (up to 60 cm) was measured from 2002 to 2009 (Map 3.5-1).

3.5.2.3 RM 6.9 to 9.2

This reach is the broadest segment of the Study Area with a relatively wide cross-sectional area (Map 3.5-1), estimated at an average of 63,000 ft^2, and moderate to low bottom shear stresses. The reach is dominated by fine-grained surface sediments (Map 3.5-3). The depositional nature of the majority of this reach is seen in the areas of shoaling observed in the channel between RM 7.8 and 9.2, and along the eastern (directly downstream of Swan Island) and western channel-edge areas downstream to RM 6.9 between 2002 and 2009 (Map 3.4-5). Maintenance dredging has been required historically along the western shoreline of this reach. The large off-channel areas in this reach (e.g., Swan Island Lagoon, Willbridge Terminal) are characterized by very low bed shear but little or no sediment deposition (Map 3.5-3). Isolated areas of deepening in the lagoon are likely the result of anthropogenic factors such as prop wash. Dredging of sediments along the Willbridge Terminal piers occurred between winter 2002 and winter 2009 (Map 3.4-5).

3.5.2.4 RM 5 to 6.9

The river again narrows in this reach to an average cross-sectional area of approximately 57,000 ft^2 (Map 3.5-1). This stretch of river is a relatively high-energy sediment transport zone with high-flow bed shear rates (4.2 N/m^2) that approach the values predicted upstream of RM 10. Predicted maximum bed shear stresses are moderate to high (Map 3.5-2).

The high-energy nature of this segment of the river results in predominantly sandy surface sediments (Map 3.5-3). The 2002 to 2009 bathymetric change (Map 3.4-5) shows the channel in this reach is a mosaic of no change, small areas of sediment accumulation (mostly associated with channel depressions), and some small-scale scour. Localized areas of exposed bedrock have been noted, particularly on the west side of the river near the St. Johns Bridge. Sand wave migration is evident along the central portion of the channel between RM 5 and 6. Outside the channel, the narrow eastern nearshore area is dominated by small-scale scour, while the narrow western nearshore zone shows small-scale sediment accumulation.

The modeled flood scenario predicts relatively deep (>100 cm) erosion throughout much the channel, with the deepest scour occurring in the thalweg. Some channel edge and off-channel areas show deposition during the high-energy event. This includes the outer portions of Willamette Cove and a narrow swath along the western nearshore areas from about RM 5.3 to 6.3. An area of off-channel erosion exceeding 30 cm is predicted on the east side of the river from RM 6 to 6.5.

3.5.2.5 RM 3 to 5

The river widens again below RM 5 to an average cross-sectional area of 65,000 ft^2 (Map 3.5-1). The bathymetry is dominated by a deep (up to -70 ft NAVD88) dredged area on the eastern half of the channel between RM 4 and 5, which gradually shoals to the typical -40 ft depth CRD downstream of the International Terminal Slip. The time-series bathymetry indicates that the majority of the riverbed in the main channel undergoes minor net shoaling (30 cm or less) with swaths of more significant sediment accumulation along east and west channel edges and nearshore areas, especially between RM 4 and 5 (Map 3.4-5). The isolated areas of scour that are evident in some nearshore areas are likely due to anthropogenic factors; some dredging is also evident at the Port's Terminal 4 slips. The hydrodynamic model predicts low to moderate bed shear stresses, with relatively lower bed shear in the deeper upstream portion of this river segment and along the channel margins (Map 3.5-2).

Surface sediments are dominated by silts with some exceptions. The International Terminal Slip is mostly sand, apparently due to dredging or other anthropogenic factors (Map 3.5-3). A cross-channel swath at RM 3.2 leading into Multnomah Channel is also dominated by sandy surface sediments.

The modeled flood scenario predicts deposition exceeding 30 cm in extent in much of the channel and nearshore area from RM 4 to 5. No change is predicted for the majority of the RM 3 to 4 segment, with small depositional zones along the western nearshore area just upstream of Multnomah Channel and just upstream of RM 3 in the eastern nearshore zone (this is a predicted nearshore shoal that continues to RM 1.9).

3.5.2.6 RM 1.9 to 3

As noted in Section 3.3.3.2, a significant fraction of the downstream LWR flow moves down the Multnomah Channel; the reduced LWR discharge volume downstream of

Multnomah Channel results in markedly reduced bottom shear in the LWR (Maps 3.4-6 and 3.5-2). In addition, the main stem of the LWR continues to widen in this reach as it bends to the northeast, to an average cross-sectional area of approximately 67,000 ft^2 (Map 3.5-1). Maximum bed shear values are very low, particularly on the inside curve of the bend (Map 3.5-2). This is the lowest energy main channel reach in the Study Area. This is reflected in the observed surface sediment texture, which is predominantly fine-grained, and in the shoaling observed in the channel and east of the channel throughout this reach between 2002 and 2009. The area to the west of the channel boundary in this reach shows little net change over this time period.

The modeled flood scenario predicts a combination of no change and deposition in this reach (Map 3.4-7). A swath of nearshore deposition is predicted along the inside bend throughout this reach, but it is less extensive than the observed shoaling measured between 2002 and 2009.

The downstream boundary of this reach (RM 1.9) is the lower end of the project-defined Study Area and so is jurisdictionally rather than hydrodynamically defined. Hydrodynamically, this reach appears to extend downstream to approximately RM 1.6.

3.5.3 Downstream Reaches

There are two reaches downstream of the Study Area that are briefly described below:

- Downstream Reach (RM 0 to 1.9)
- Multnomah Channel (from the LWR to the Sauvie Island Bridge).

3.5.3.1 Downstream Reach (RM 0 to 1.9)

The remaining river segment downstream of the Study Area extends to the Willamette's confluence with the Columbia River. Bed-shear stresses are low to moderate, increasing from about RM 1.6 downstream as the river narrows, becoming more dynamic as it reaches the Columbia (Map 3.5-2). Net shoaling (to 60+ cm) was observed along the eastern channel edge and east of the channel to around RM 1.5. (This is a continuation of the pattern seen upstream of RM 1.9; this is the furthest downstream extent of significant sediment deposition in the LWR channel.) Net deepening (60 cm or less) occurred from 2002 to 2009 in a narrow strip outside the channel along the western nearshore area, particularly in the final one mile of this reach, possibly representing natural channel migration along the outside bend of the river.

Surface sediments transition from silts to sands at approximately RM 1.5 and remain predominantly coarse-grained to the Columbia. The modeled flood predicts little riverbed elevation change from RM 1.9 to the end of the model run at RM 1 in the main channel (Map 3.4-7). Some deposition is predicted in the eastern nearshore areas around the Port's Terminal 5 dock structures.

3.5.3.2 Multnomah Channel (LWR to the Sauvie Island Bridge)

Multnomah Channel between the LWR and Sauvie Island Bridge sees relatively high flows and bottom shear forces. The channel is notably shallower than the main stem of the LWR, and the flow moving down the channel is constricted (Map 3.4-4). Sandy sediments dominate the channel and the area immediately adjacent to it in the LWR (Map 3.5-3). Time-series bathymetric change data from 2002 to 2009 is not available for the Multnomah Channel. The modeled flood scenario includes the entrance and uppermost portions of the Multnomah Channel and indicates little or no change in the riverbed elevations in this area.

3.6 HABITAT

The majority of the Study Area is industrialized, with modified shoreline and nearshore areas. Wharfs and piers extend out toward the channel, and bulkheads and riprap revetments armor portions of the riverbank. Active dredging has produced a uniform channel with little habitat diversity. However, some segments of the Study Area are more complex, with small embayments, shallow water areas, gently sloped beaches, localized small wood accumulations, and less shoreline development, providing some habitat for a suite of local fauna.

The City of Portland updated its natural resource inventory of the Willamette River in 2008 (City of Portland 2008c). The natural resource inventory update (NRIU) is intended to be a refinement of the information presented in two prior documents: the *Willamette River Inventory: Natural Resources* (Adolfson et al. 2000) and Metro's (Portland-area regional government agency) inventory of regionally significant fish and wildlife habitat published in 2005 (Metro 2005). To date, the City has updated the proposed draft natural resource inventory of the North Reach of the Willamette River and plans to update the Central and South Reaches in the future. The proposed draft NRIU defines the North Reach as the 12 miles (RM 0 to 12) of river extending from the Broadway Bridge to the Columbia River, which encompasses all of the Study Area (RM 1.9 to 11.8). It is a proposed draft and subject to revision.

The inventory accounts for special habitat areas (SHAs), defined as areas that contain or support special status fish or wildlife species, sensitive/unique plant populations, wetlands, native oak, bottomland hardwood forests, riverine islands, river delta, migratory stopover habitat, connectivity corridors, grasslands, and other unique or unusual habitat features (City of Portland 2008c). It also includes federally designated critical areas for salmonids. The inventory qualitatively ranked riparian corridors and wildlife habitat areas by applying a geographic information systems (GIS) model that evaluated vegetation and water-related information. Wildlife habitat areas were ranked based on connectivity to patches, connectivity to water, interior area, and patch size. Riparian corridor function was ranked based upon six classes of attributes, including riparian movement corridor, large wood/channel dynamics, food web, flow/flood storage, microclimate/shade, and bank function/water quality (City of Portland 2008c). The City of Portland incorporated information collected by Adolfson et al. (2000) in the

most recent draft version of the NRIU and has published maps depicting the relative ranks of wildlife habitat areas and riparian corridor function. This inventory is currently a proposed draft inventory and subject to further review and revision. In the City's NRIU (2008c), all in-water habitat is designated as an SHA for salmonids in the North Reach and is therefore ranked high. However, this ranking is not a representation of habitat quality—the inventory does not evaluate features that determine the variability of aquatic habitat or function to the same extent that it does terrestrial habitat—but an indication that the river supports federal- or state-listed species.

This section describes the general types and quality of aquatic habitat available to ecological species in the LWR.[8] The habitats for each ecological receptor group are described in greater detail in the BERA (Appendix G).

3.6.1 Open-Water Habitat

The LWR is characterized by a developed navigation channel and shoreline. The LWR historically had large amounts of off-channel habitat in the form of floodplain lakes such as Ramsey, Doane, and Guild's lakes. After industrialization, only a few shallower backwater sites (e.g., Willamette Cove, Swan Island Lagoon, individual slips), as well as a tributary (Columbia Slough) and a secondary channel (Multnomah Channel) remain. The deep open water provides foraging habitat for fish and wildlife that feed in the water column. Shallow-water habitats provide refuge for juvenile salmonids and other fishes, as well as greater foraging opportunities for birds and mammals. ODFW (Friesen et al. 2004) found that juvenile salmon were present in every month sampled from May 2000 to July 2003. Juvenile salmon were captured more frequently during winter and spring than during other seasons. Coho and steelhead were generally present only during winter and spring.

Historically the LWR was dominated by shallow water habitat, with approximately 80 percent of the river with depths less than 20 ft CRD. Dredging and alteration of the river channel have reversed these ratios, and the river is now 20 percent shallow water and 80 percent deep (City of Portland 2009b). Shallow-water habitats, such as those preferred by some foraging wildlife (e.g., otter and mink), are now largely limited to the narrow strip between the shoreline and the navigation channel, which generally is vulnerable to disturbance and anthropogenic alteration due to its proximity to shore. Remaining pockets of shallow water habitat include areas such as Willamette Cove, Swan Island Lagoon, the mouth and channel of Multnomah Channel, and the Sauvie Island shoreline.

There are three types of benthic habitats in the open water of the LWR:

1. Unconsolidated sediments (sands and silts) in the deeper water (greater than approximately 20 ft CRD) of the navigation channel and lower channel slopes

[8] Habitat information was compiled from observations made during field investigations conducted for the RI and risk assessments, as well as supporting studies conducted by others and historical information, as cited.

2. Unconsolidated sediments (sands and silts) in shallow water depths (less than 20 ft CRD) in gently sloping nearshore areas (e.g., beaches and benches) and on the upper channel slopes
3. Developed shoreline (e.g., rock riprap, sheet pile, bulkheads, piers).

In addition, very limited areas of rock and rock outcrop are present in the LWR. The navigation channel habitat is subject to variable (daily [tidal], seasonal, and annual) hydrodynamic forces, the impacts of navigation, natural sediment deposition, bed load transport/erosion, and periodic navigational dredging. These forces vary spatially through the system, largely as a function of the channel cross-sectional area, resulting in the presence of both relatively stable and unstable sedimentary environments and patchy infaunal and epibenthic communities that are characteristic of the local physical regime. The physical sedimentary regimes are a function of the local riverbank morphologies, and sheltered areas away from anthropogenic disturbance should support well-developed infaunal invertebrate communities that are characteristic of large river systems.

Conversely, exposed nearshore areas, particularly around berths, docks, and boat ramps, likely have limited benthic communities due to the greater physical disturbance in these areas. Tidal and seasonal water level variability and nearshore disturbances (e.g., boat wakes) have a much larger effect in shallow water than they do in deeper water. The hard surfaces of the developed shoreline provide habitat for an epibenthic community.

3.6.2 Bank and Riparian Habitat

The most common bank types occurring in the Study Area are riprap, sandy and rocky beach, unclassified fill, and seawall (Map 3.6-1).[9] In 2008, the City of Portland reported that vegetated riprap (25 percent), unclassified fill (21 percent), and beach (23 percent) were the dominant bank types in the North Reach (Broadway Bridge to the Columbia River; City of Portland 2008c). The bank types classified in the NRIU were identified based on physical characteristics and were not associated with a specific range of shoreline elevations. The riprap or rocky bank type is usually fairly steep with no or very narrow adjacent shallow water habitat present. These areas are usually exposed to heavy wave action and strong currents. The sandy bank type with little to no vegetation is characterized by gently sloped beaches (i.e., sand banks are rarely steep). However, this bank type is often adjacent to steep riprapped shorelines or developed uplands that are frequently exposed to heavy wave action and faster moving water. The rocky or sandy bank types with a mix of native and invasive vegetation are common within the Study Area. These bank types range from gently to steeply sloped beaches and, similar to the sandy bank type without vegetation, are often adjacent to steep uplands, although the uplands are either of sandy or rocky substrate. The rocky or sandy bank types are generally located in areas with less development and a lack of

[9] Classifications on Map 3.6-1 are based upon an ODFW 2000–2003 study (Vile and Friesen 2004) and are known to be outdated or incorrect in some locations.

bank hardening, such as in Swan Island Lagoon, the Multnomah Channel, Kelley Point Park, and Sauvie Island.

The type of riverbank present in the Study Area is expected to influence fish species occurrence and use of a given area. Riverbanks with large woody debris and riparian vegetation that provides cover and creates small shallow pools will likely be used by juvenile salmonids and other small fish species (Bjornn and Reiser 1991, Sedell and Froggatt 1984). Areas with limited wood accumulations include the beach adjacent to Freightliner Corp., Kelley Point Park, and Mar Com. ODFW (Friesen et al. 2004) found that in the LWR, coho preferred beach habitat and rock outcrops and avoided riprap and artificial fill, and the abundance of all species was low at seawall sites. The riprap and rocky substrate are the preferred habitats of sculpin and smallmouth bass (Farr and Ward 1992, SEA et al. 2003, Wydoski and Whitney 2003). Sculpin are predominately present in the shallow water habitats, and smallmouth bass are present in areas with moderate current. The shallow backwater pools and slow-moving areas of the river provide habitats for juvenile largescale suckers (yearling and subyearling) and peamouth (Wydoski and Whitney 2003). The peamouth remains nearshore during winter months and moves to deeper waters in the summer months. The shallow waters with abundant plants and woody debris available for cover are the preferred habitats for largemouth bass.

Numerous aquatic and shorebird species such as cormorants and spotted sandpipers use the habitats in the LWR. The upland environment near the LWR is primarily urban, with fragmented areas of riparian forest, wetlands, and associated upland forests. Historical development and filling of channels and wetlands has left only small strips or isolated pockets of riparian wildlife habitat, with the exception of areas such as Harborton Wetlands, Oaks Bottom, Forest Park, and Powers Marine Park. Therefore, although isolated wildlife habitat areas along the LWR corridor exist, linkages to the larger landscape are limited to a few areas, such as Forest Park.

The City of Portland updated its NRIU in 2008, and it is intended to update both the documentation and mapping of the regional Habitats of Concern identified in Metro's inventory for the North Reach (2005), as well as the City's earlier inventory (Adolfson et al. 2000, City of Portland 2008c). The River Plan North Reach Discussion Draft (City of Portland 2008b) identified 20 "restoration sites," which were areas along the river that currently could provide important ecological functions, and that could be enhanced through additional restoration. The 2008 NRIU identified 20 SHAs within the North Reach (which encompasses the Study Area), including the entire Willamette River; portions of the Columbia Slough; Johnson Creek; Tryon Creek; urban nesting sites, such as bridges and chimney roosts; bluff areas; grasslands at Powell Butte; native oak assemblages; bottomland hardwood forests; and wetlands (City of Portland 2008c). SHAs were mapped at a coarse level and include areas identified as federally designated Critical Habitat. The SHAs are not to be interpreted as areas of high quality habitat; rather, they are an indication of habitat features or geographic resources.

Potential general wildlife habitat areas in the Study Area are shown on Map 3.6-2. These include the sites identified in the Adolfson et al. (2000) inventory or were based on field observations made during the shorebird habitat reconnaissance (Windward 2004, pers. comm.) or site bathymetry. In the City of Portland's earlier version of the Willamette River corridor natural resource inventory (Adolfson et al. 2000), 15 sites of habitat value for fish, reptiles, amphibians, and wildlife were identified. These habitat sites are known to be utilized by numerous aquatic birds and semi-aquatic mammals. Notable habitat sites in the Study Area included the South Rivergate corridor at the north end of the Study Area, the Harborton forest and wetlands, Willamette Cove, the railroad corridor, and the Swan Island beaches and lagoon on the southern end (Adolfson et al. 2000). Other habitat sites identified in the general area were Kelley Point, at the confluence of the Willamette and the Columbia rivers, and the Ross Island and Oaks Bottom Complex around RM 16.

3.7 HUMAN ACCESS AND USE

This section describes the current understanding of the physical and biological setting of the Study Area as it pertains to potential human uses, including specialized groups that may use the river for various activities. Most of the demographic information relating to the Study Area is based on historical background and documented human uses. This information is used to determine potential receptor populations and to develop the general CSM.

Portland Harbor and the Willamette River have served as a major industrial water corridor for more than a century. Industrial use of the Study Area and adjacent areas has been extensive. The majority of the Study Area is currently zoned for industrial land use and is designated as an "Industrial Sanctuary" on the Portland Comprehensive Plan Map (City of Portland 2006b). The Portland industrial sanctuary policy is designed to encourage the growth of industrial activities in the city by preserving industrial land. In addition to industrial use zoning designation, the City of Portland citywide zoning map (January 2009) displays several other zoning designations for smaller portions of the Study Area including: open space (e.g., Cathedral Park and Willamette Cove); general employment (mixed use allowed though primarily an industrial use focus); and multi-dwelling residential (e.g., University of Portland).

The Guild's Lake Industrial Sanctuary Plan (GLISP), which covers one portion of the Study Area zoned for industrial use, is intended to preserve and enhance industrial land in the Guild's Lake area, generally bounded by Vaughn Street on the south, the St. Johns Bridge on the north, Highway 30 on the west, and the Willamette River on the east (City of Portland 2001a). Over many decades, public and private investments in infrastructure, such as marine, rail, and highway facilities, as well as investments in industrial physical plants, have occurred within this area. The stated purpose of the GLISP is to maintain and protect this area for heavy and general industrial uses. The plan's objectives were adopted as part of Portland's Comprehensive Plan to ensure preservation of this land use over the next 20 years.

Much of the shoreline in the Study Area includes relatively steeply sloped banks. Some sections of the shoreline are also covered with riprap or constructed bulkheads, and other human-made structures such as piers and wharfs extend out over the water in various locations. A comprehensive update of Portland's Willamette Greenway Plan and related land use policies and zoning (The River Plan) is underway, addressing all of the Willamette riverfront in Portland (City of Portland 2006b). The plan update may affect land use practices in Portland Harbor, but it will not affect the "Industrial Sanctuary" designation.

People interact with the riverine environments in a number of ways. Worker activities that may include contact with sediments and surface water at industrial and commercial facilities in the Study Area are limited in the shoreline areas due to the sparse beach areas and high docks associated with most of the facilities.

In addition, the LWR provides many natural areas and recreational opportunities, both within the river itself and along the riverbanks. Within the Study Area, Cathedral Park, located under the St. Johns Bridge, includes a sandy beach area and a public boat ramp and is used for water skiing, occasional swimming, and waterfront recreation. Recreational beach use also may occur within Willamette Cove, which is a riverfront natural area; in Swan Island Lagoon; and on the southern end of Sauvie Island, which is within the Study Area. Swan Island Lagoon includes a public boat ramp. Additional LWR recreational beach areas exist on the northern end of Sauvie Island and in Kelley Point Park, both of which are outside of the Study Area. Potential human use beach areas in the Study Area are shown in Map 3.7-1.

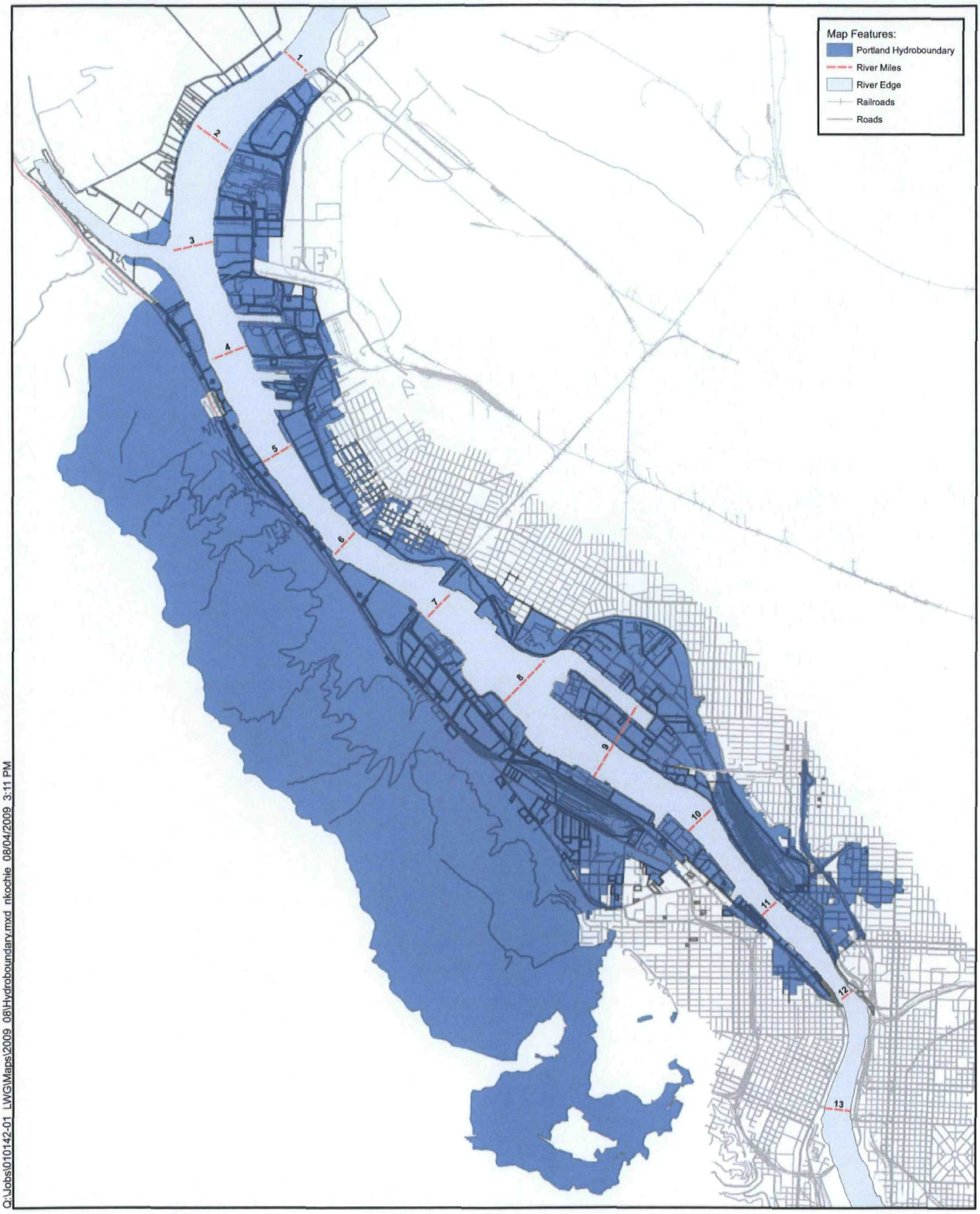
Diving activity also occurs in the LWR. In the Study Area, the majority of divers are expected to be commercial divers. Some diving for scientific purposes, including some aspects of site characterization for this RI, has occurred in the Study Area. In a memo dated September 2, 2008, the EPA provided information on the types of diving conducted in the Portland Harbor area. According to the EPA, "diving is done by several groups of people including: the public for recreation and gathering of biota for consumption; the sheriff's office for investigations and emergency activities; and, commercial divers for a variety of purposes, including marine construction, underwater inspections, routine operation and maintenance, and activities related to environmental work. The majority of divers are expected to be commercial divers."

The St. Johns Town Center is a mixed-use district that extends to the waterfront on the east side of the Willamette River at the St. Johns Bridge. The recent St. Johns/Lombard Plan (City of Portland 2004) includes a proposed redevelopment of this area near the Willamette River. The Riverfront Subdistrict included in the St. Johns/Lombard Plan is currently zoned as Open Space and as a Central Employment (EX) zone. The development standards of the Central Employment (EX) zone are intended to ensure that the Riverfront Subdistrict is developed in a manner consistent with adjacent areas and to support existing industry by limiting uses that may be less compatible with industry (City of Portland 2004).

The exact extent to which commercial fishing occurs within the Study Area is currently not known. No reports of commercial fisheries for anadromous salmonids on the Willamette River have been found. A commercial crayfish fishery exists in the LWR. Crayfish landings must be reported to ODFW by water body and county. Per ODFW, the crayfish fishery is not considered a large fishery (Grooms 2008, pers. comm.). Based on ODFW's data for 2005–2007, no commercial crayfish landings were reported for the Willamette River in Multnomah County.

Non-commercial fishing is conducted throughout the LWR basin and within the Study Area, both by boaters and from locations along the banks. Limited interviews by ATSDR suggest that the groups most likely to be catching and eating fish from the LWR are immigrants from Eastern Europe and Asia, African-Americans, and Hispanics. The same source also suggests that the most consumed species are carp, brown bullhead (a catfish), crappie, and smallmouth bass (ATSDR 2002a). Other sources (Columbia River Inter-Tribal Fish Commission; CRITFC 1994) suggest that Native Americans fish in the Willamette River. The LWR provides a ceremonial and subsistence fishery for Pacific lamprey (particularly at Willamette Falls) and spring Chinook salmon for Native American tribes. Many areas in the LWR are also important for cultural and spiritual uses by local Native Americans. There is also an active recreational fishery for salmon, steelhead, and sturgeon in the LWR.

Transients have been observed along the LWR, including some locations within the Study Area. The observation of tents and makeshift dwellings during RI sampling events confirms that transients were present along some riverbank areas. Transients are expected to intermittently utilize this area in the future. Conversations were conducted with transients about their consumption of fish or shellfish from the Willamette River as part of a project by the Linnton Community Center (Wagner 2004, pers. comm.). The transients that were contacted reported harvesting and consuming various fish species as well as crayfish and clams. It should be noted that the most common clam species in the Portland Harbor is an invasive species, the harvesting of which is illegal. Many of the individuals indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. However, the interviews did not quantify the frequency or duration of transient presence along the shoreline.



Q:\Jobs\010142-01 LWG\Maps\2009 08\Hydroboundary.mxd nkochie 08/04/2009 3:11 PM

ANCHOR ENVIRONMENTAL, L.L.C.

LWG LOWER WILLAMETTE GROUP

FEATURE SOURCES:
Land Use/Zoning, Streams, Water Bodies: Metro RLIS.
Channel & River miles: US Army Corps of Engineers.

N

0 3,000 6,000 Feet

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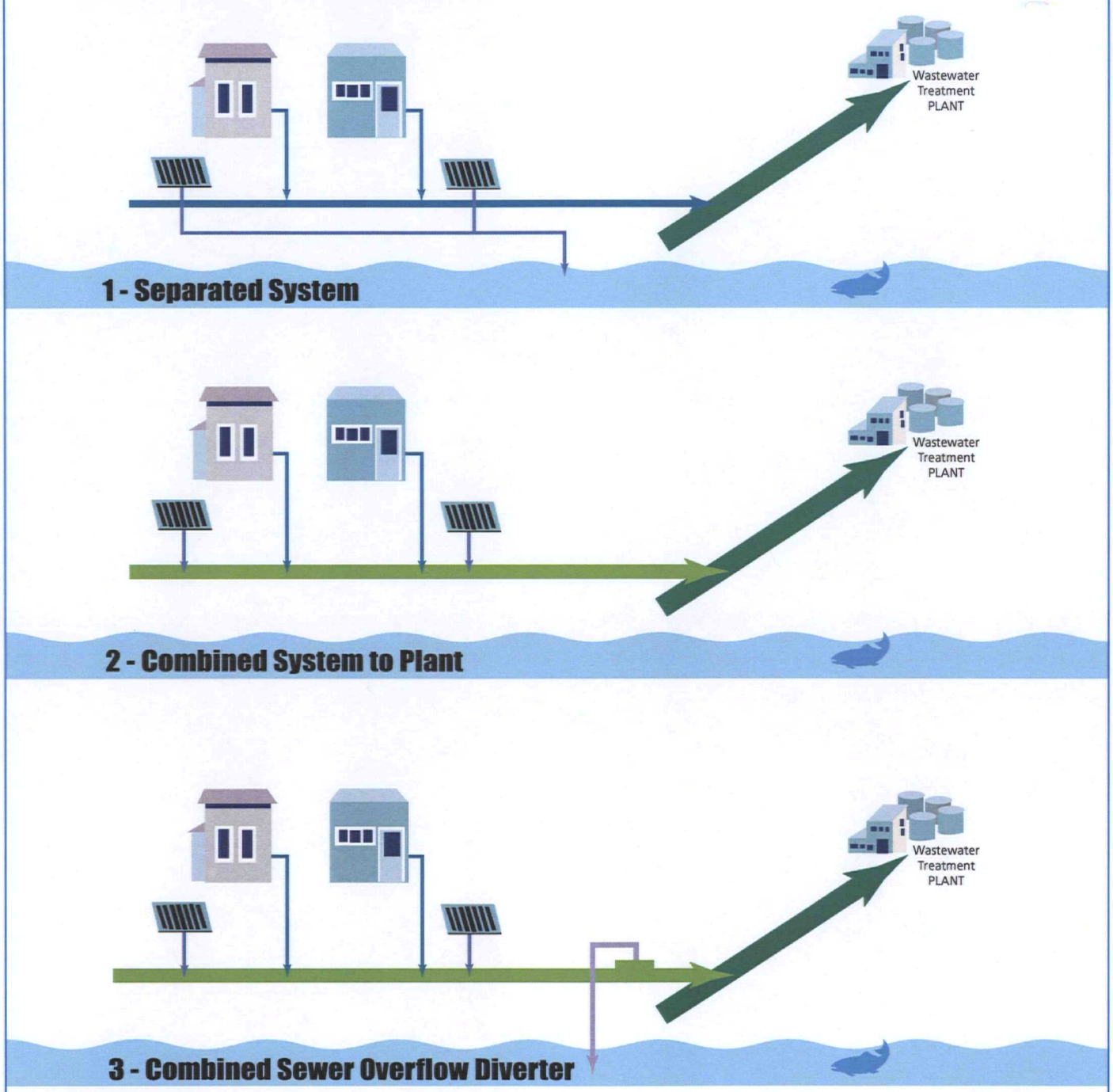
Figure 3.1-1
Portland Harbor RI/FS
Draft Remedial Investigation Report
Stormwater Basin Hydroboundary
River Miles 1-11.8

TYPES OF CONVEYANCE SYSTEMS



- Stormwater only
- Sanitary Only
- Combined
- Interceptor
- CSO Diversion

Figure 3.1-2
Portland Harbor RI/FS
Draft Remedial Investigation Report
Types of Conveyance Systems
(City of Portland 2009)

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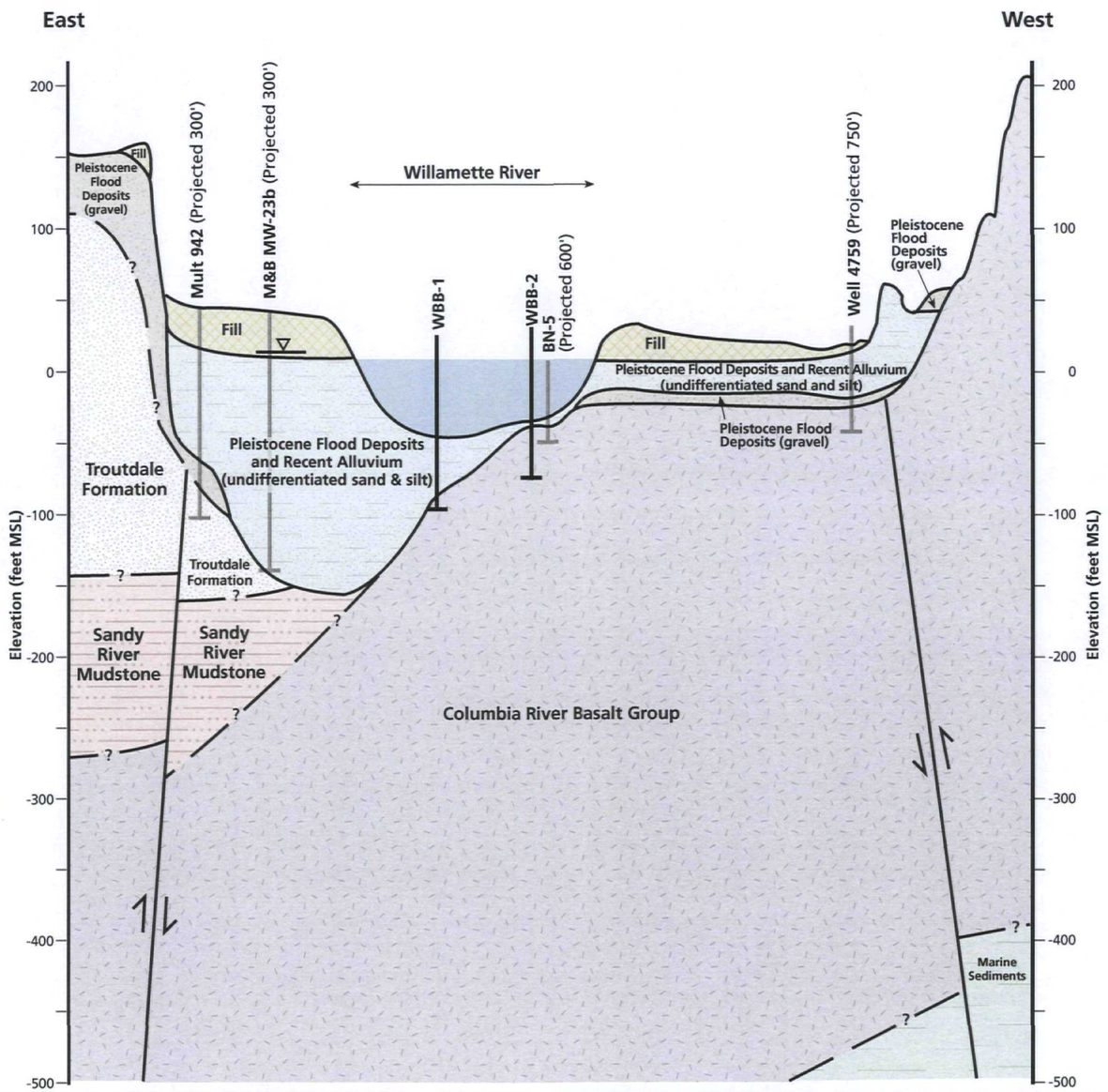
10/22/03 Generalized Geologic Section



LEGEND

0 1,000 2,000

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 10X

Notes: Scale and elevations are approximate.
Geologic information from City of Portland Force Main Project (URS 2000) (Beeson, et al. 1991)

Reference: Fault locations and orientation based on Wong (2001)

Mult 53996 — Boring/Well ID (WRD ID where available)

Surface elevation along profile

Boring/Well, Projected

Bottom of boring/well

- Fill
- Pleistocene Flood Deposits and Recent Alluvium (Sand and Silt)
- Pleistocene Flood Deposits (Gravel)
- Troutdale Formation
- Sandy River Mudstone
- Columbia River Basalt
- Marine Sediments

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Groundwater Solutions Inc.

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Figure 3.2-1
Portland Harbor RI/FS
Draft Remedial Investigation Report
Generalized Geologic Section

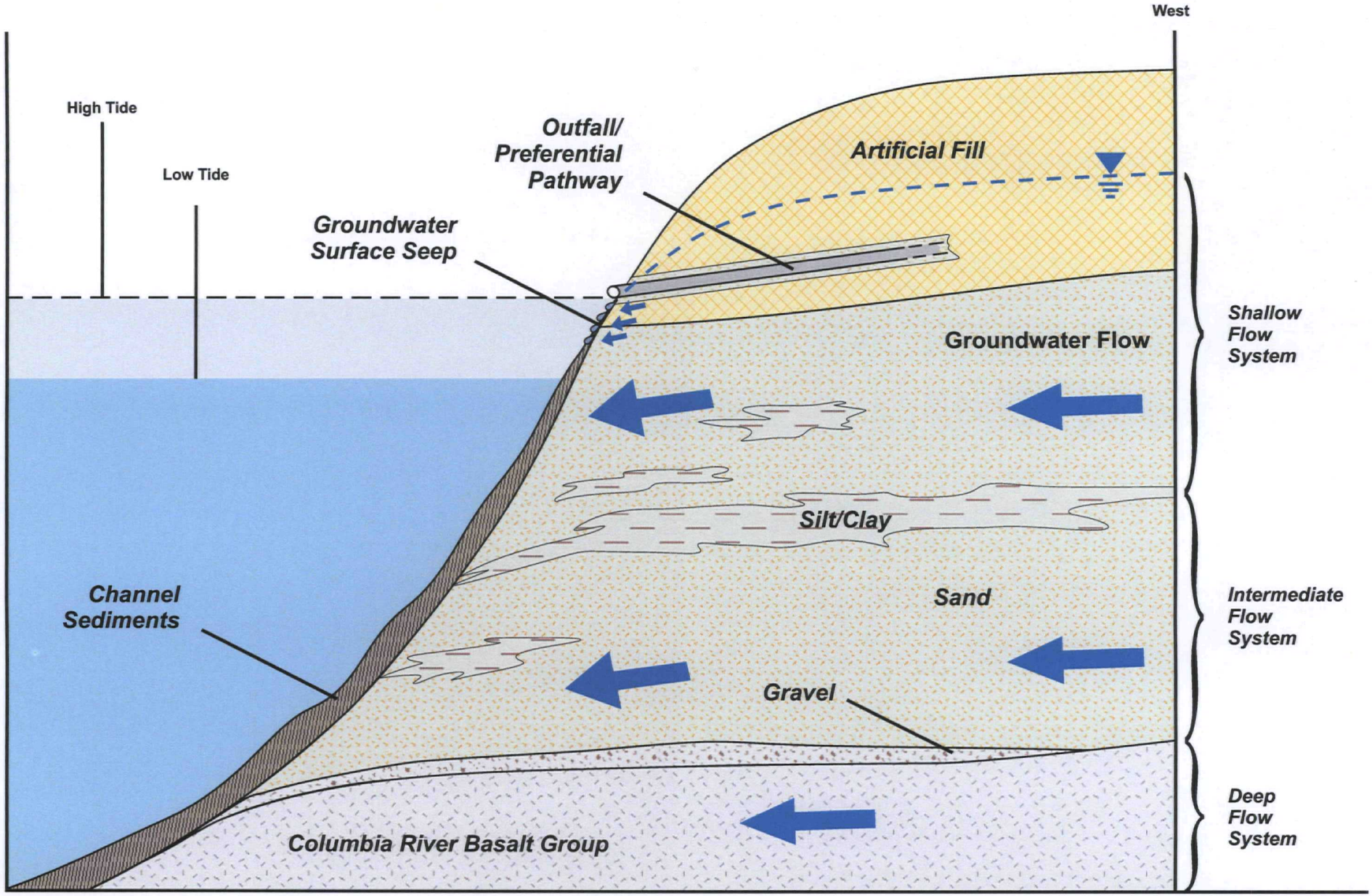

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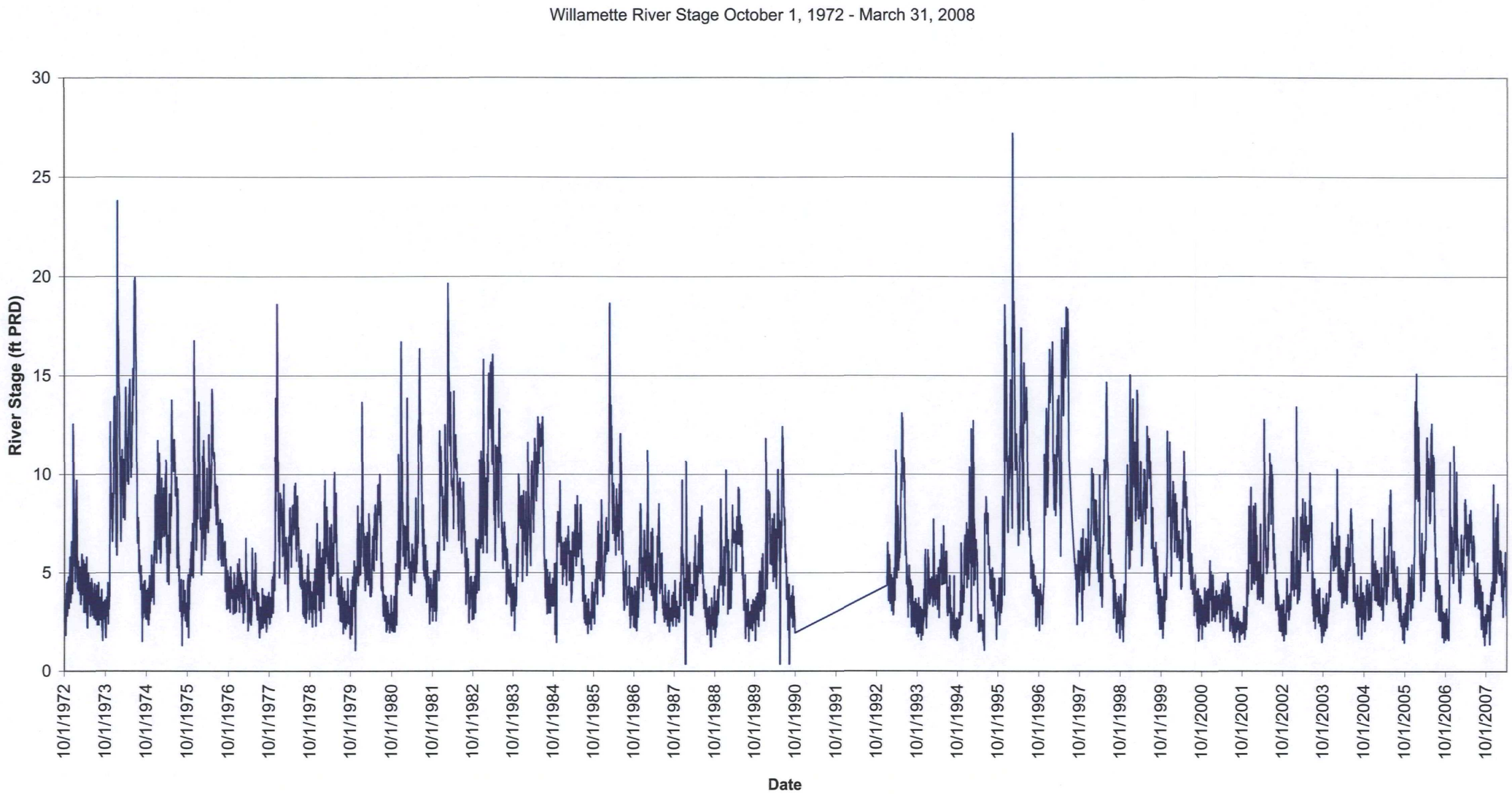
Figure 3.2-2
Portland Harbor RI/FS
Draft Remedial Investigation Report
Conceptual Model of Groundwater Flow



Note: Final river stage data was not available from 10/01/1990 through 10/01/1992 from the USGS Real Time National Water Information System (NWIS) Database for the Morrison Bridge station 14211720.

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Figure 3.3-1
Portland Harbor RI/FS
Draft Remedial Investigation Report
Willamette River Stage Data,
October 1972 - March 2008

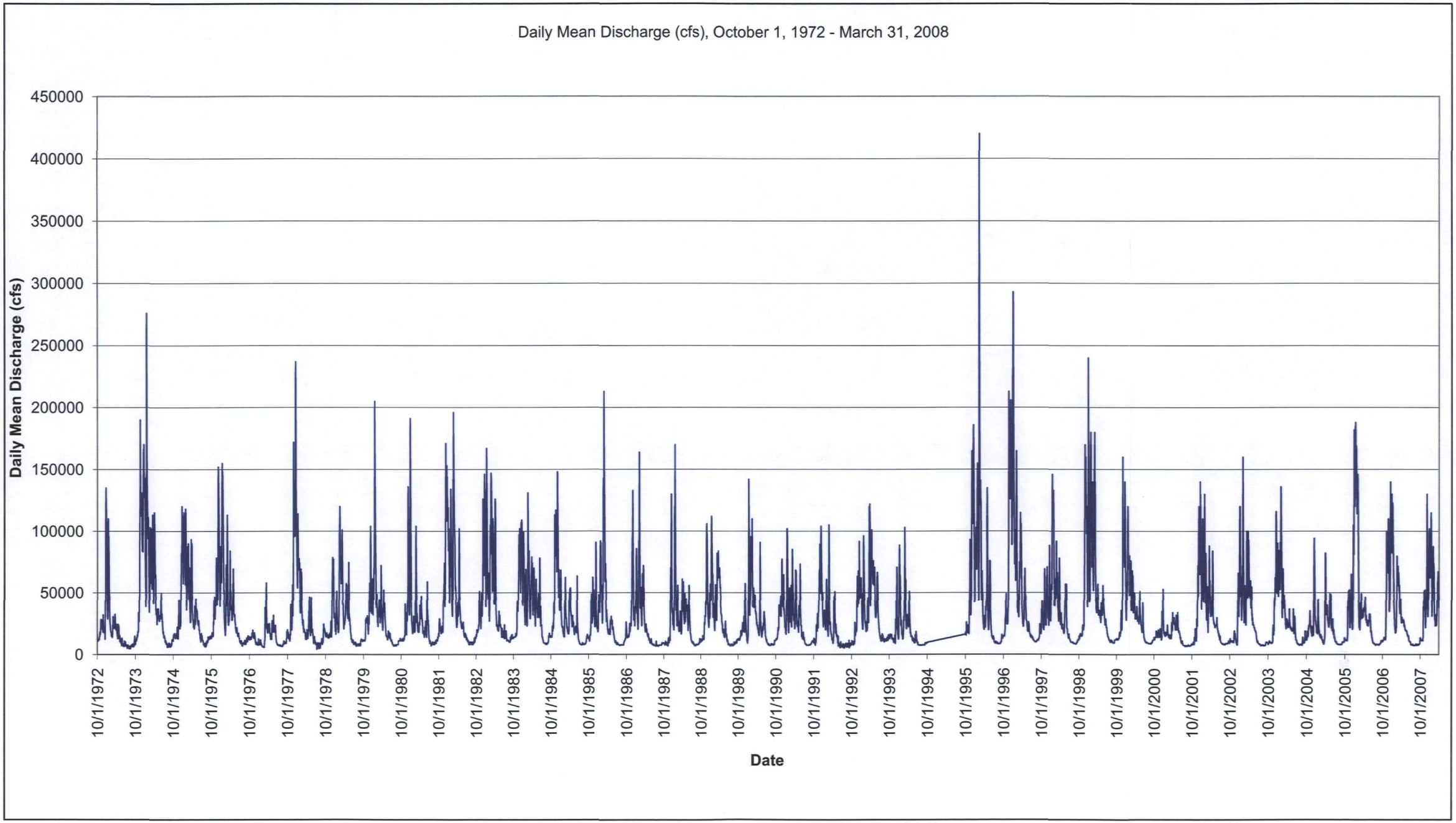

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Figure 3.3-2
Portland Harbor RI/FS
Draft Remedial Investigation Report
Daily Mean Discharge (cfs),
October 1, 1972 through March 31, 2008

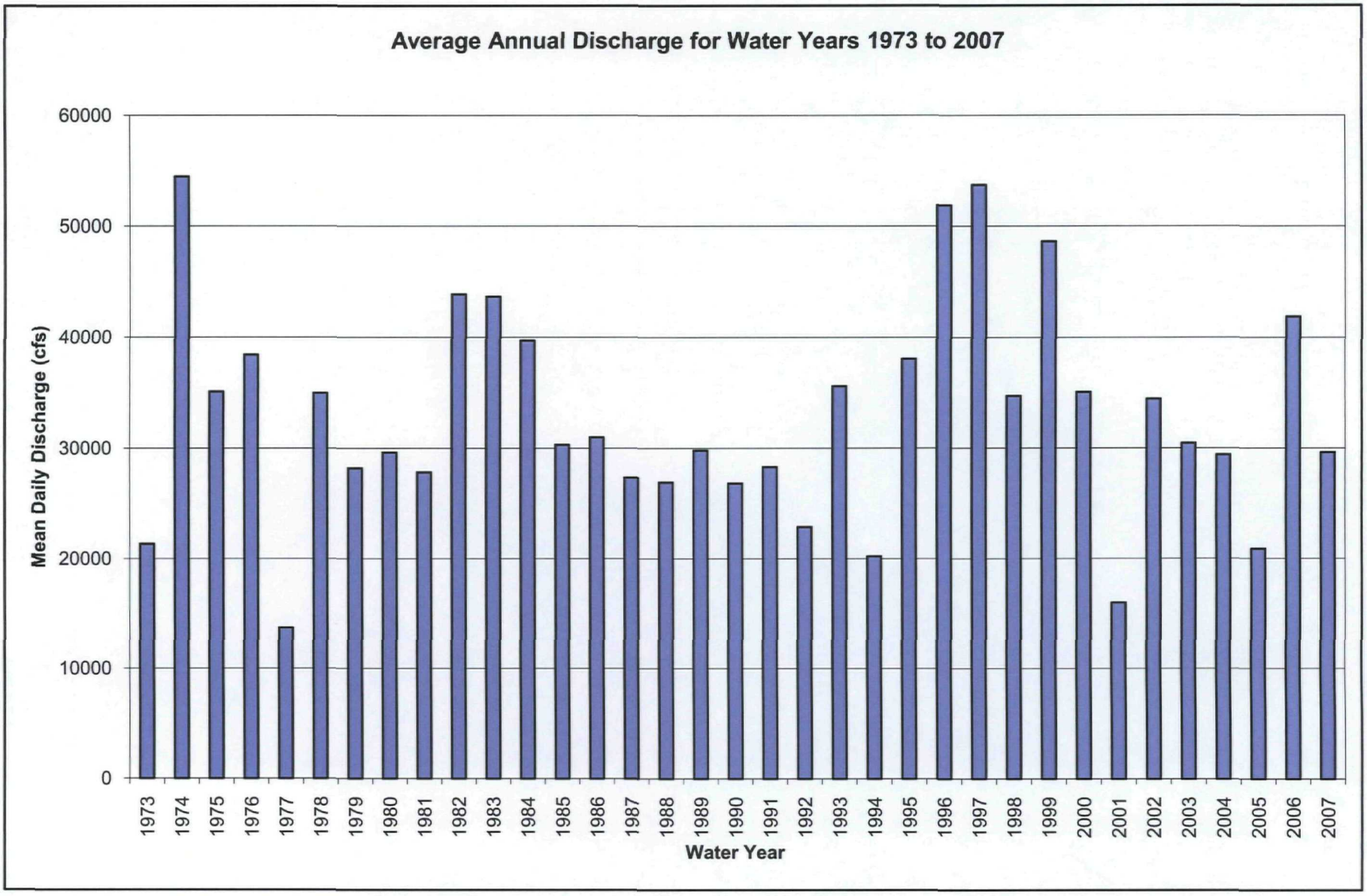

Figure 3.3-3
Portland Harbor RI/FS
Draft Remedial Investigation Report
Average Annual Discharge for
Water Years 1973 to 2007

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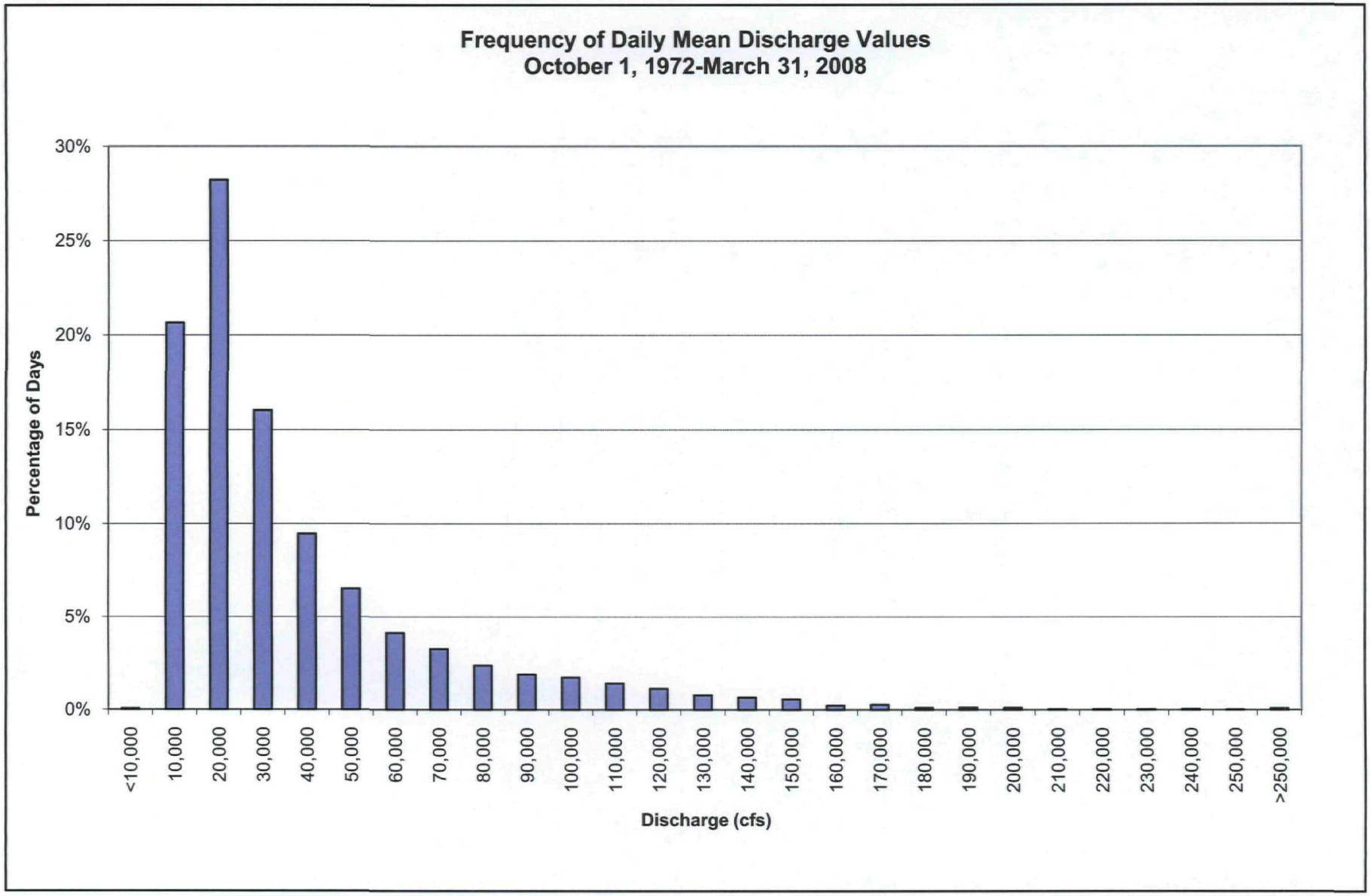

Figure 3.3-4
Portland Harbor RI/FS
Draft Remedial Investigation Report
Frequency of Daily Mean Discharge Values,
October 1, 1972 - March 31, 2008

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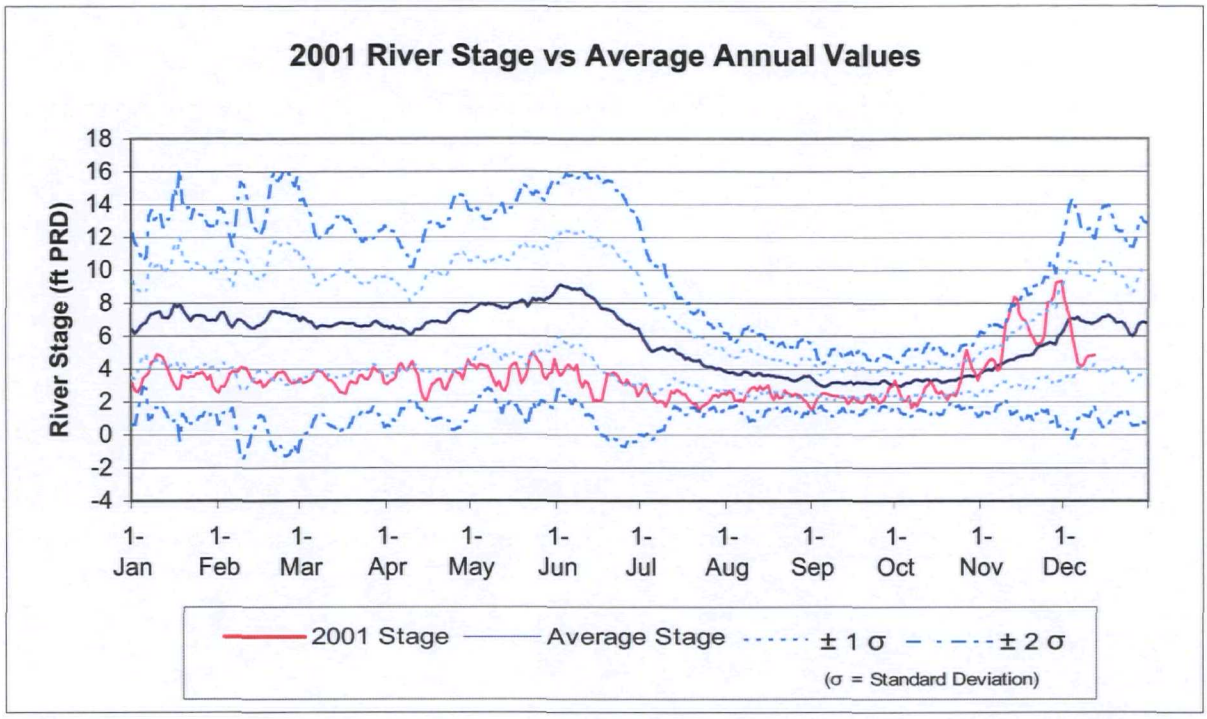


Figure 3.3-5a
2001 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

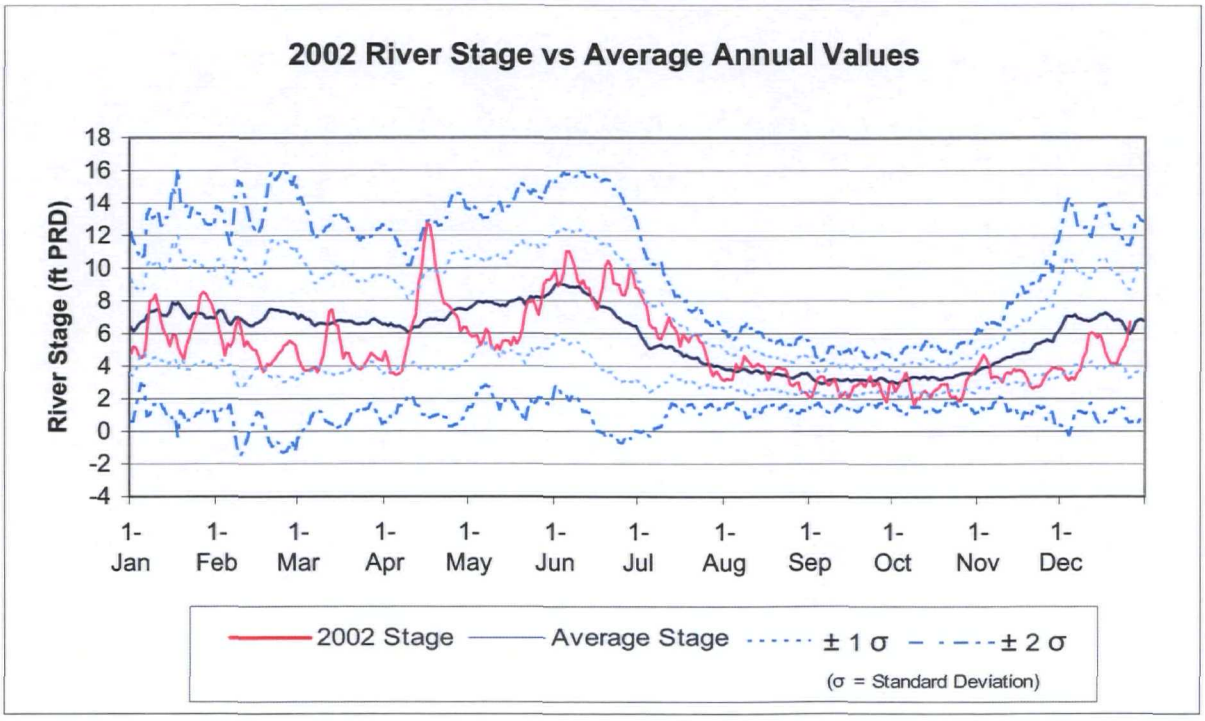


Figure 3.3-5b
2002 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

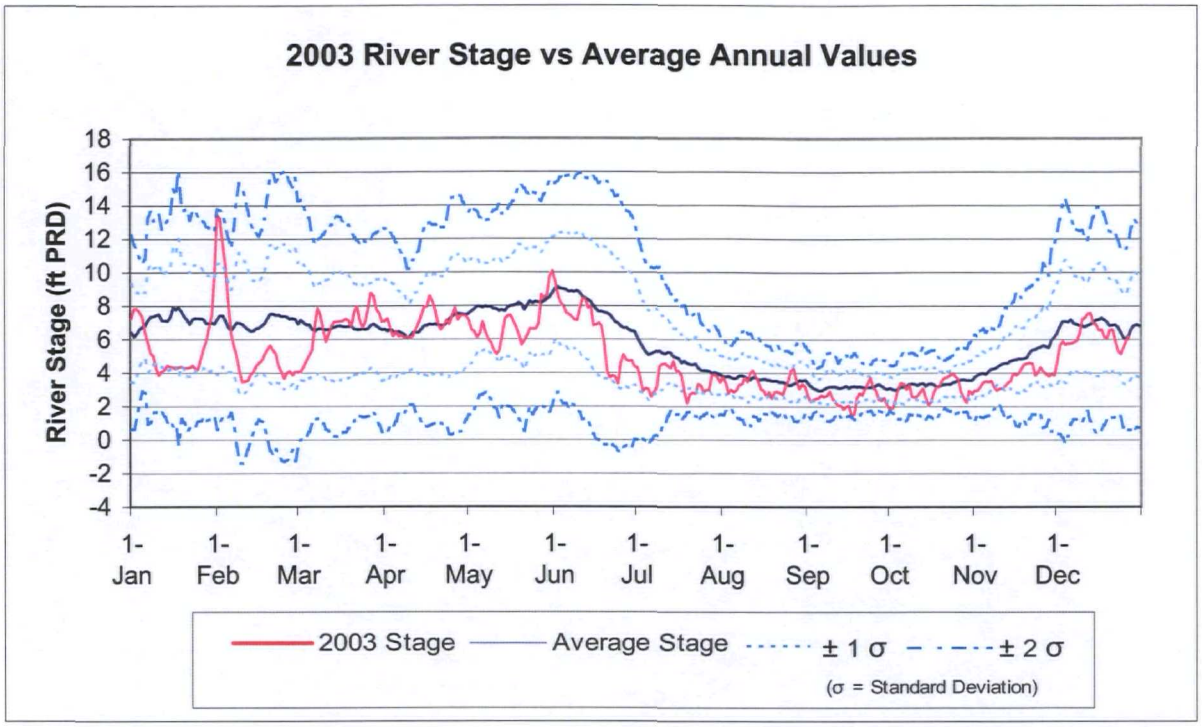


Figure 3.3-5c
2003 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

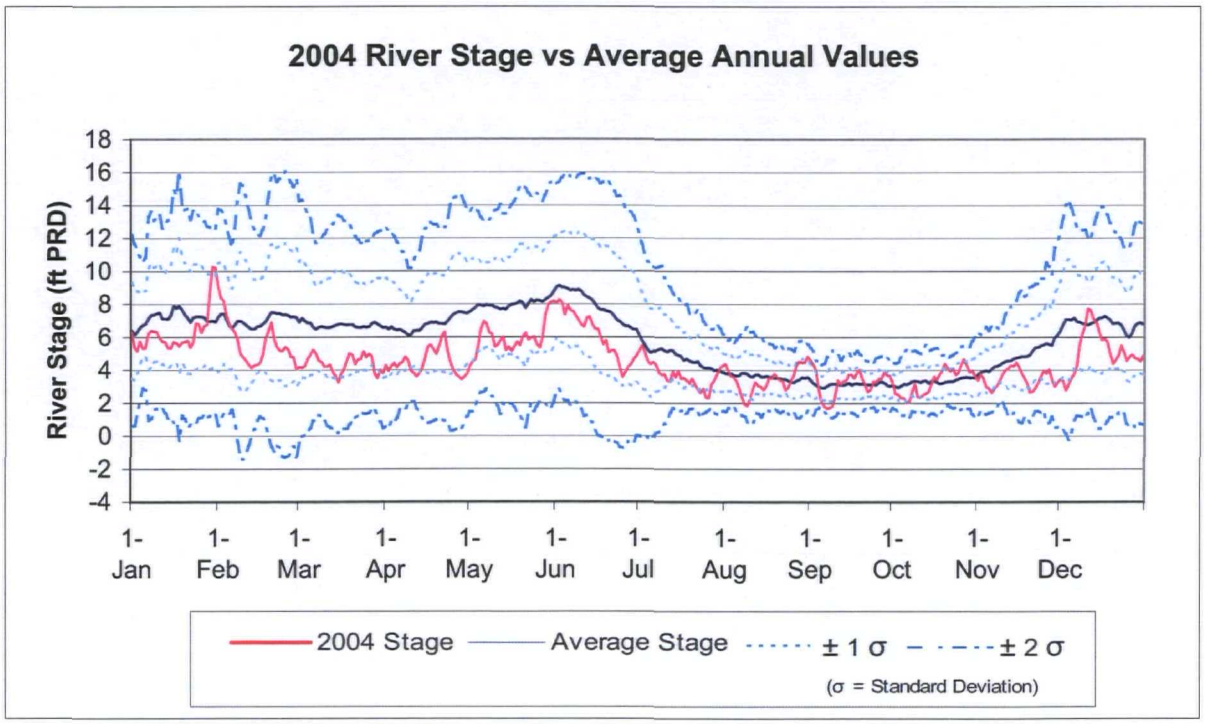


Figure 3.3-5d
2004 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

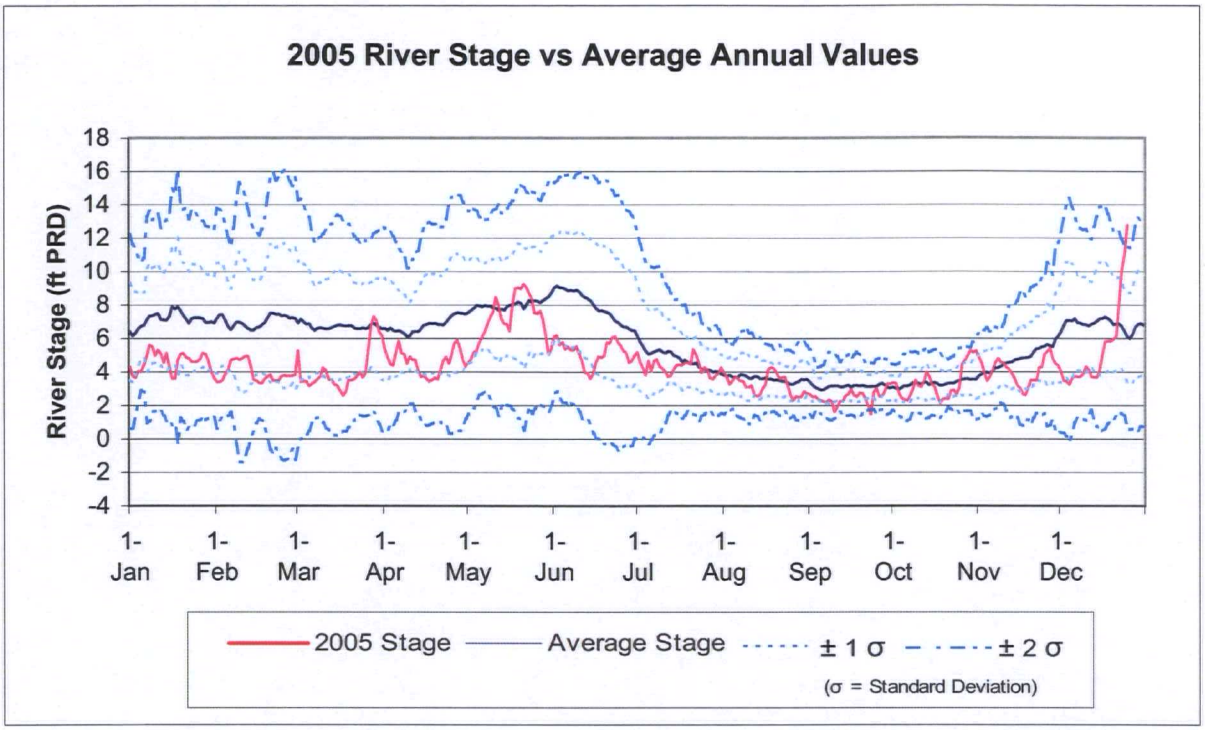


Figure 3.3-5e
2005 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

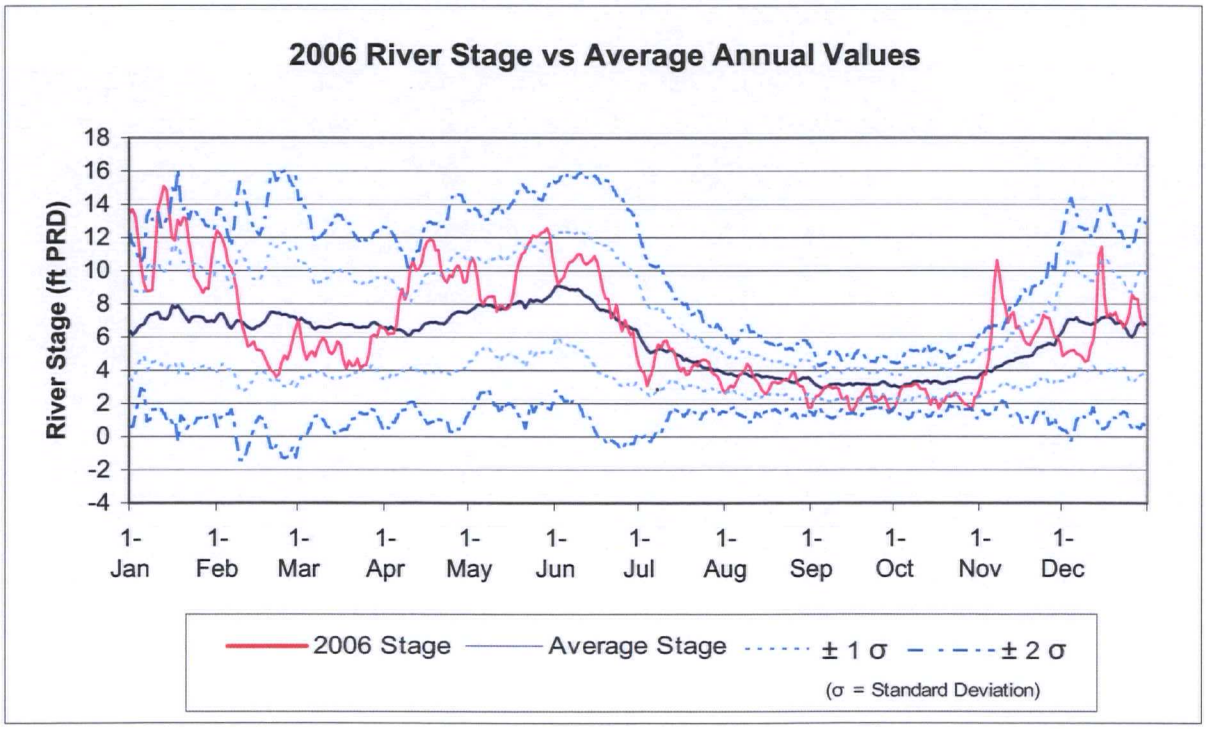


Figure 3.3-5f
2006 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

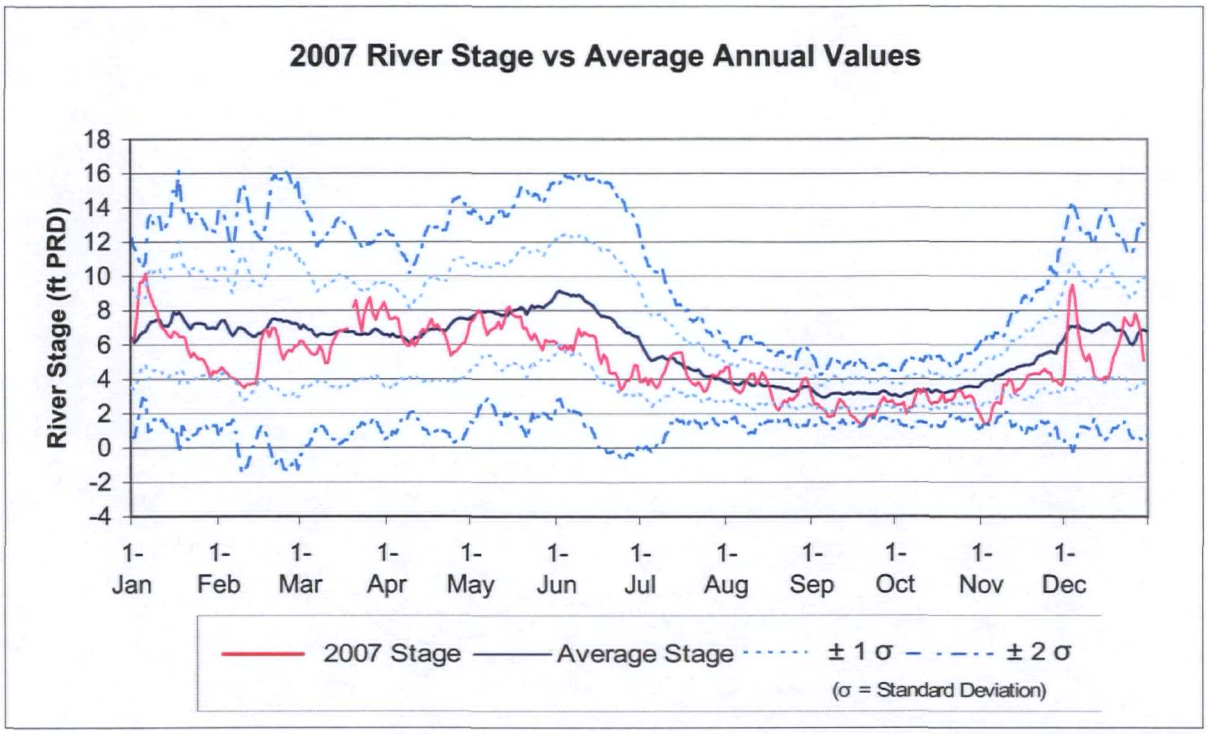


Figure 3.3-5g
2007 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

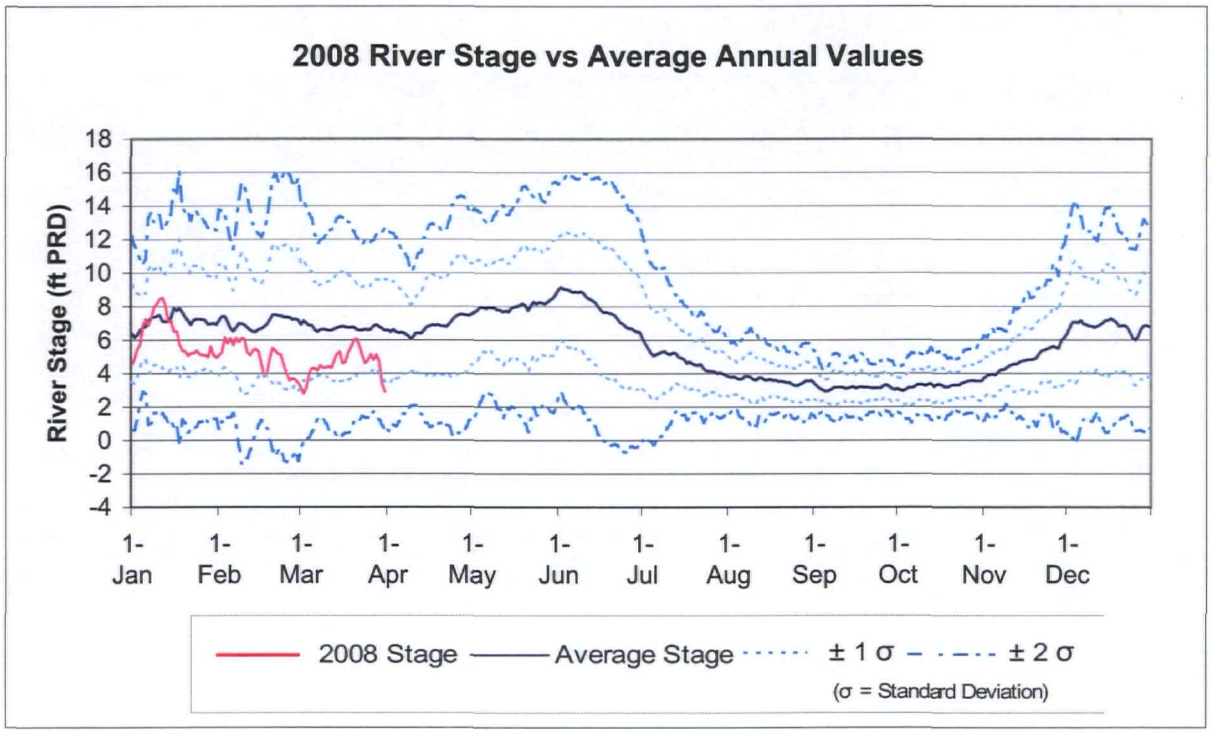


Figure 3.3-5h
2008 Willamette River Stage Data Versus
Average Annual Values (October 1972 – March 2008)

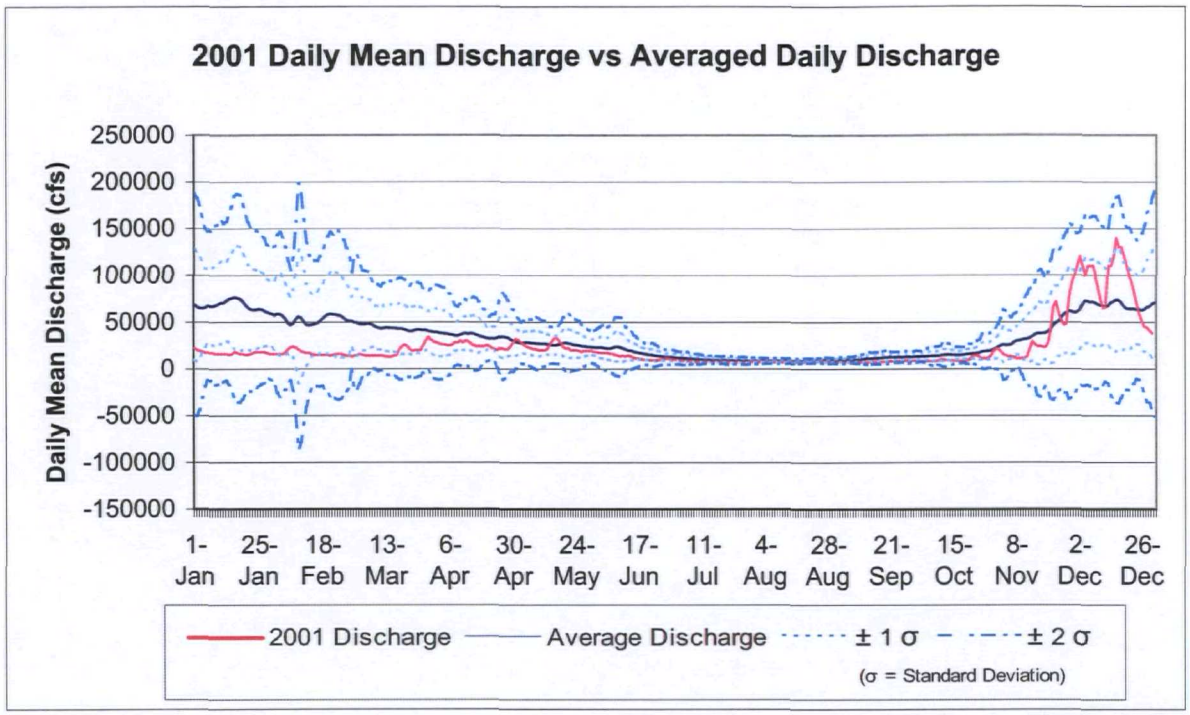


Figure 3.3-6a
2001 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

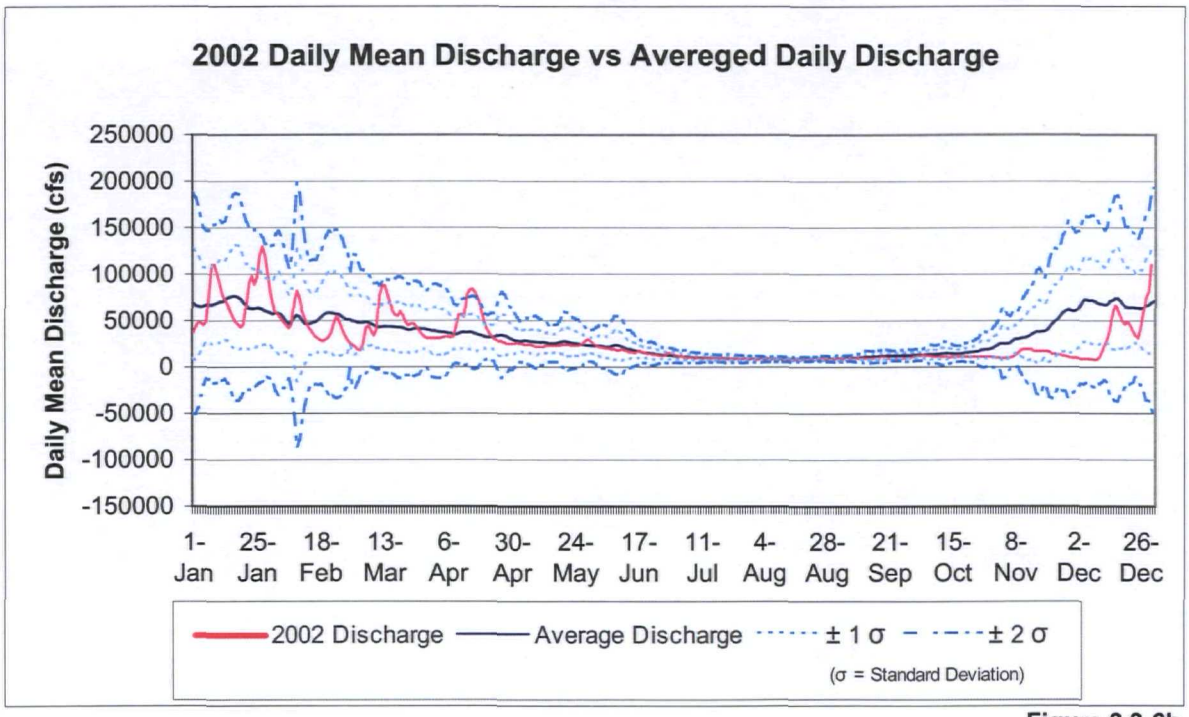


Figure 3.3-6b
2002 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

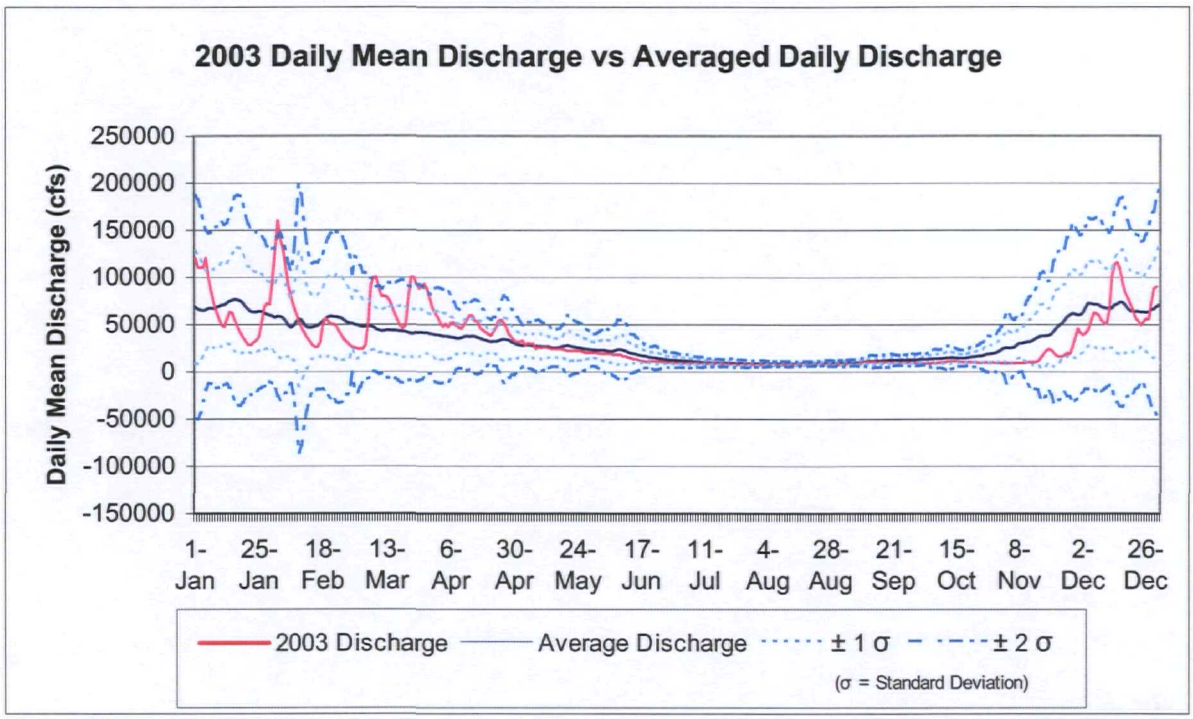


Figure 3.3-6c
2003 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

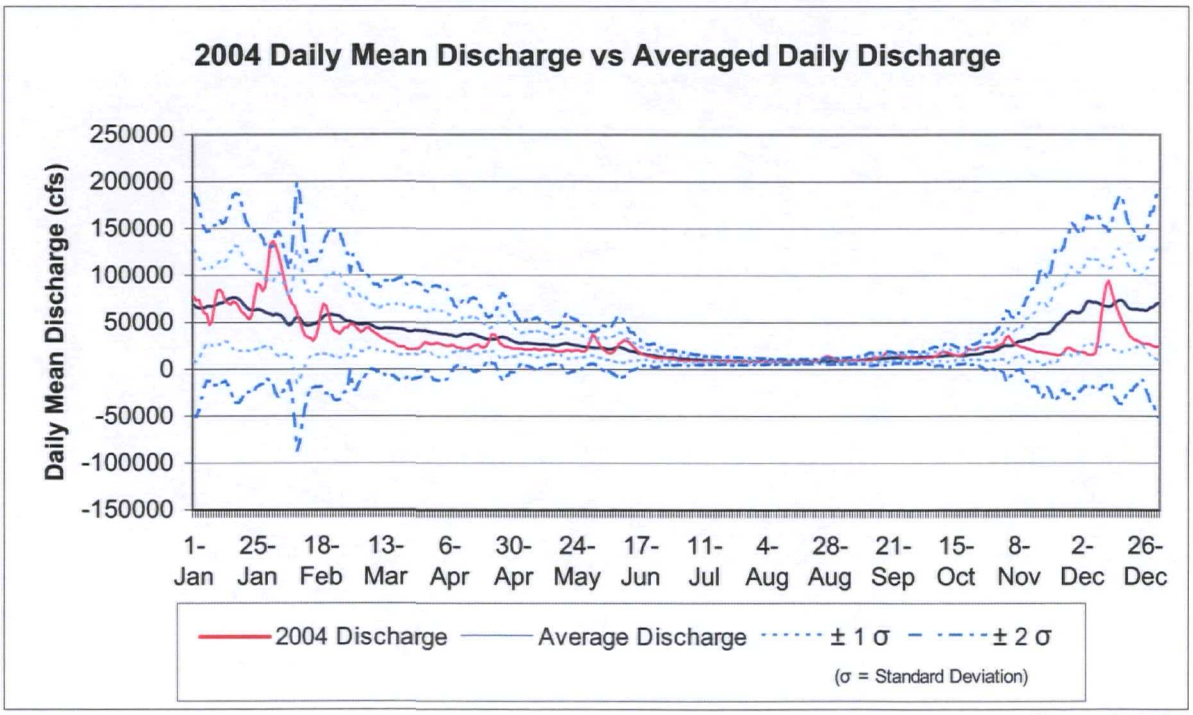


Figure 3.3-6d
2004 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

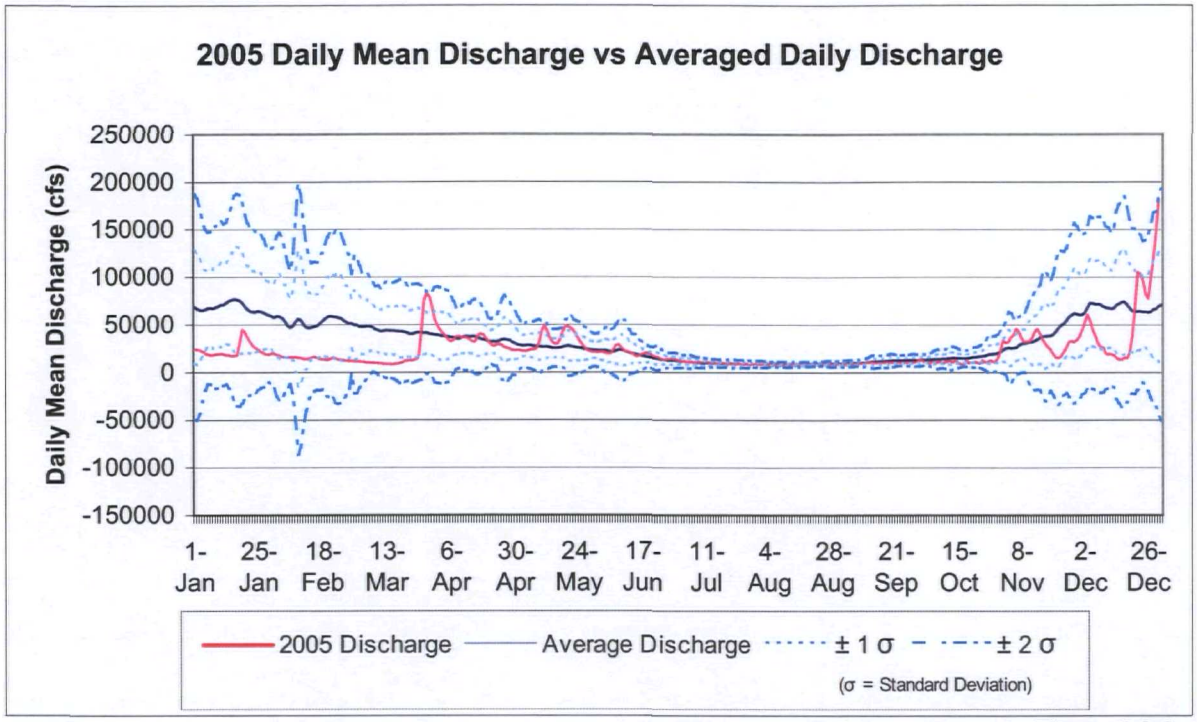


Figure 3.3-6e
2005 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

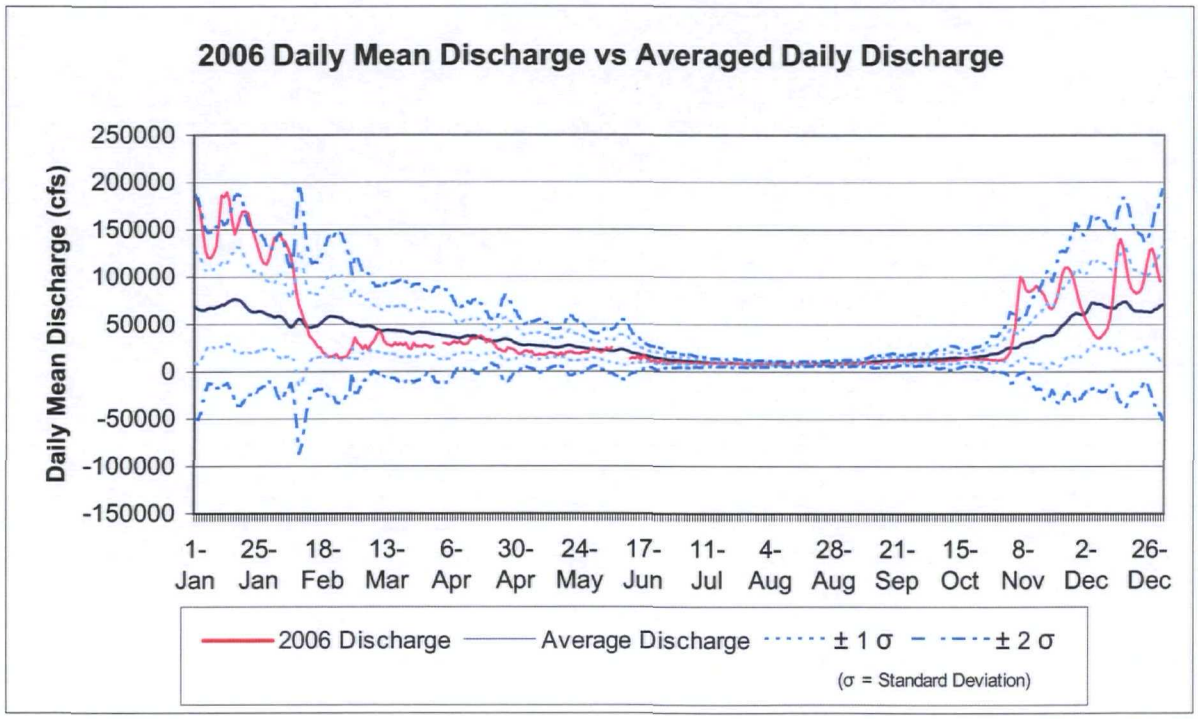


Figure 3.3-6f
2006 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

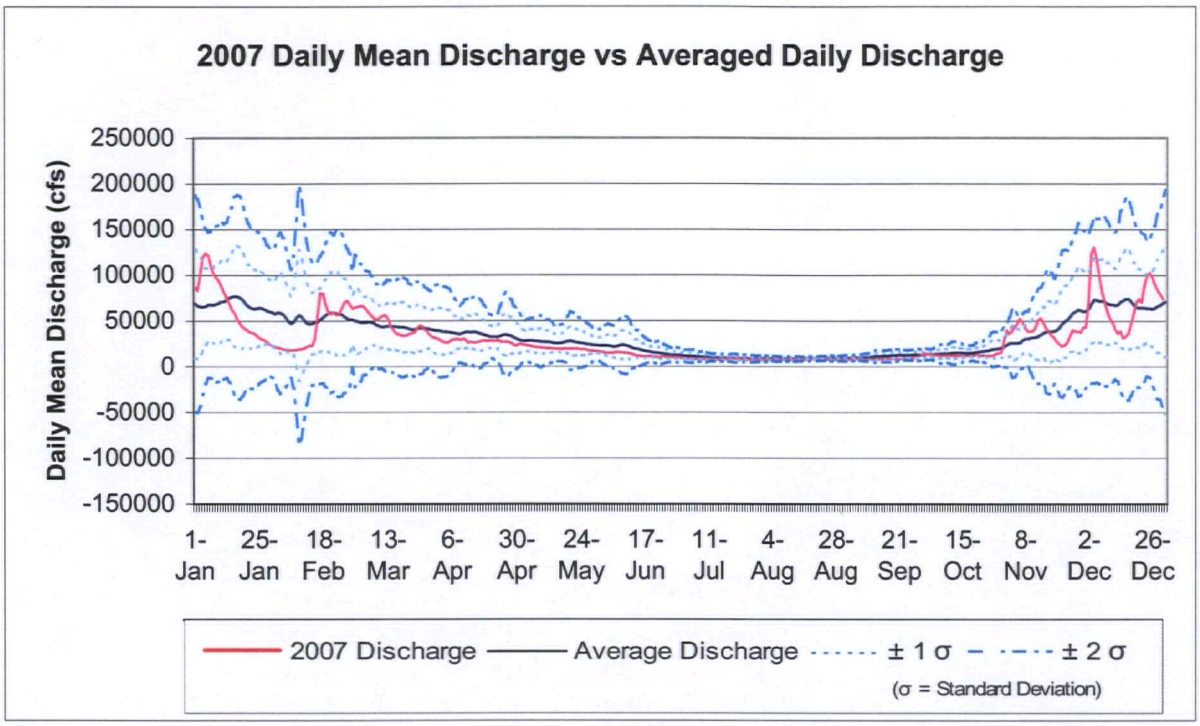


Figure 3.3-6g
2007 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)

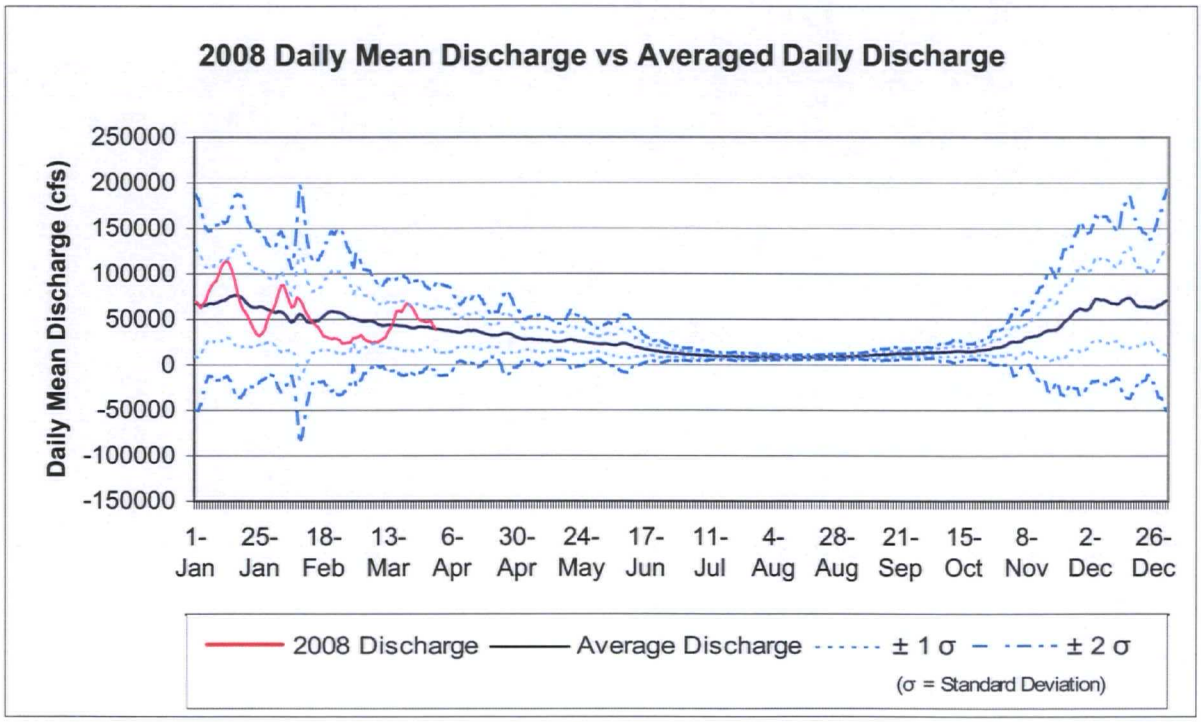
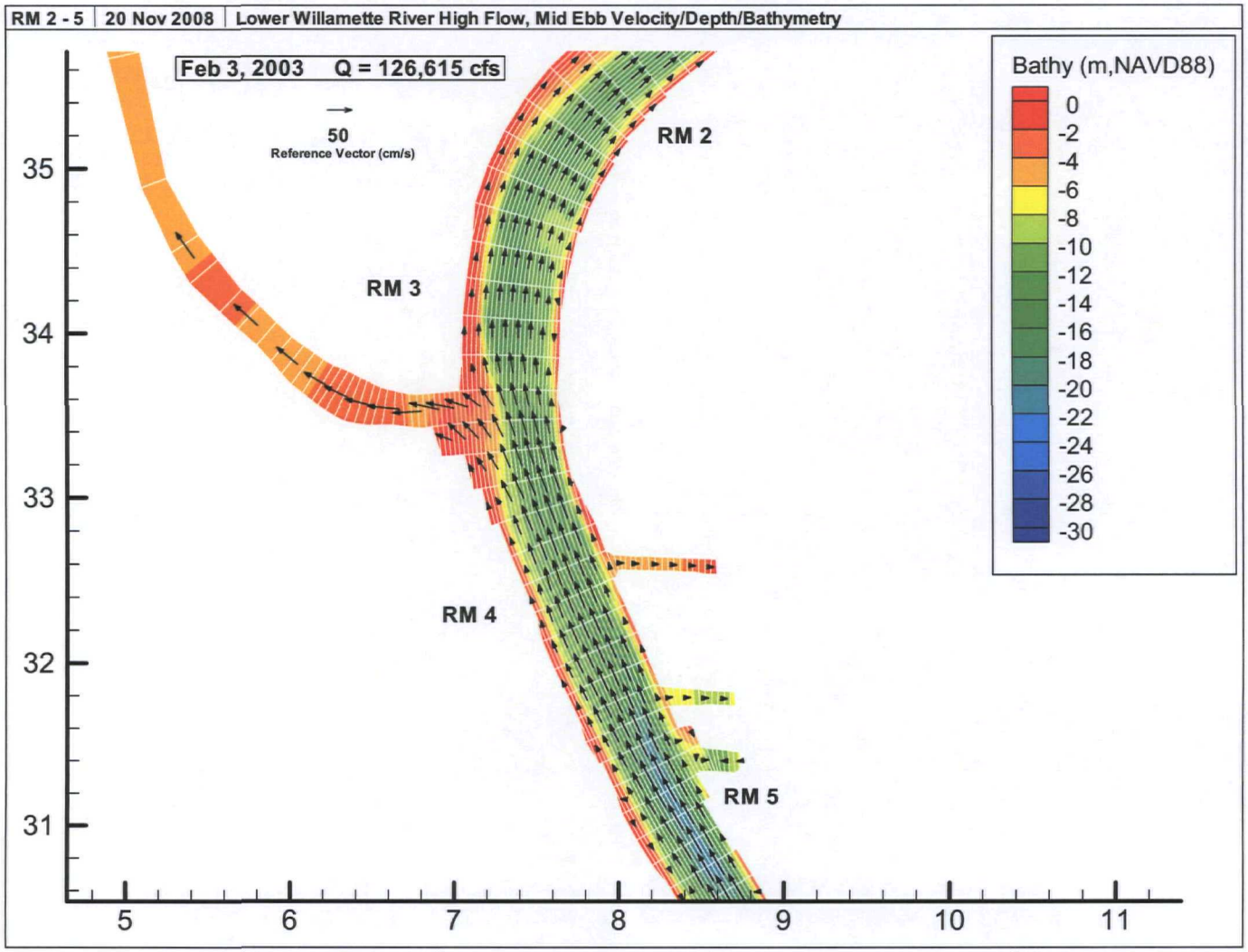


Figure 3.3-6h
2008 Willamette River Daily Mean Discharge Versus
Averaged Daily Discharge (October 1972 – March 2008)



Note: Bathymetric data collected in Feb 2004.

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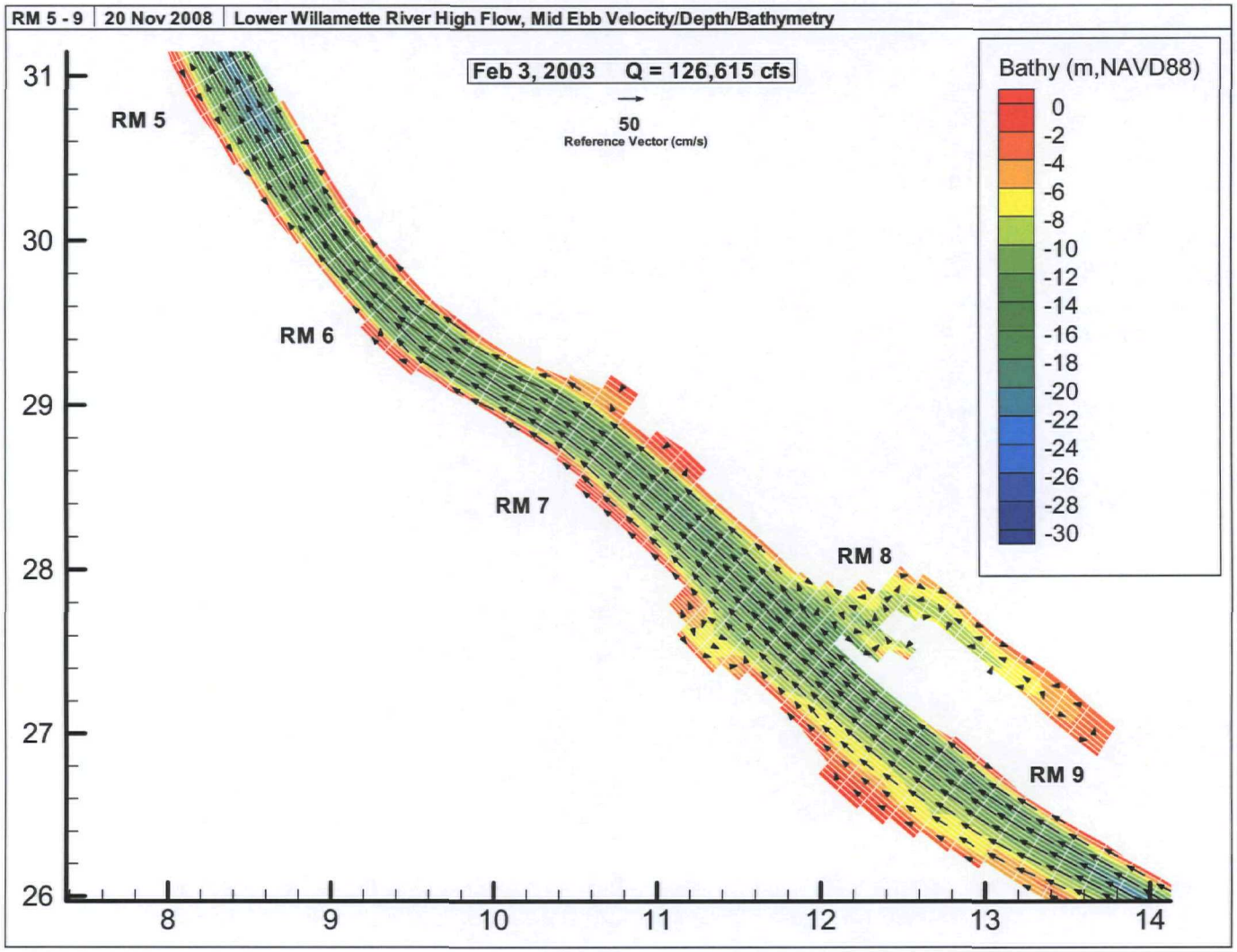
Figure 3.3-7a
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
Mid Ebb, RM 2-5



Note: Bathymetric data collected in Feb 2004.

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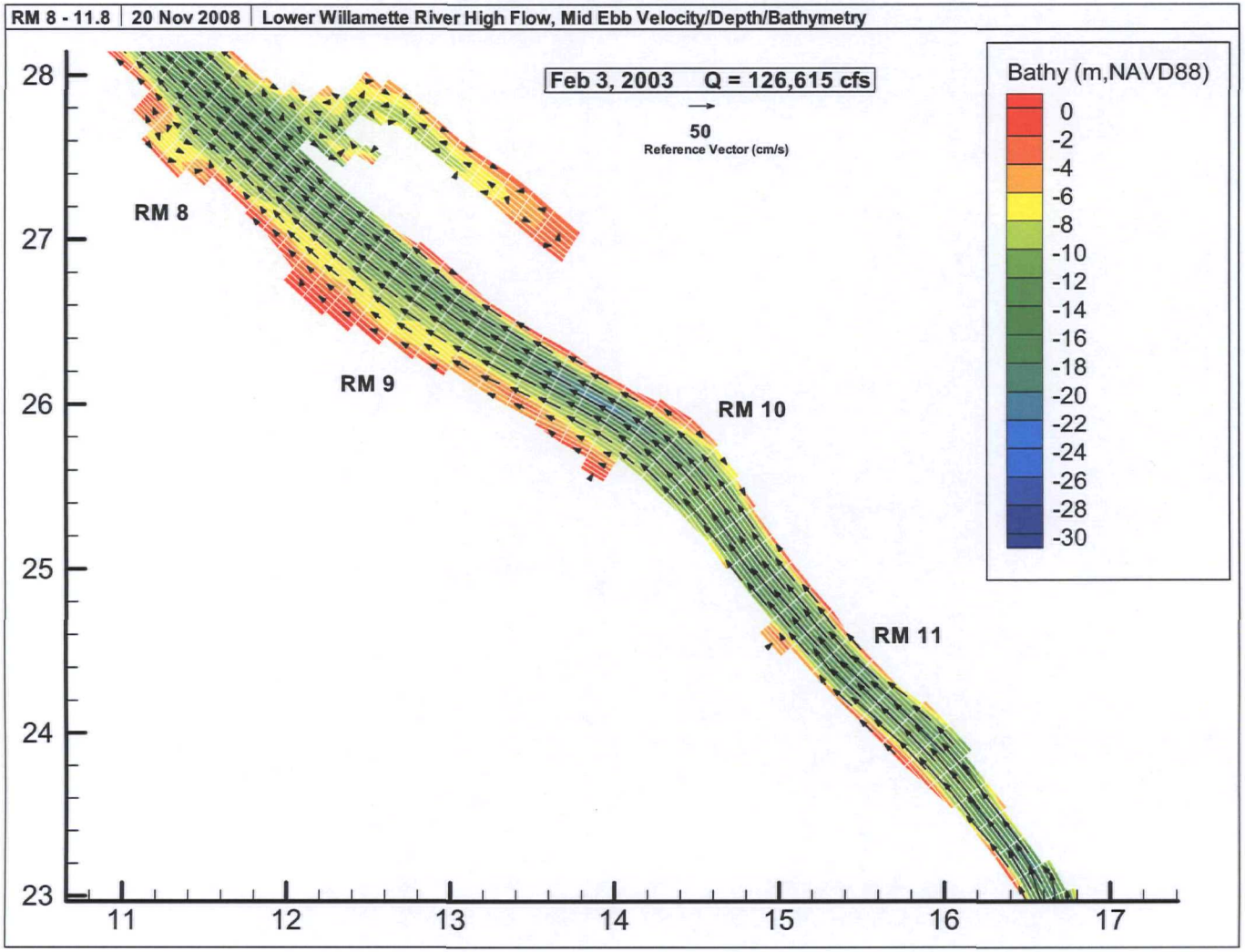
Figure 3.3-7b

Portland Harbor RI/FS

Draft Remedial Investigation Report

Vector Velocity Plot, High Flow

Mid Ebb, RM 5-9



Note: Bathymetric data collected in Feb 2004.

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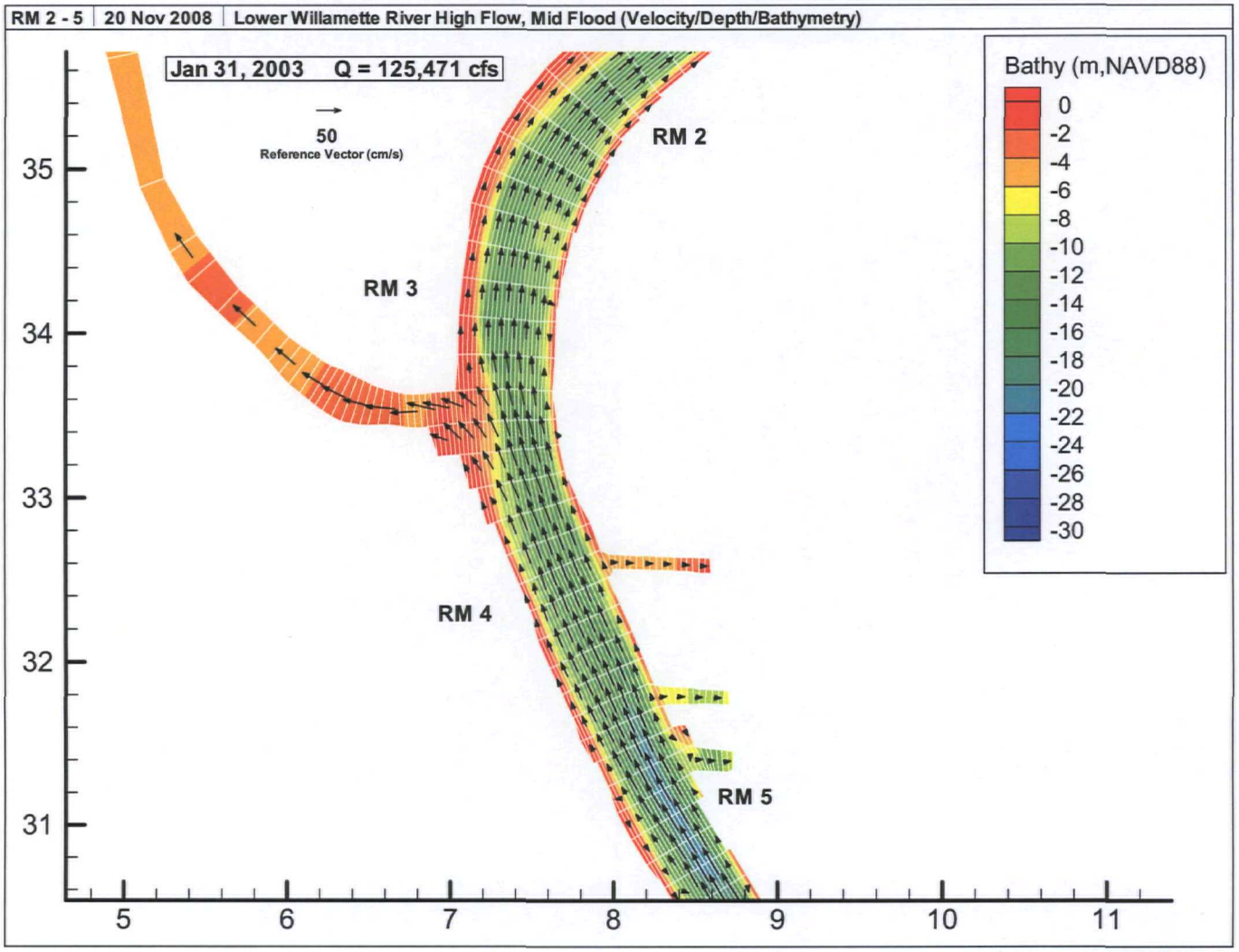
Figure 3.3-7c
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
Mid Ebb, RM 8-11.8



Note: Bathymetric data collected in Feb 2004.

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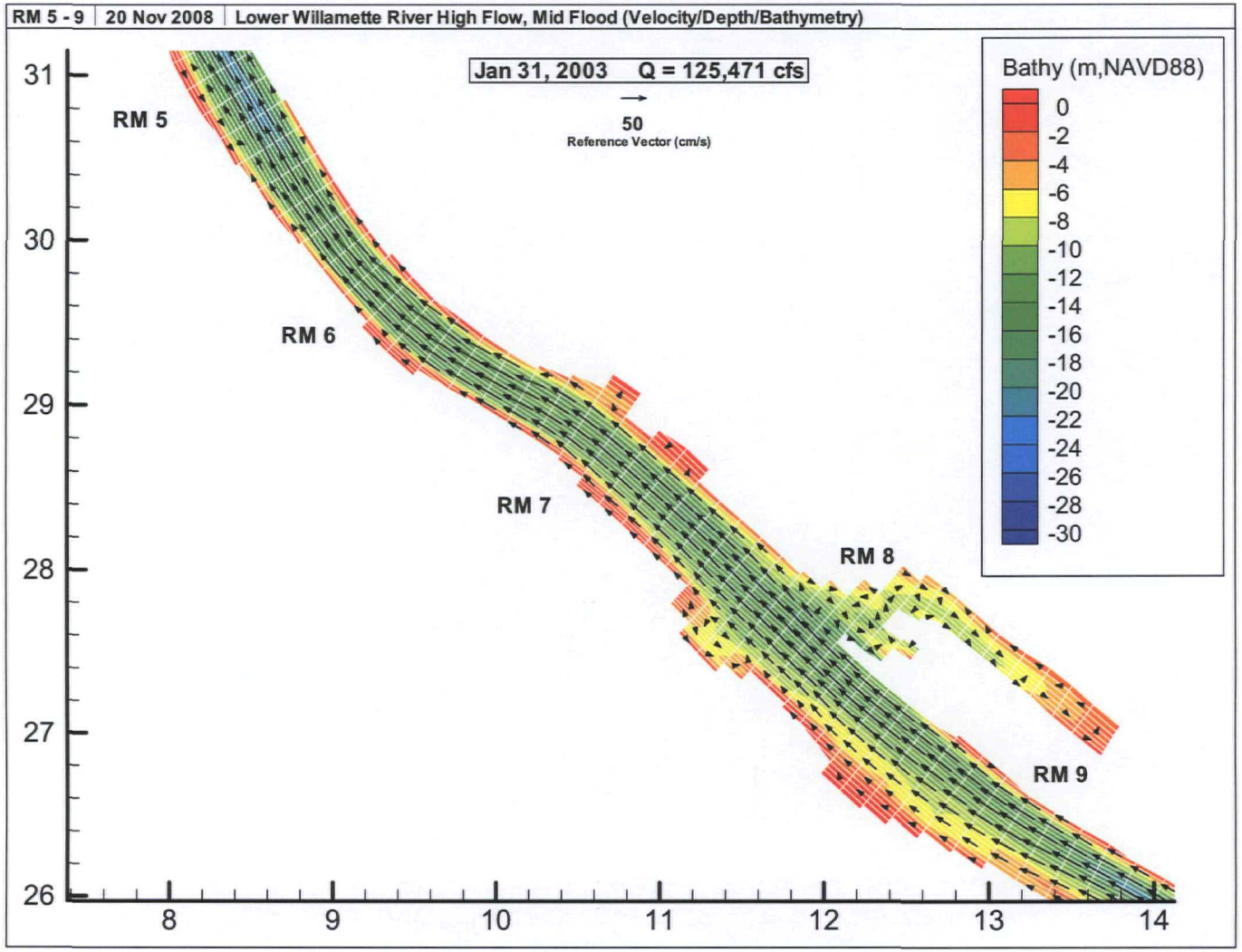
Figure 3.3-8a

Portland Harbor RI/FS

Draft Remedial Investigation Report

Vector Velocity Plot, High Flow

Mid Flood, RM 2-5



Note: Bathymetric data collected in Feb 2004.

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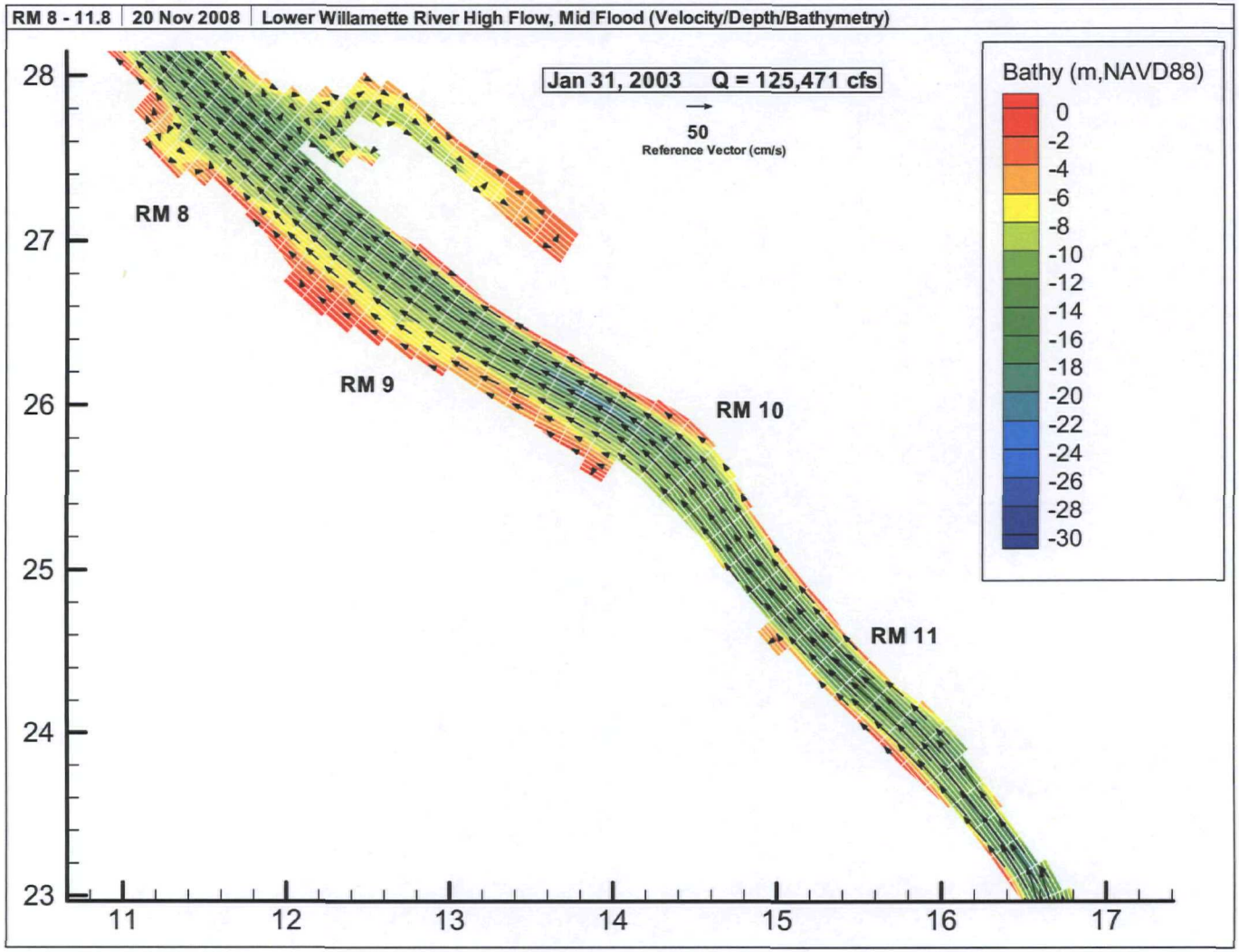
Figure 3.3-8b
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
Mid Flood, RM 5-9



Note: Bathymetric data collected in Feb 2004.

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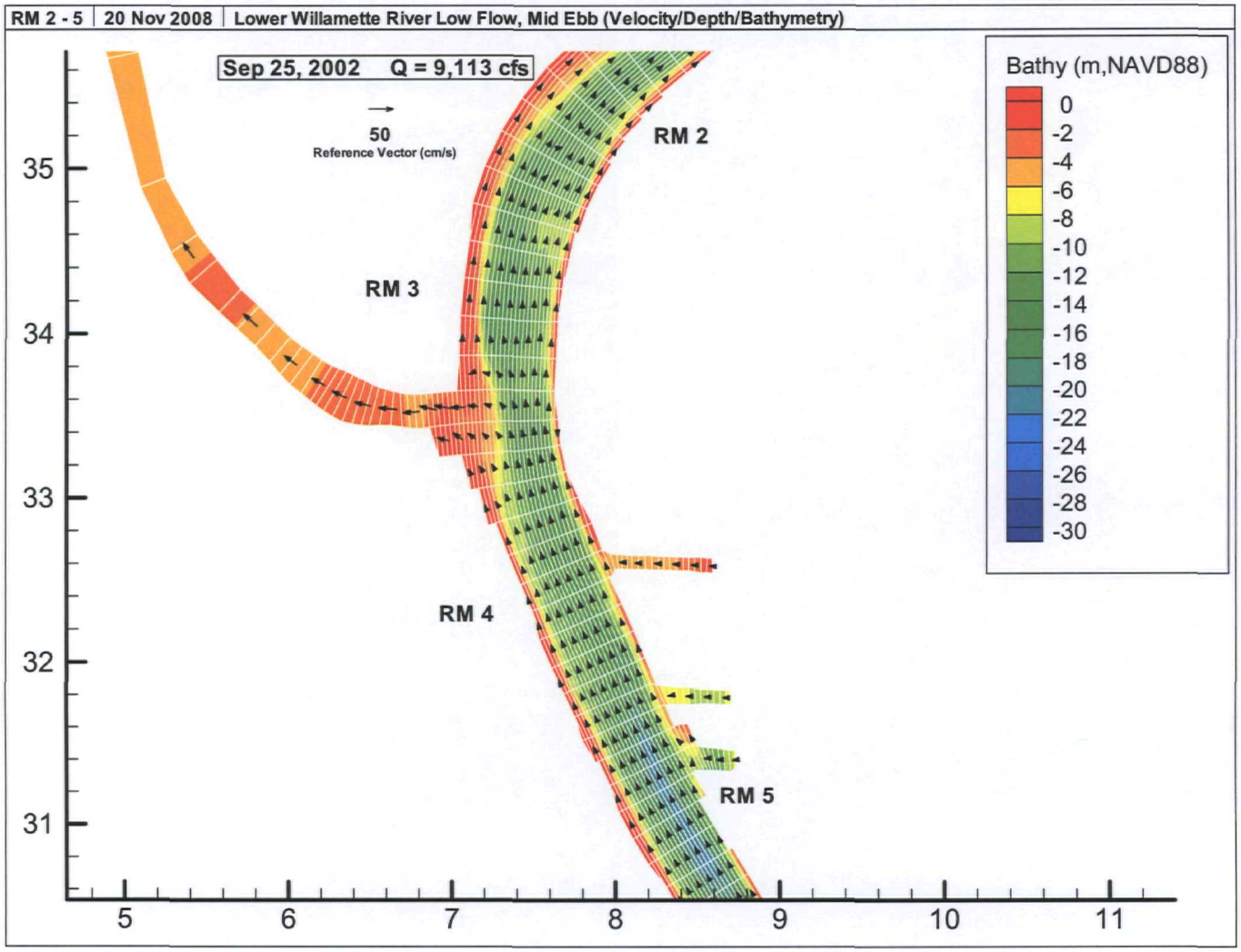
Figure 3.3-8c
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
Mid Flood, RM 8-11.8



Note: Bathymetric data collected in Feb 2004.

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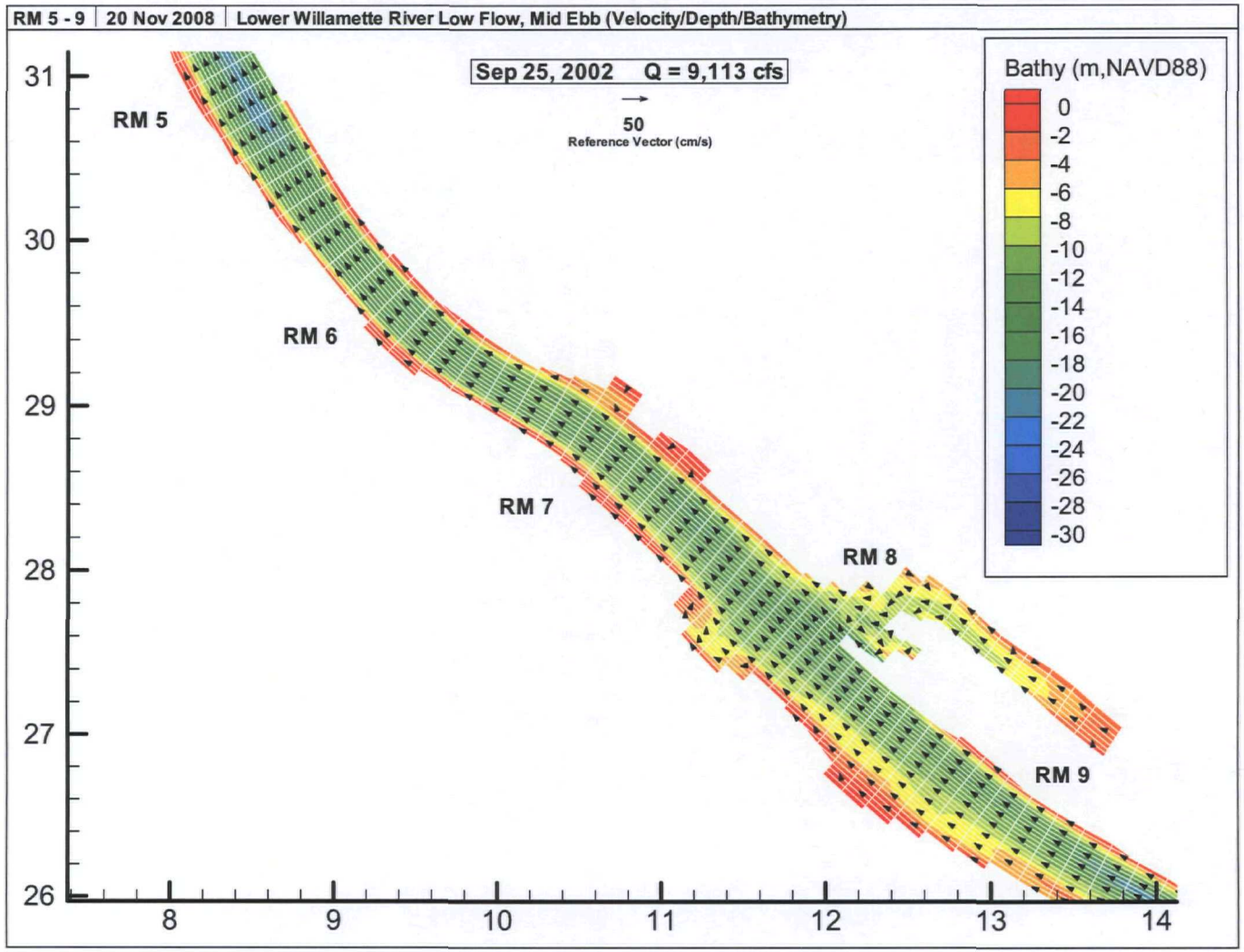
Figure 3.3-9a

Portland Harbor RI/FS

Draft Remedial Investigation Report

Vector Velocity Plot, Low Flow

Mid Ebb, RM 2-5



Note: Bathymetric data collected in Feb 2004.

Figure 3.3-9b
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Mid Ebb, RM 5-9

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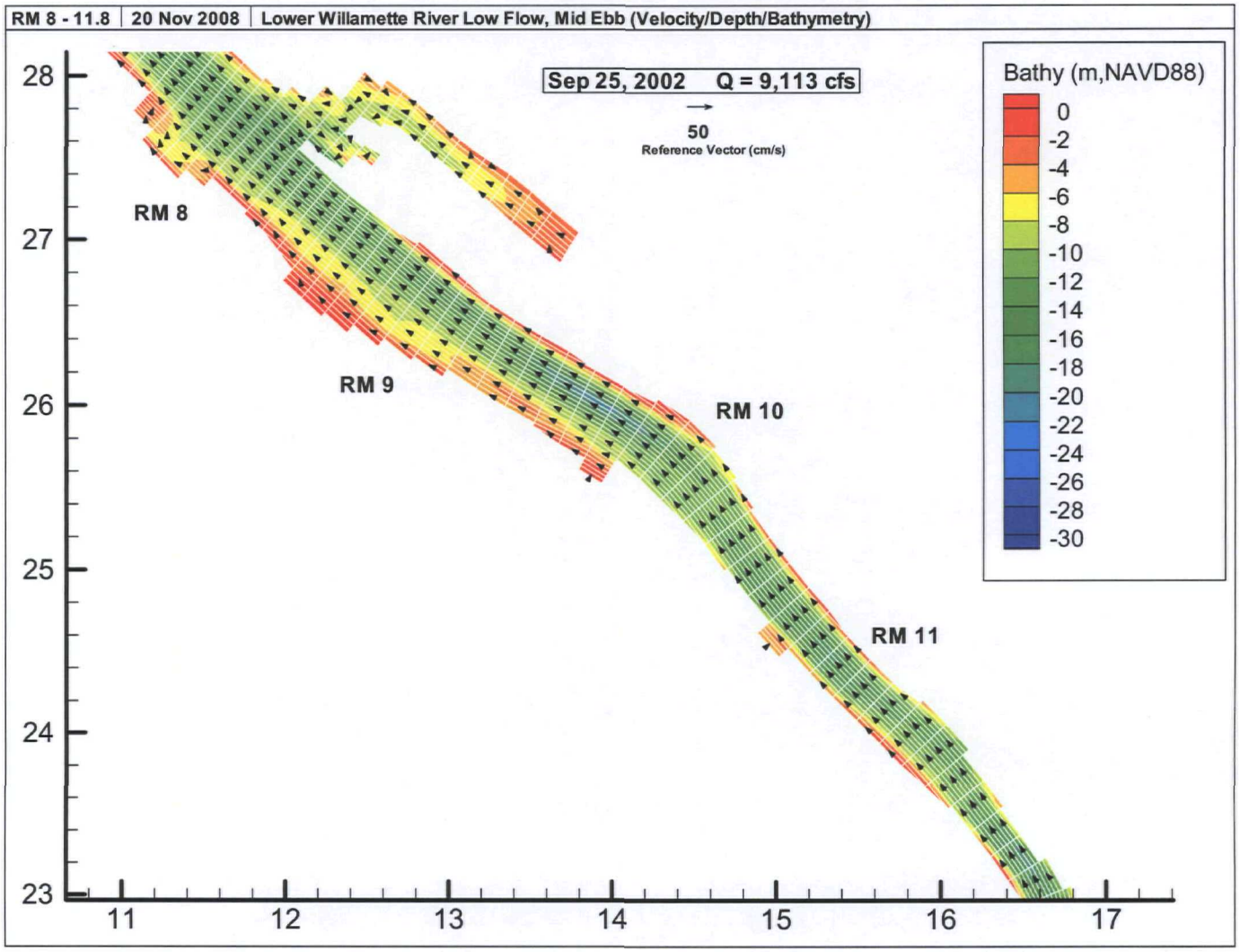

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Figure 3.3-9c

Portland Harbor RI/FS

Draft Remedial Investigation Report

Vector Velocity Plot, Low Flow

Mid Ebb, RM 8-11.8

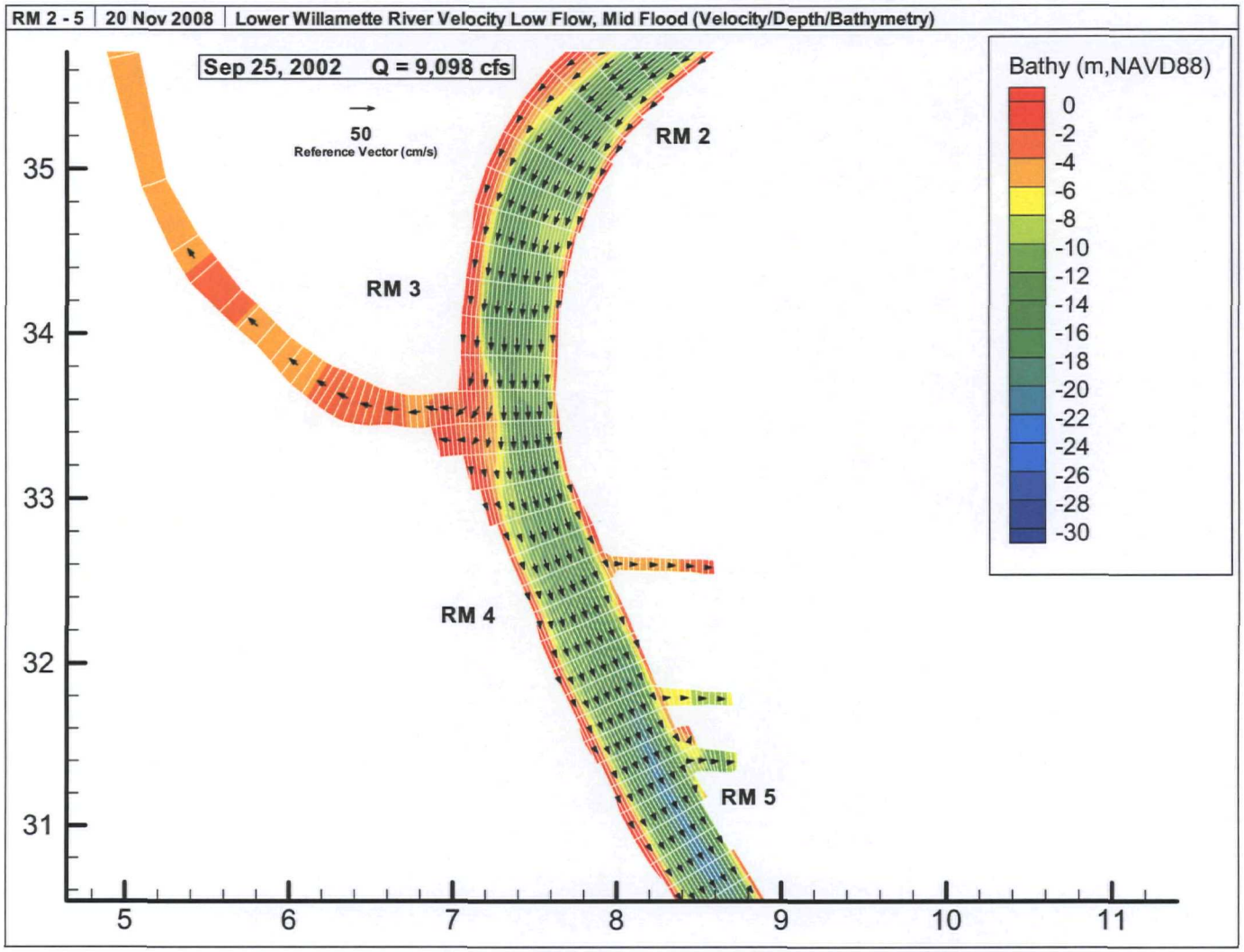

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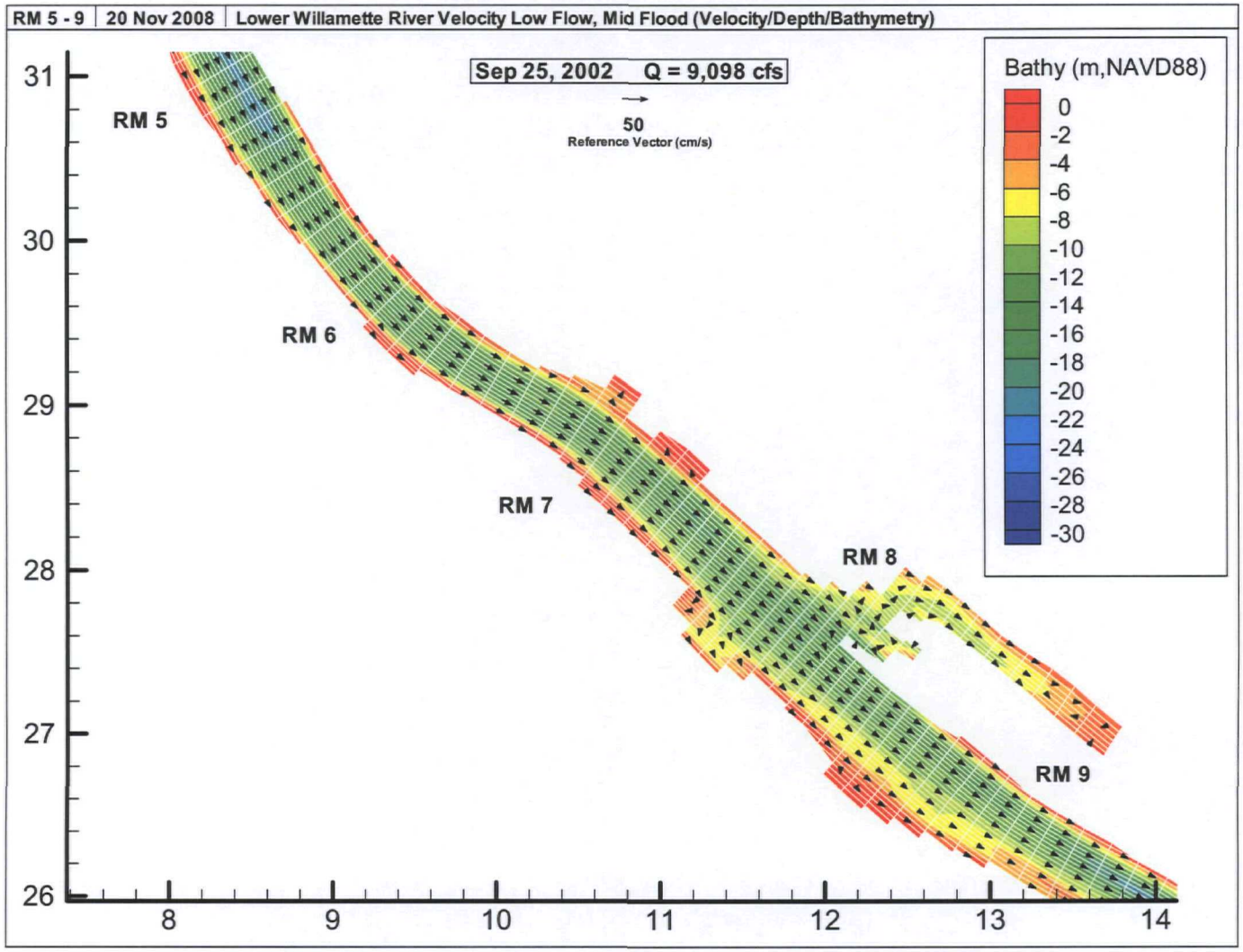
Figure 3.3-10a
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Mid Flood, RM 2-5



Note: Bathymetric data collected in Feb 2004.

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Figure 3.3-10b
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Mid Flood, RM 5-9

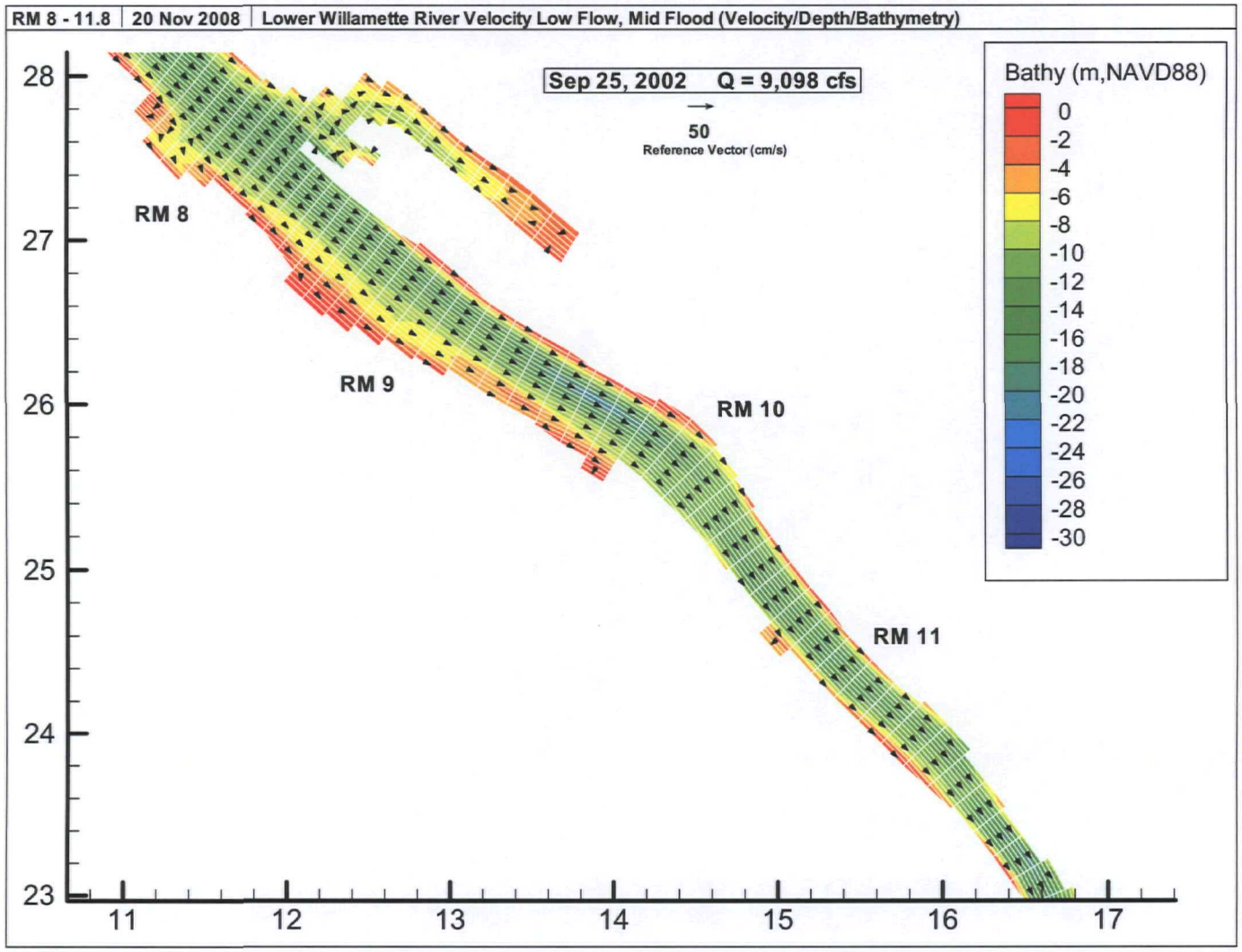

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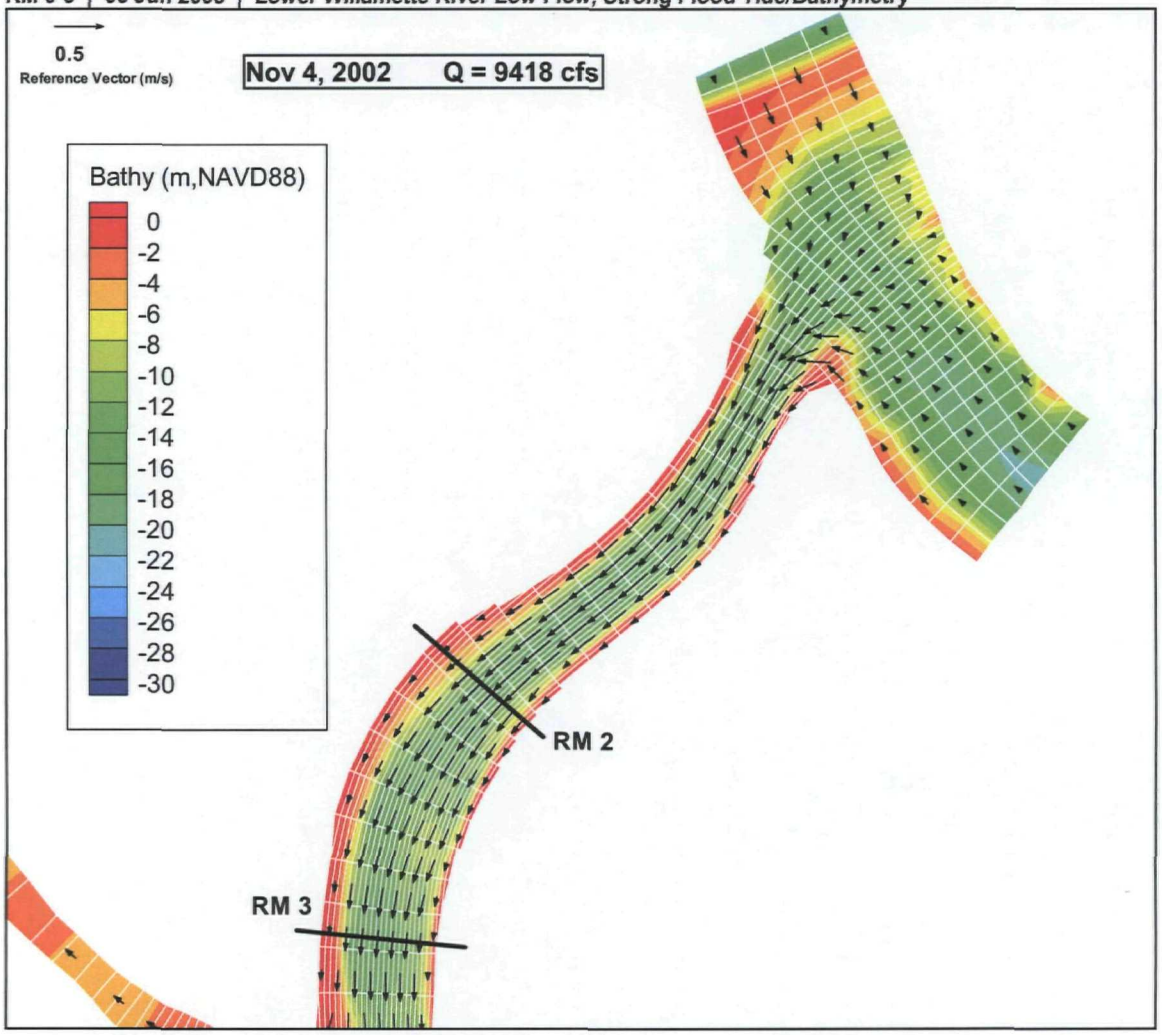
Figure 3.3-10c
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Mid Flood, RM 8-11.8

RM 0-3 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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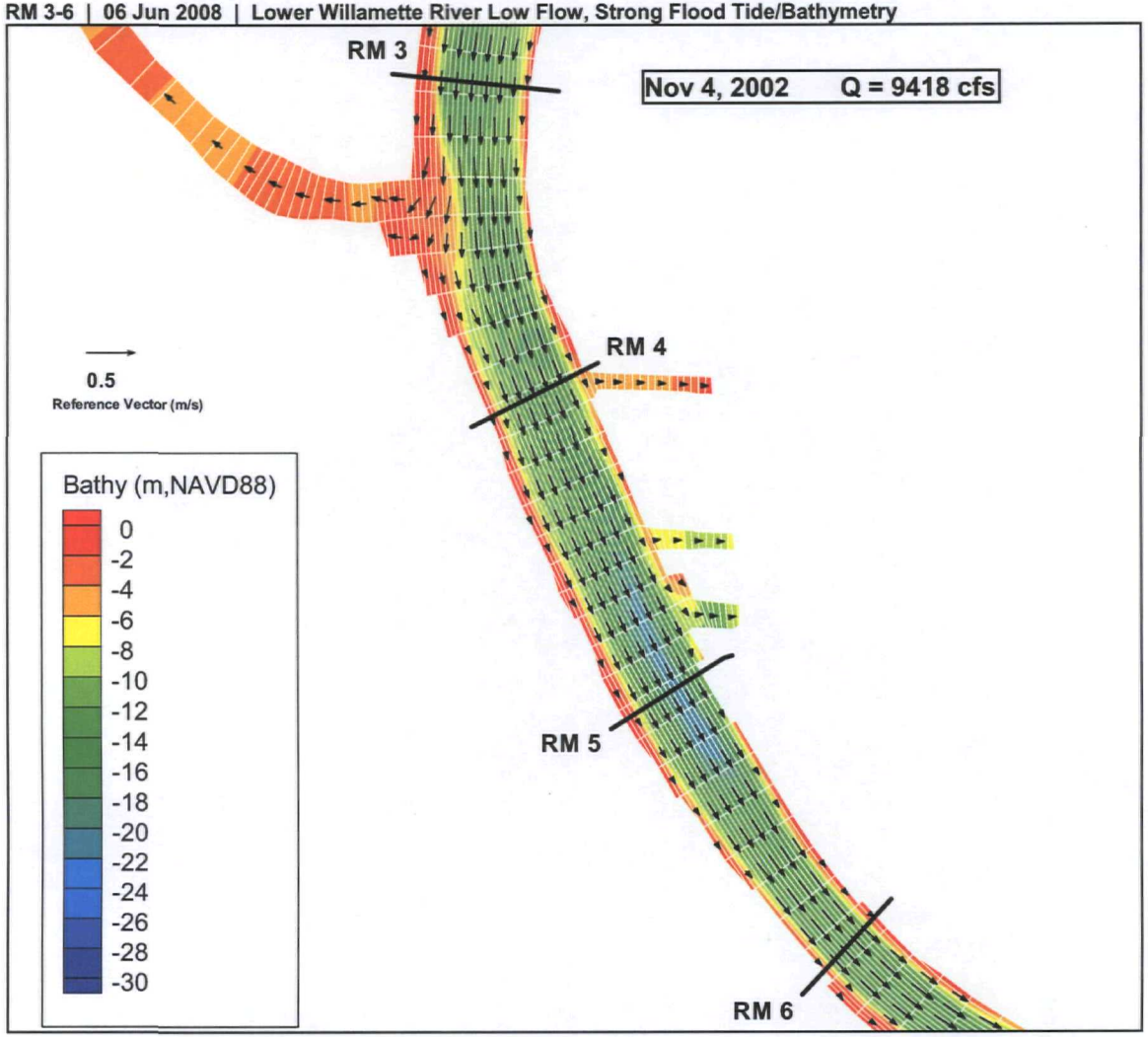
Figure 3.3-11a
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 0-3

RM 3-6 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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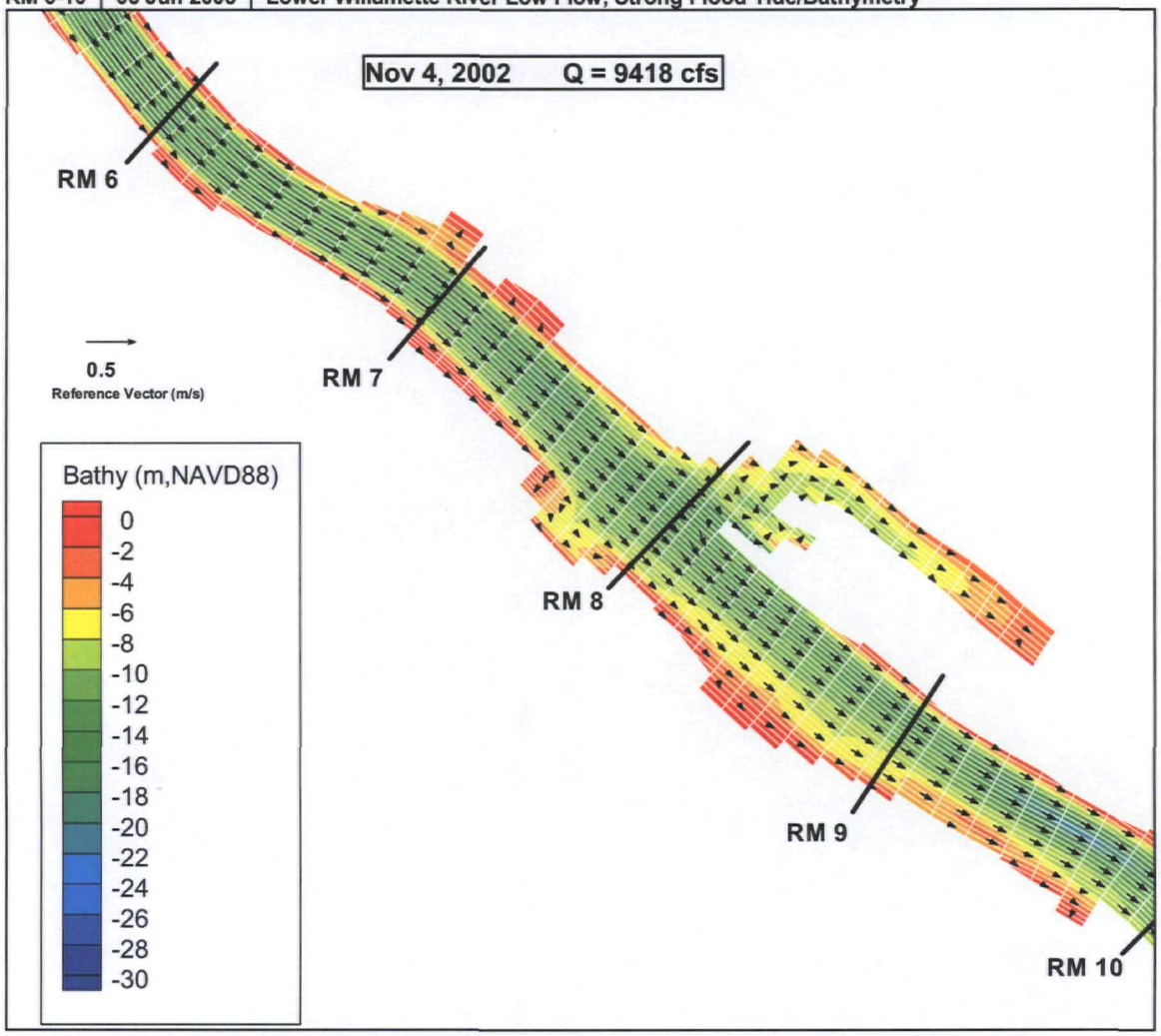
Figure 3.3-11b
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 3-6

RM 6-10 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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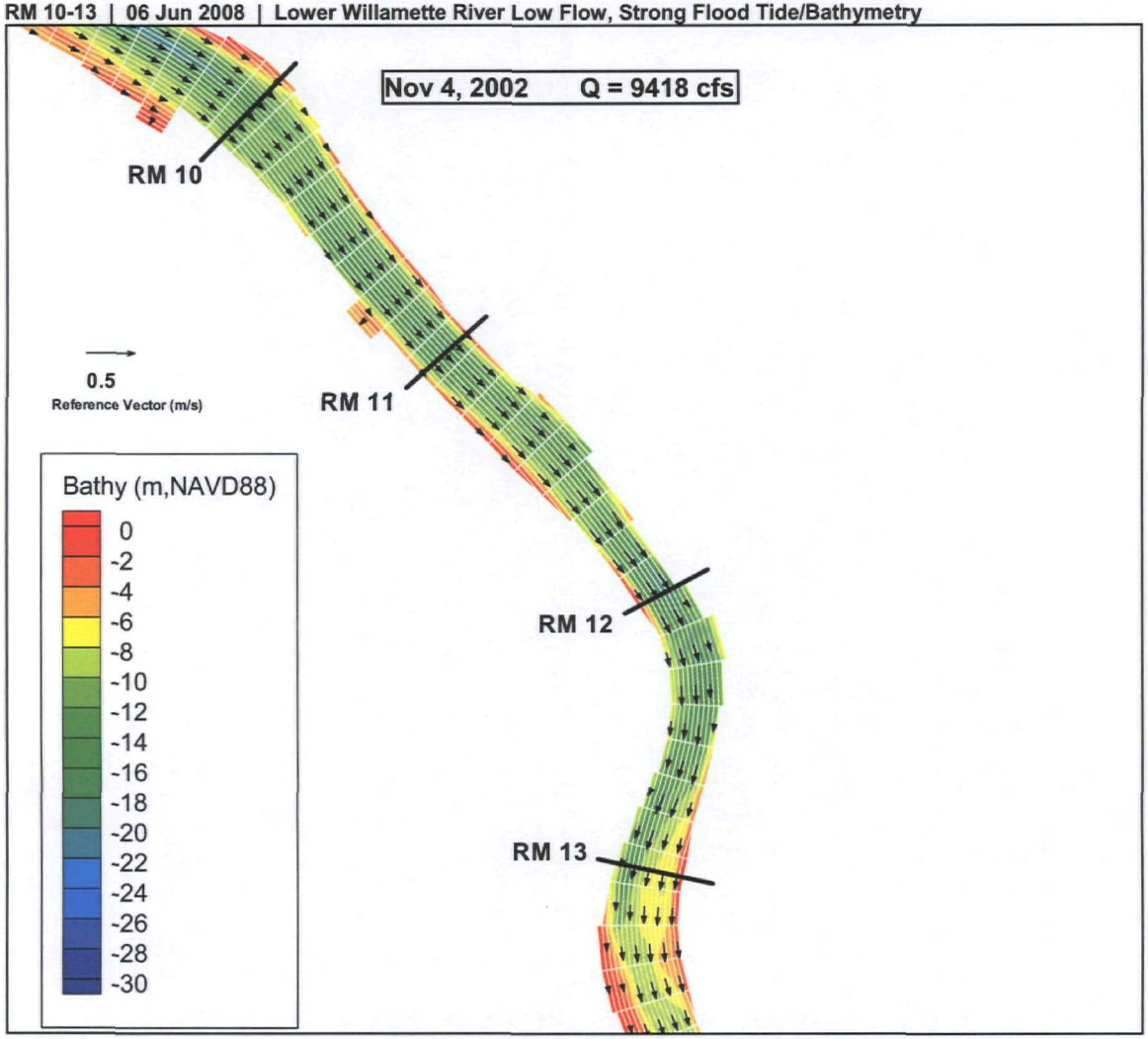
Figure 3.3-11c
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 6-10

RM 10-13 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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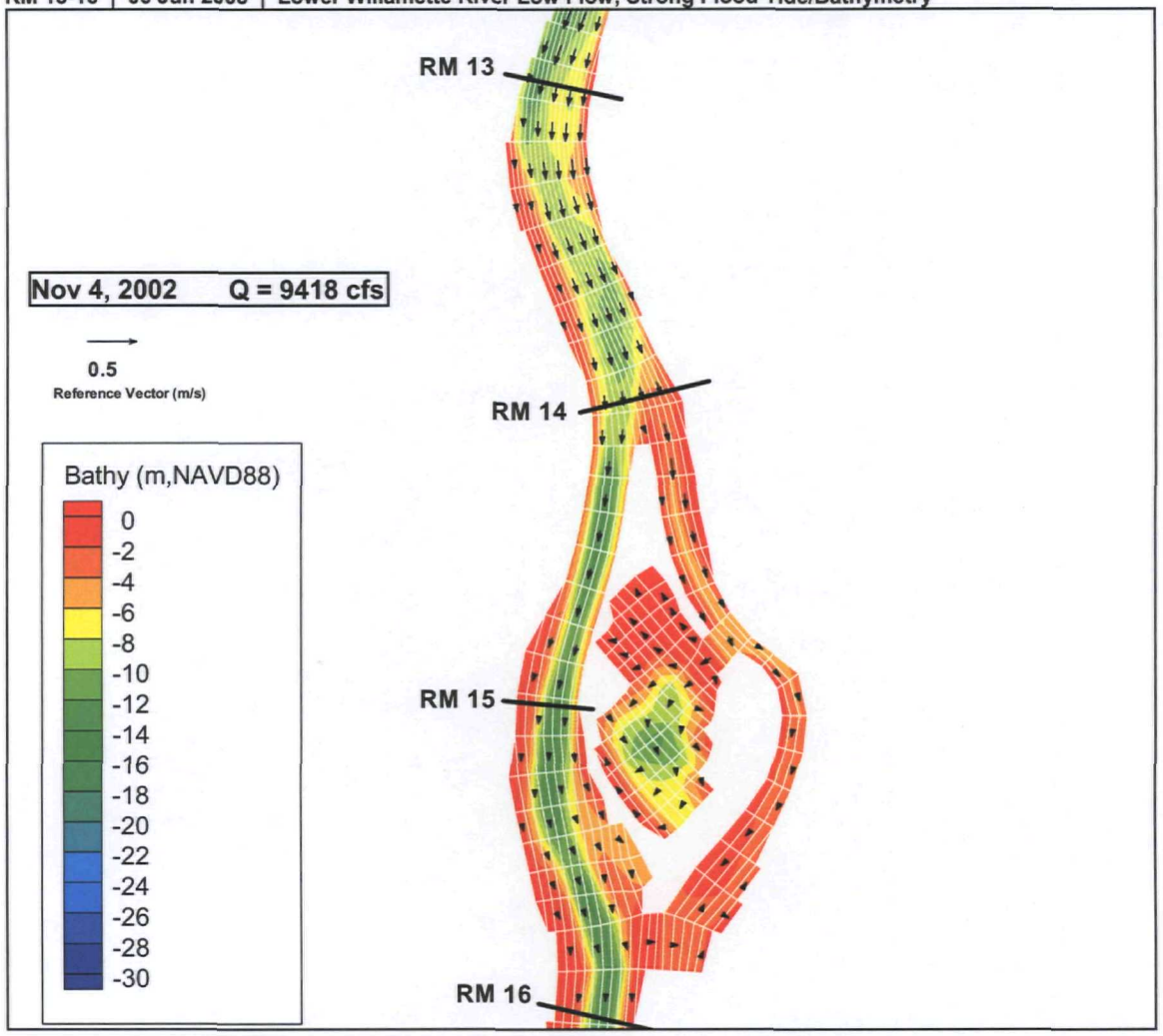
Figure 3.3-11d
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 10-13

RM 13-16 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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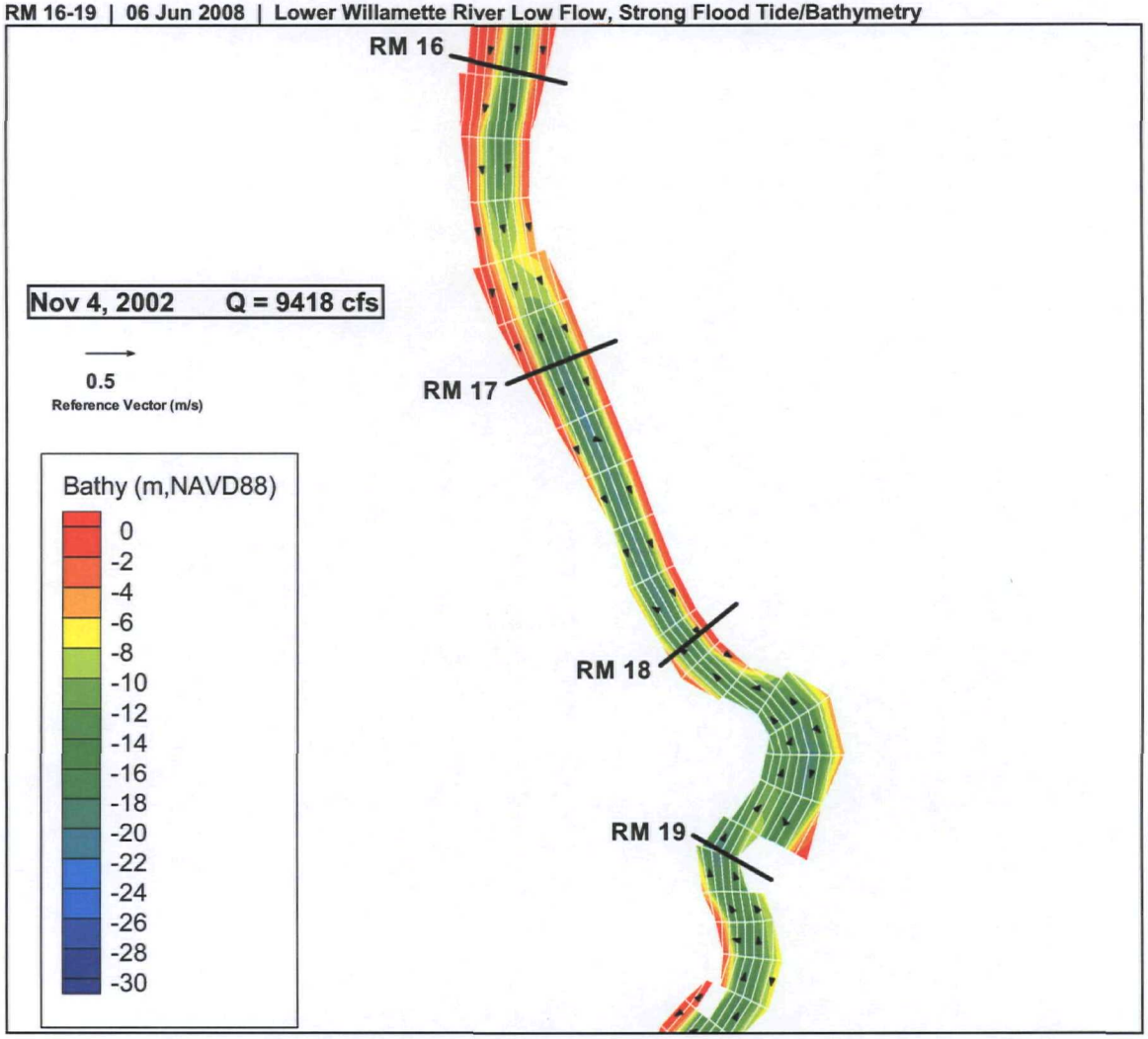
Figure 3.3-11e
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 13-16

RM 16-19 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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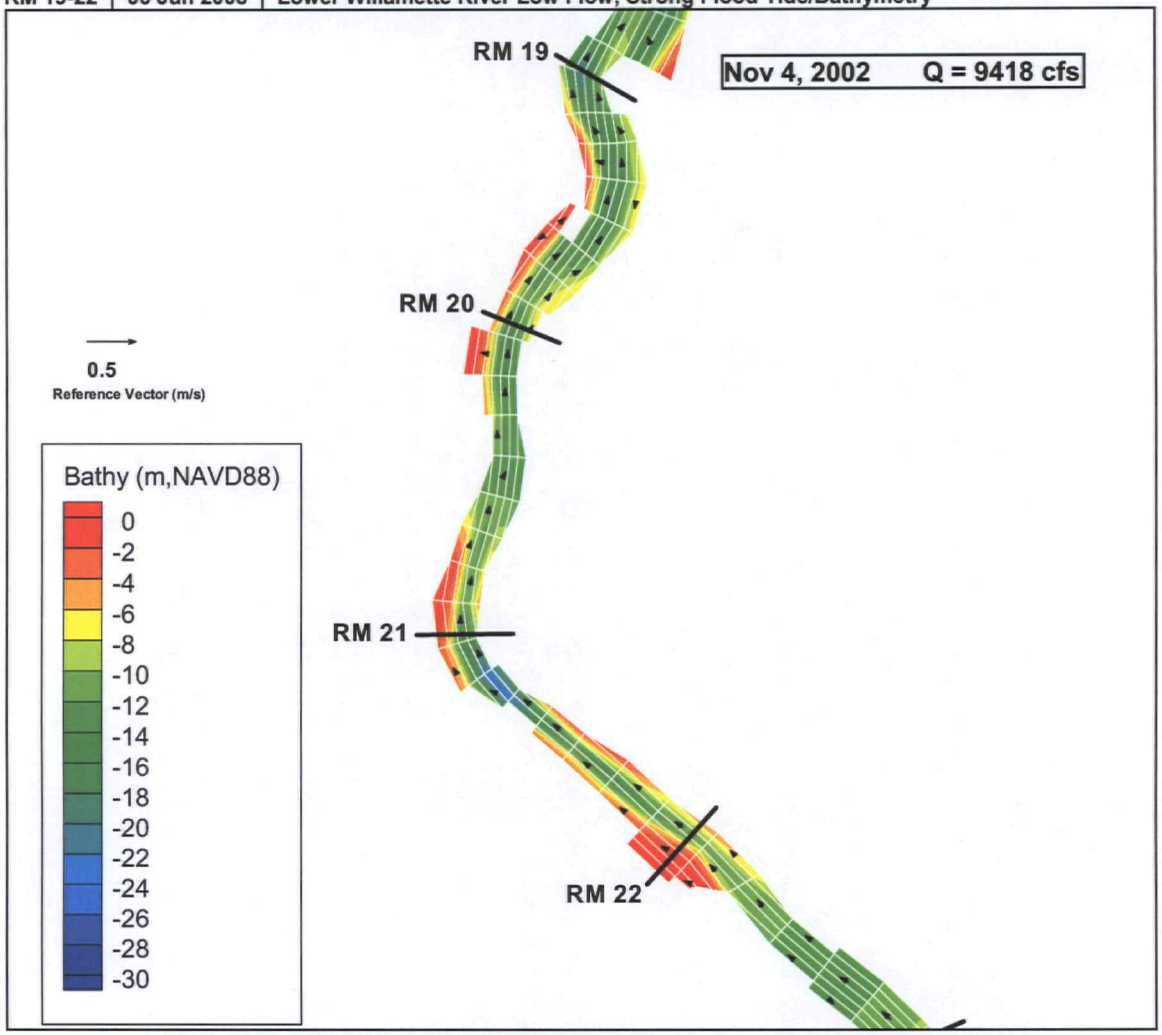
Figure 3.3-11f
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 16-19

RM 19-22 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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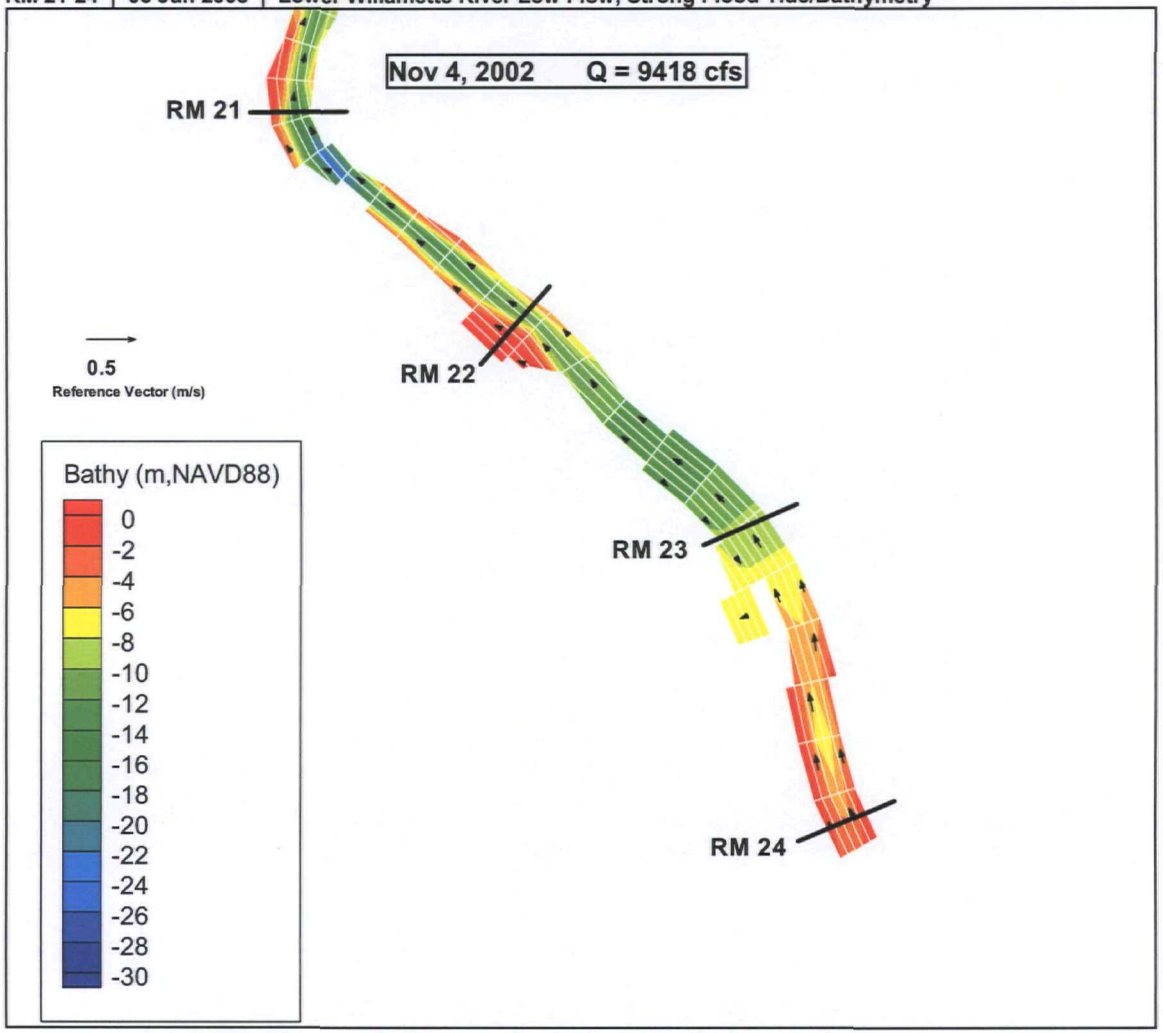
Figure 3.3-11g
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 19-22

RM 21-24 | 06 Jun 2008 | Lower Willamette River Low Flow, Strong Flood Tide/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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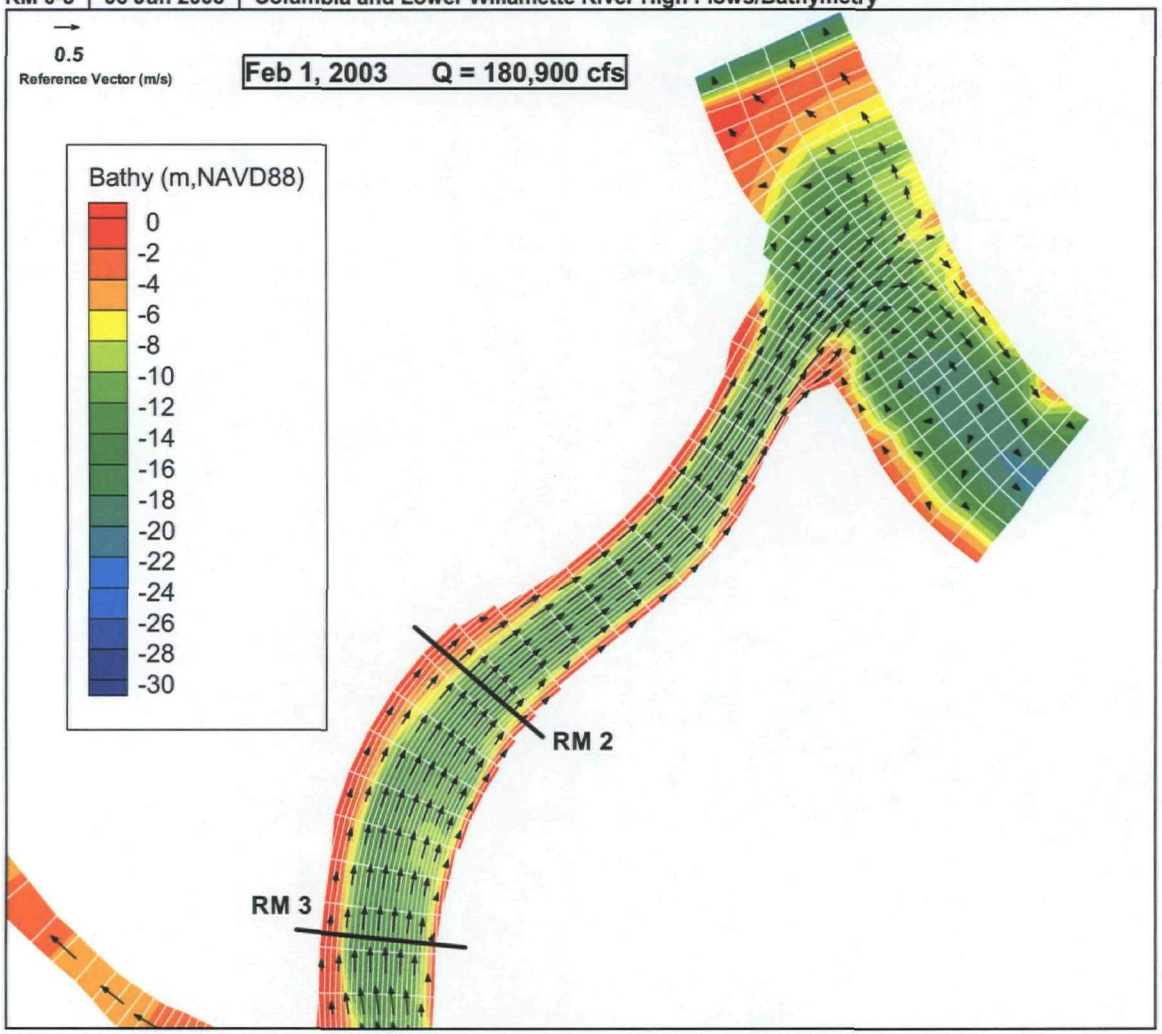
Figure 3.3-11h
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, Low Flow
Strong Flood, RM 21-24

RM 0-3 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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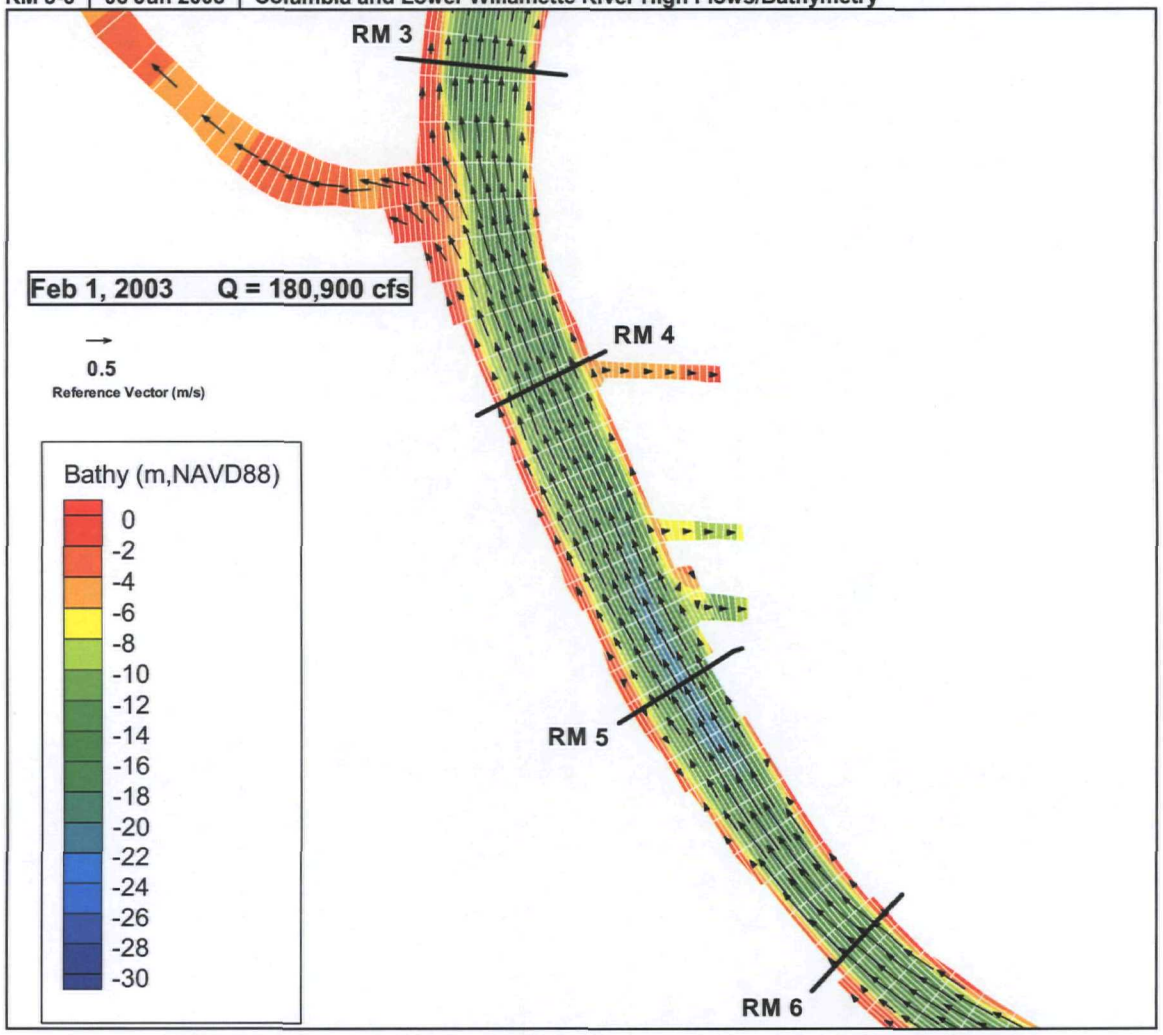
Figure 3.3-12a
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 0-3

RM 3-6 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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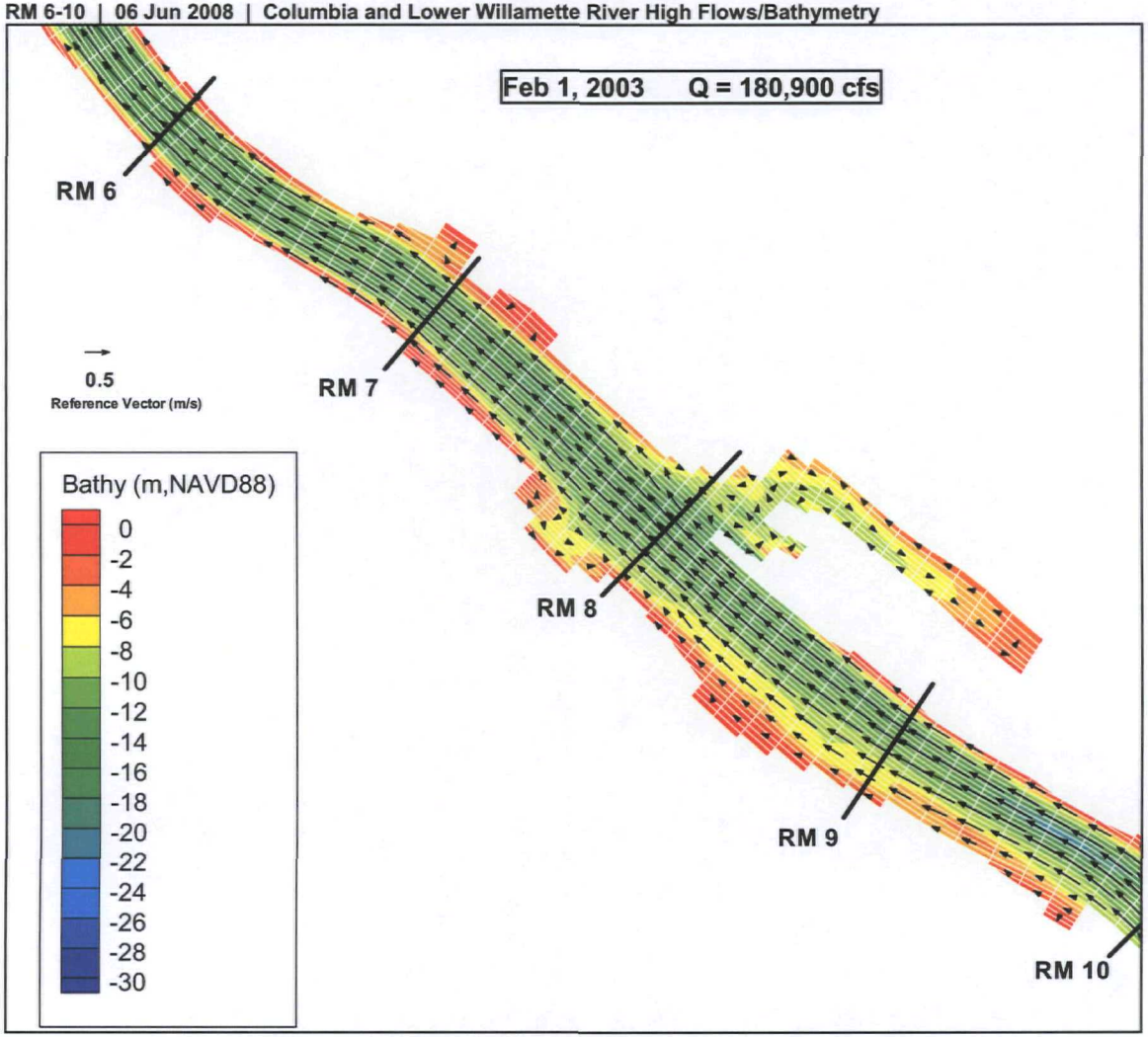
Figure 3.3-12b
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 3-6

RM 6-10 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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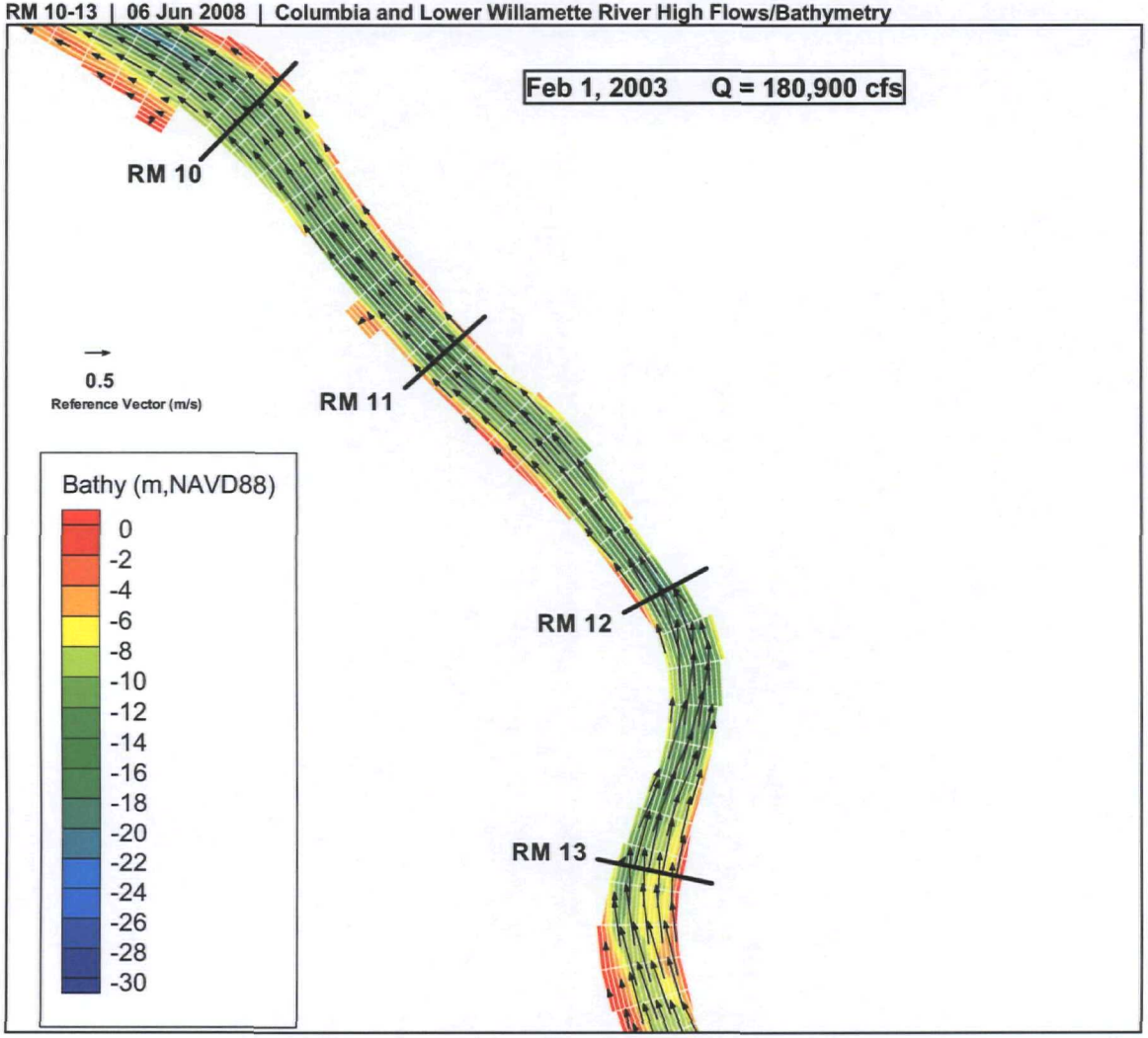
Figure 3.3-12c
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 6-10

RM 10-13 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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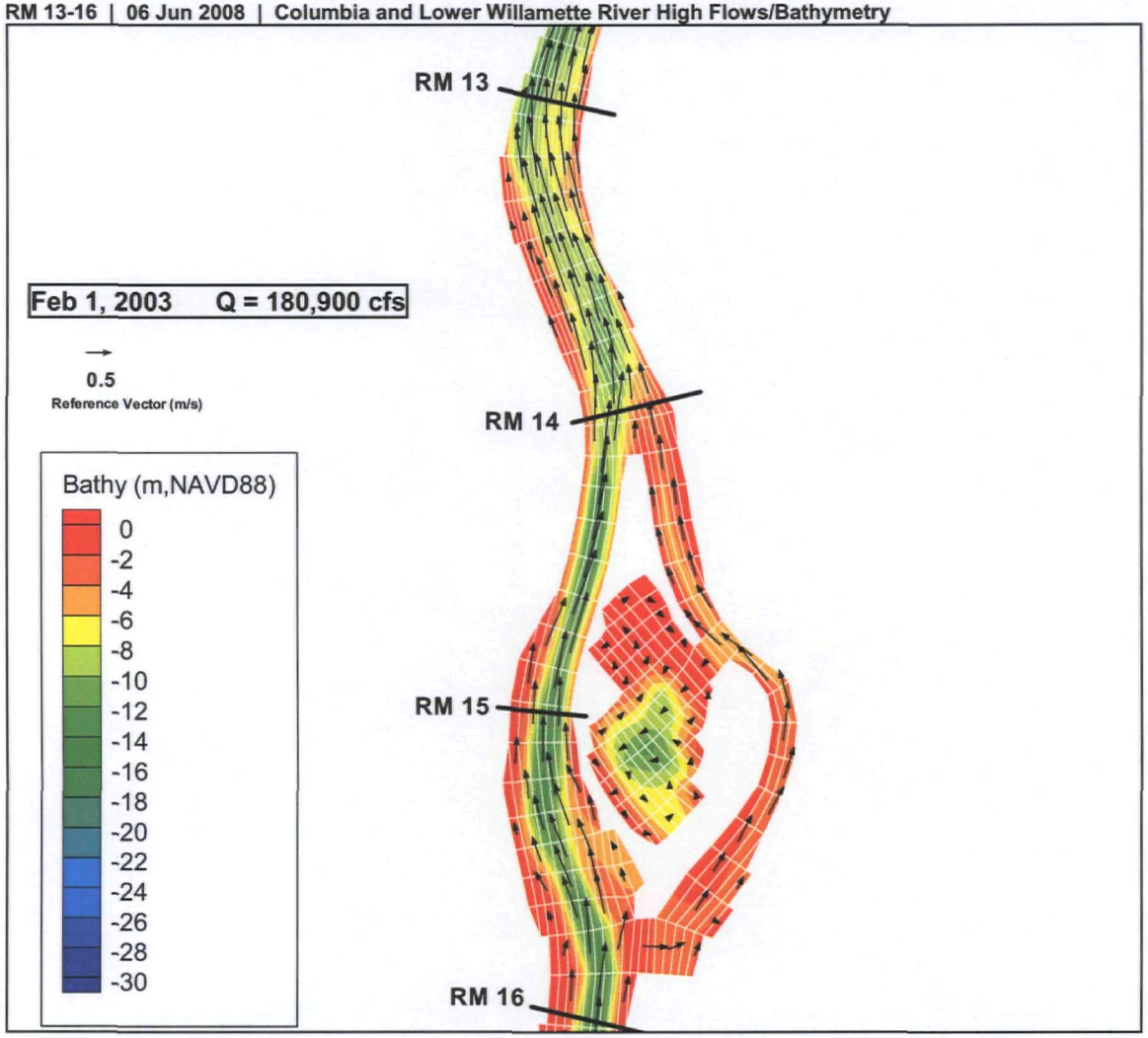
Figure 3.3-12d
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 10-13

RM 13-16 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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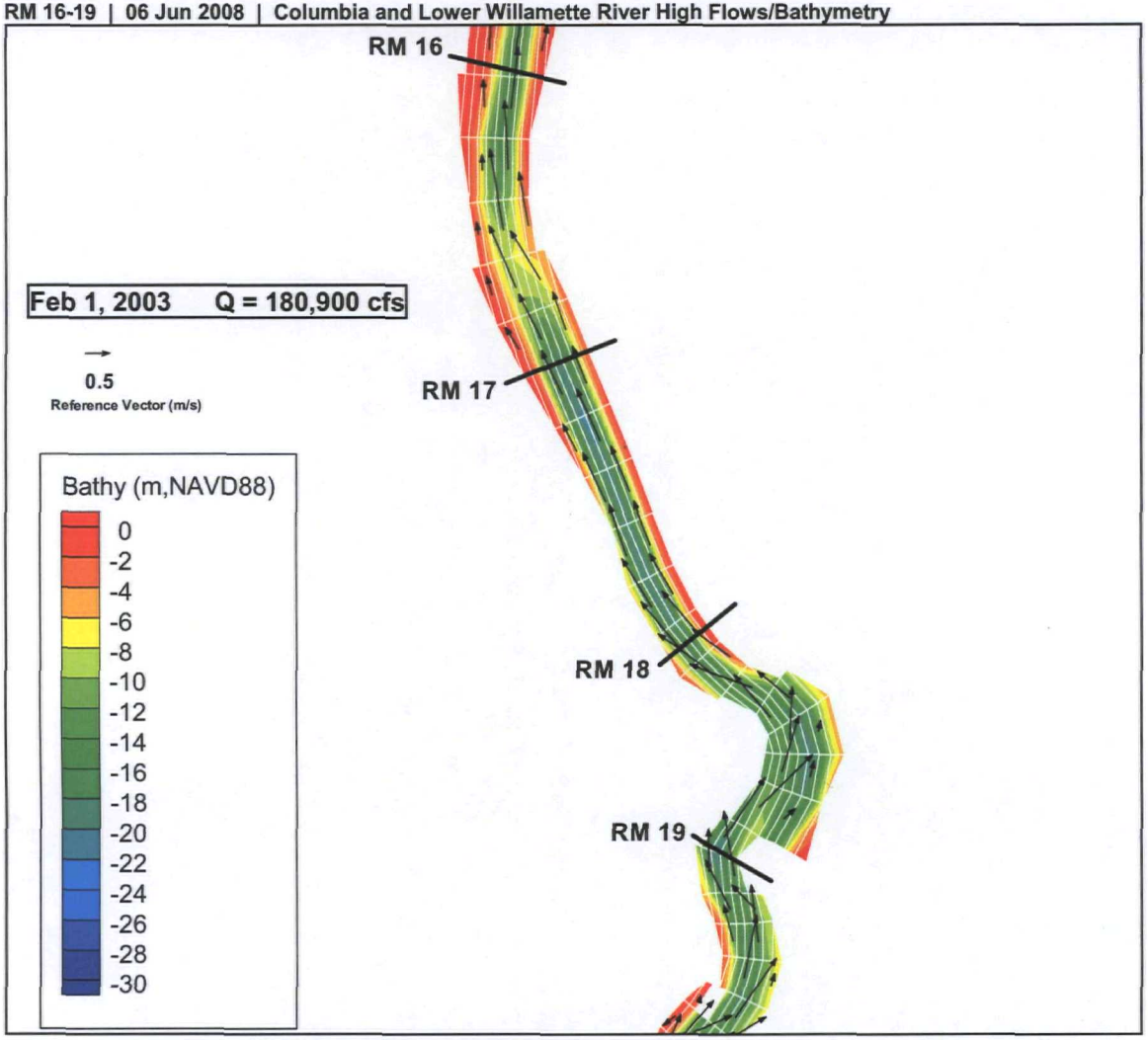
Figure 3.3-12e
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 13-16

RM 16-19 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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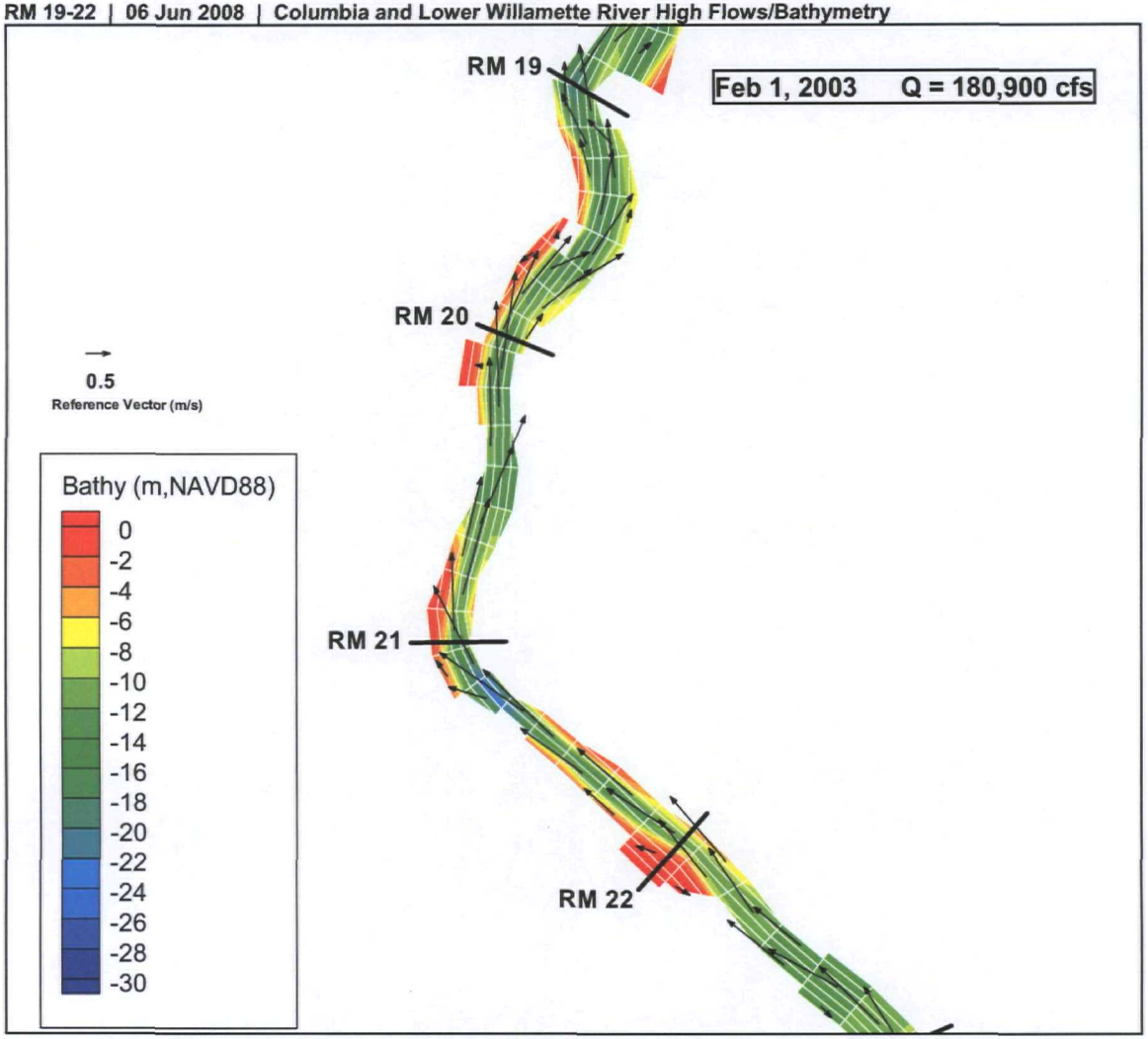
Figure 3.3-12f
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 16-19

RM 19-22 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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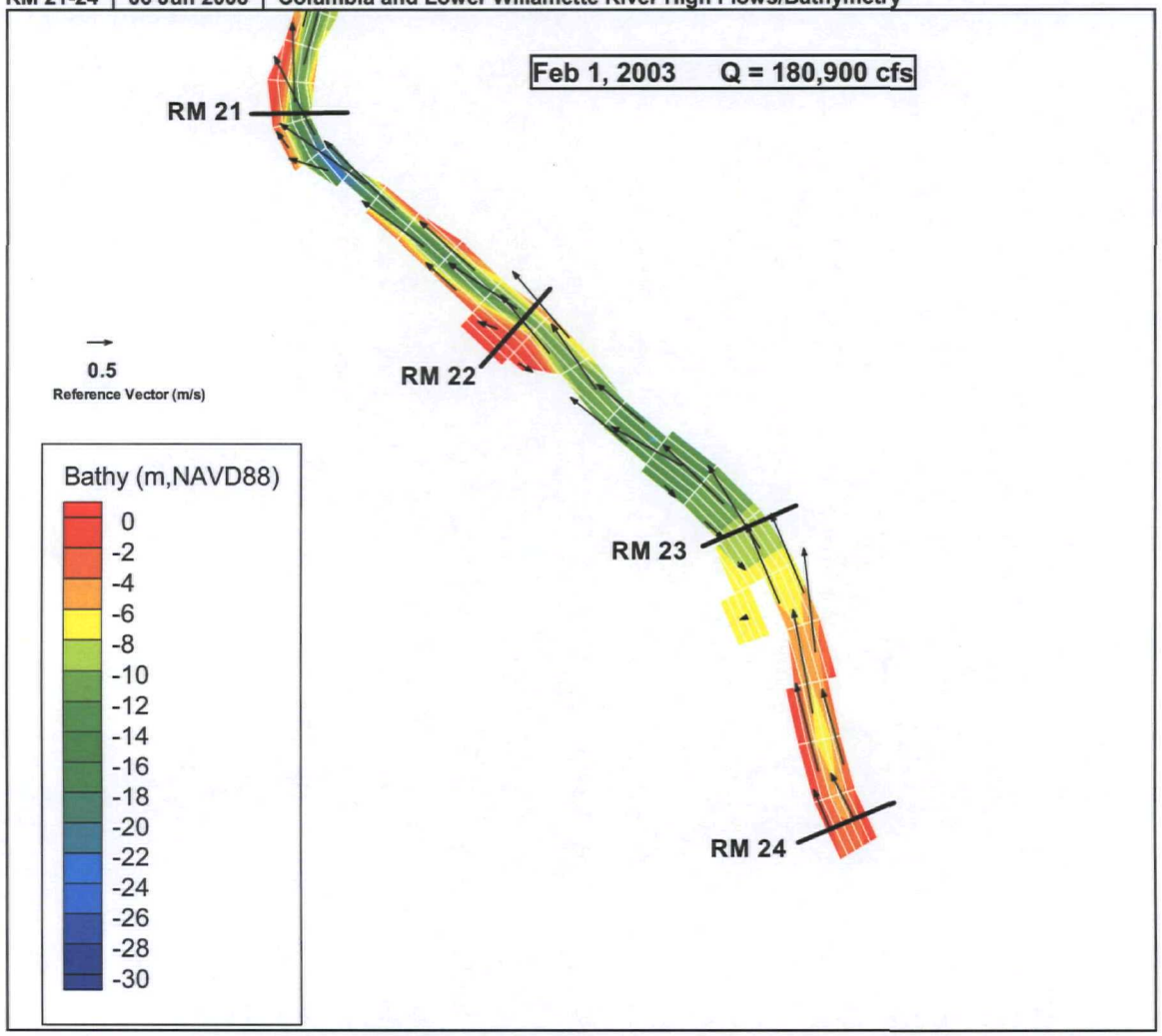
Figure 3.3-12g
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 19-22

RM 21-24 | 06 Jun 2008 | Columbia and Lower Willamette River High Flows/Bathymetry



Note: Bathymetric data collected in Feb 2004.

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Figure 3.3-12h
Portland Harbor RI/FS
Draft Remedial Investigation Report
Vector Velocity Plot, High Flow
RM 21-24

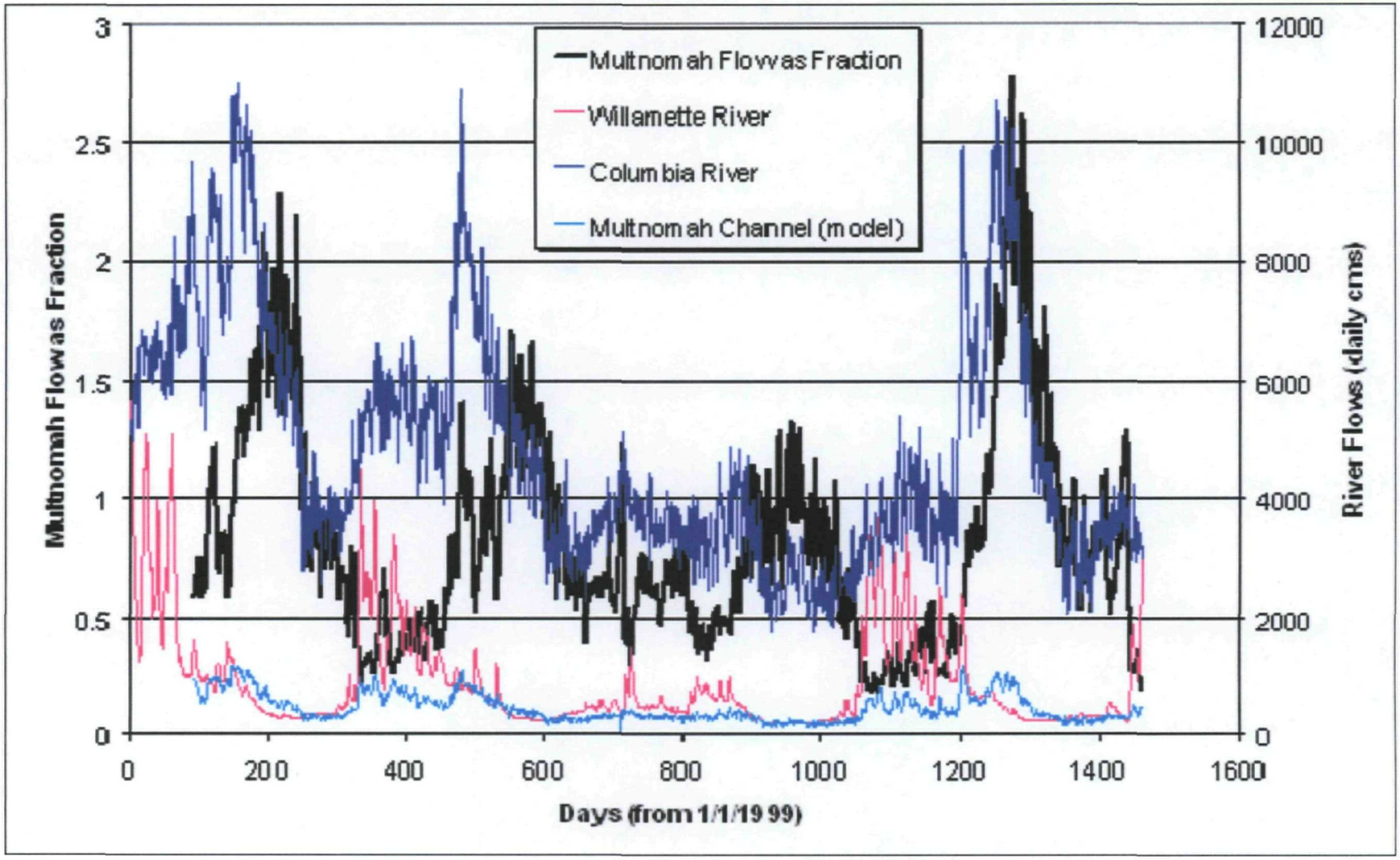

Figure 3.3-13
Portland Harbor RI/FS
Draft Remedial Investigation Report
Willamette and Columbia River Flows and
Modeled Multnomah Channel Flows
as a Fraction of the Willamette Flow

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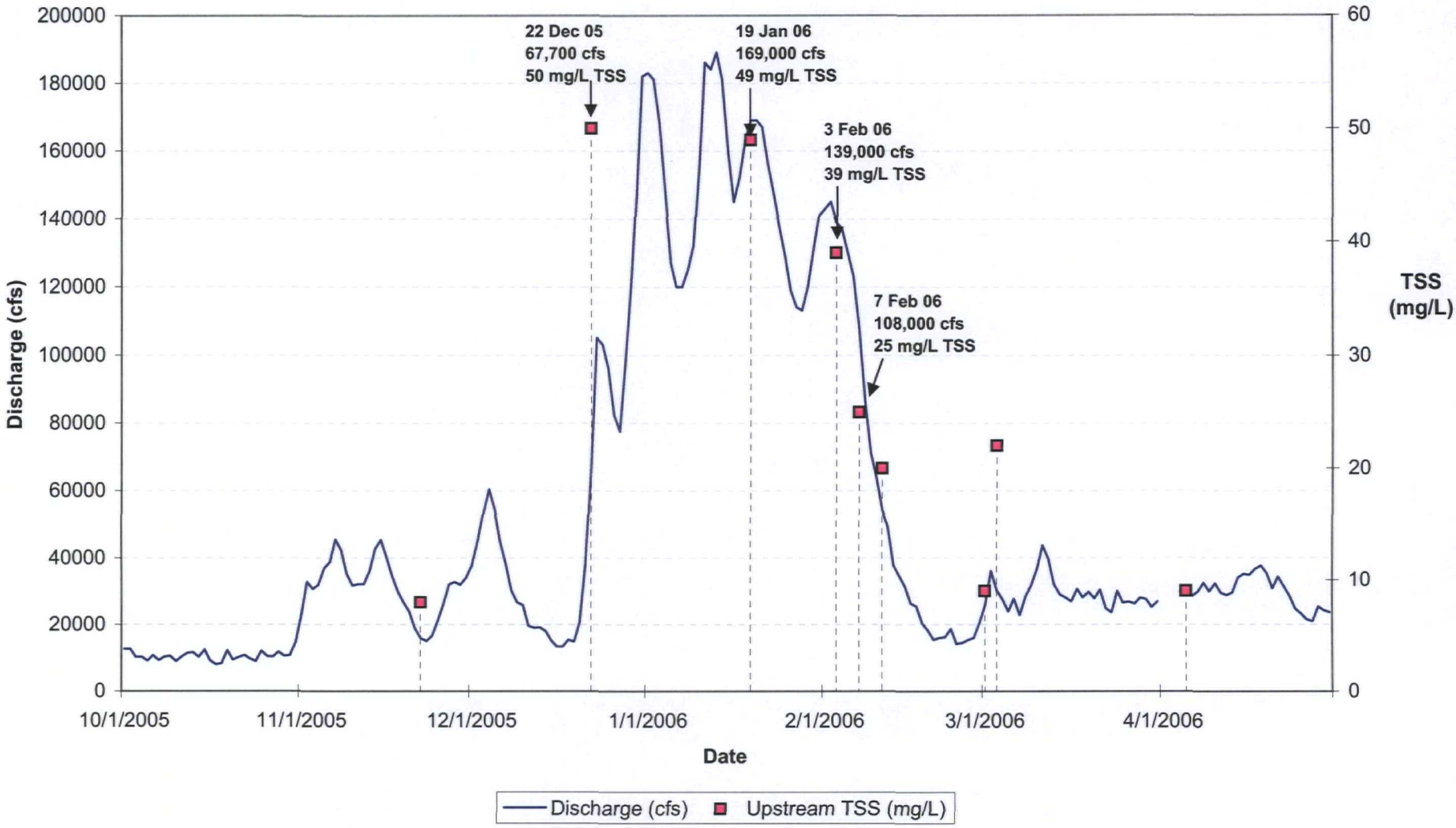
Upstream TSS Concentrations and Study Period Flow Rates



Note: Daily mean discharge was not available for 04/01/2006 0000 hrs through 0400 hrs from the USGS Real Time National Water Information System (NWIS) Database for the Morrison Bridge station 14211720.

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Figure 3.4-1
Portland Harbor RI/FS
Draft Remedial Investigation Report
Upstream TSS Concentrations and Study Period Flow Rates

LISST Suspended Particle Size Measurements with Depth

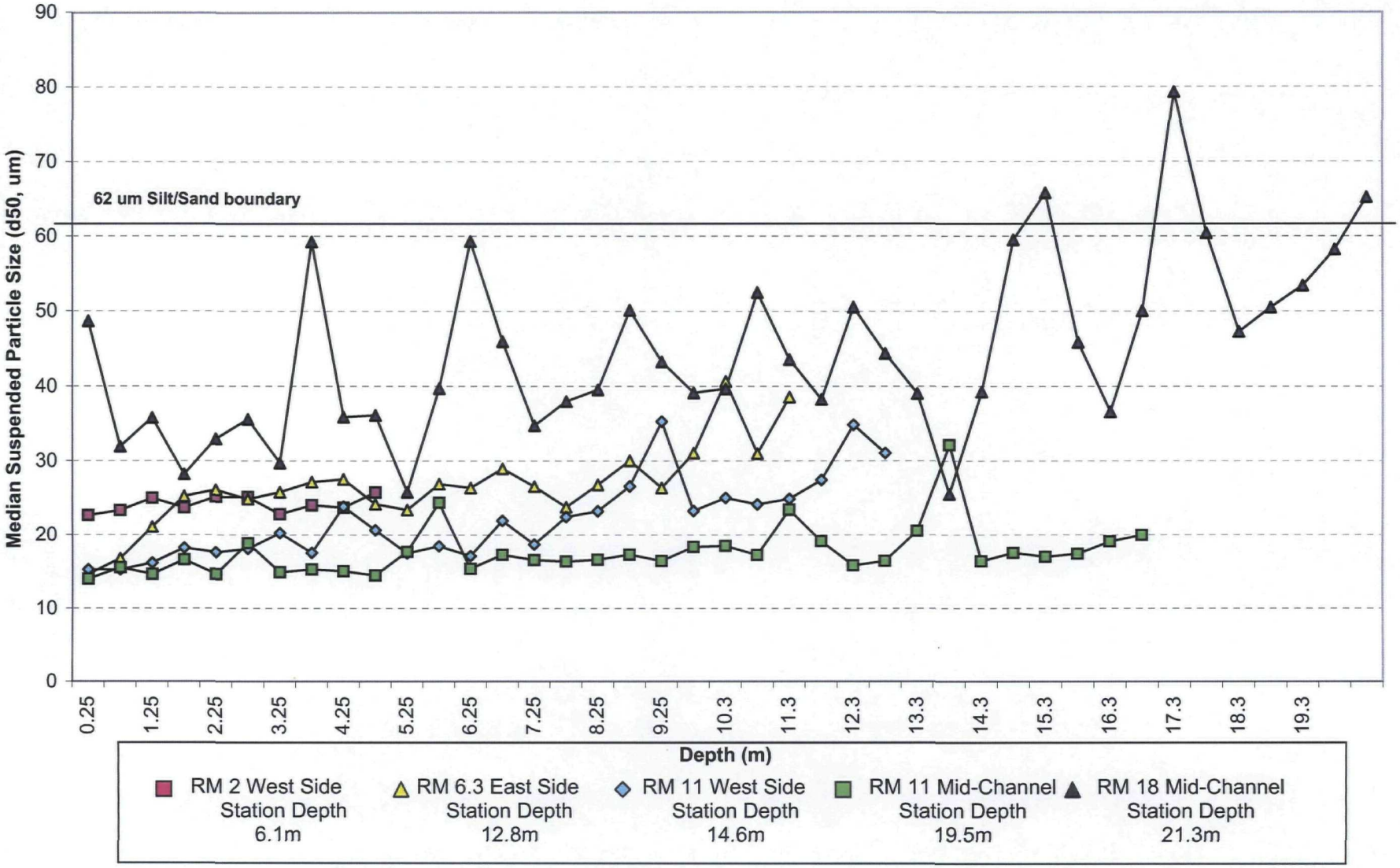

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Figure 3.4-2
Portland Harbor RI/FS
Draft Remedial Investigation Report
LISST Suspended Particle Size Measurements with Depth

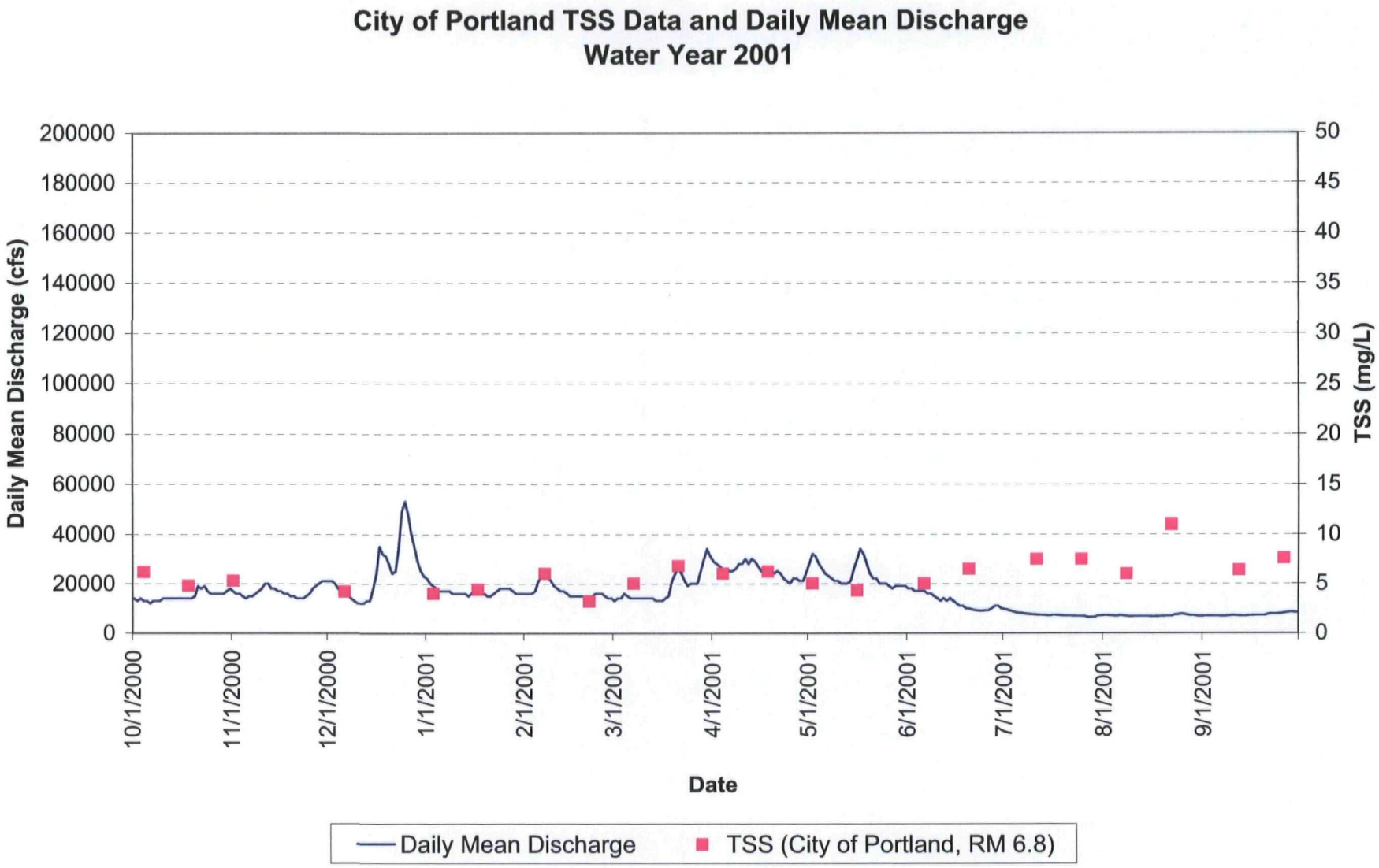

Figure 3.4-3a
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2001

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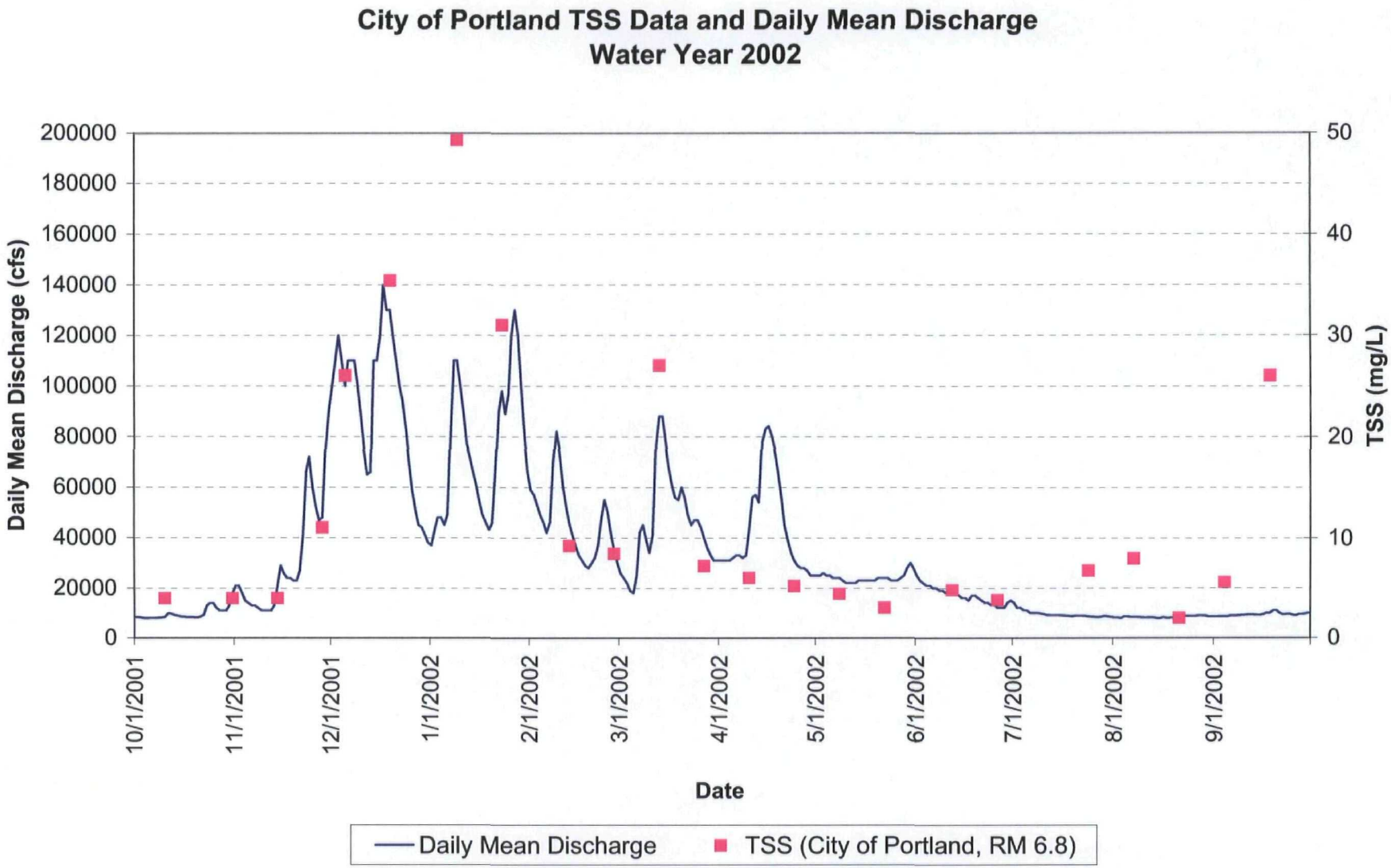

Figure 3.4-3b
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2002

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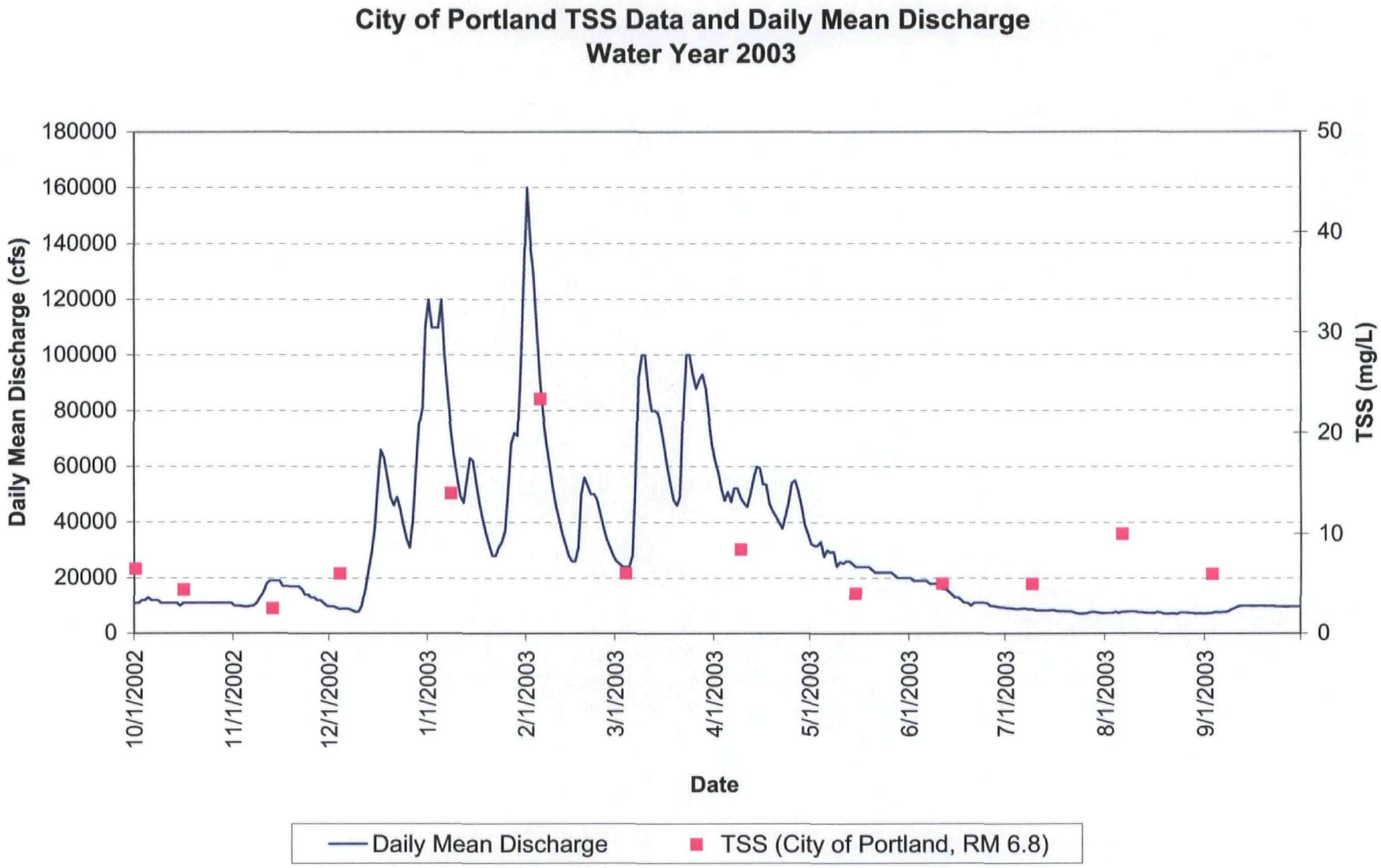

Figure 3.4-3c
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2003

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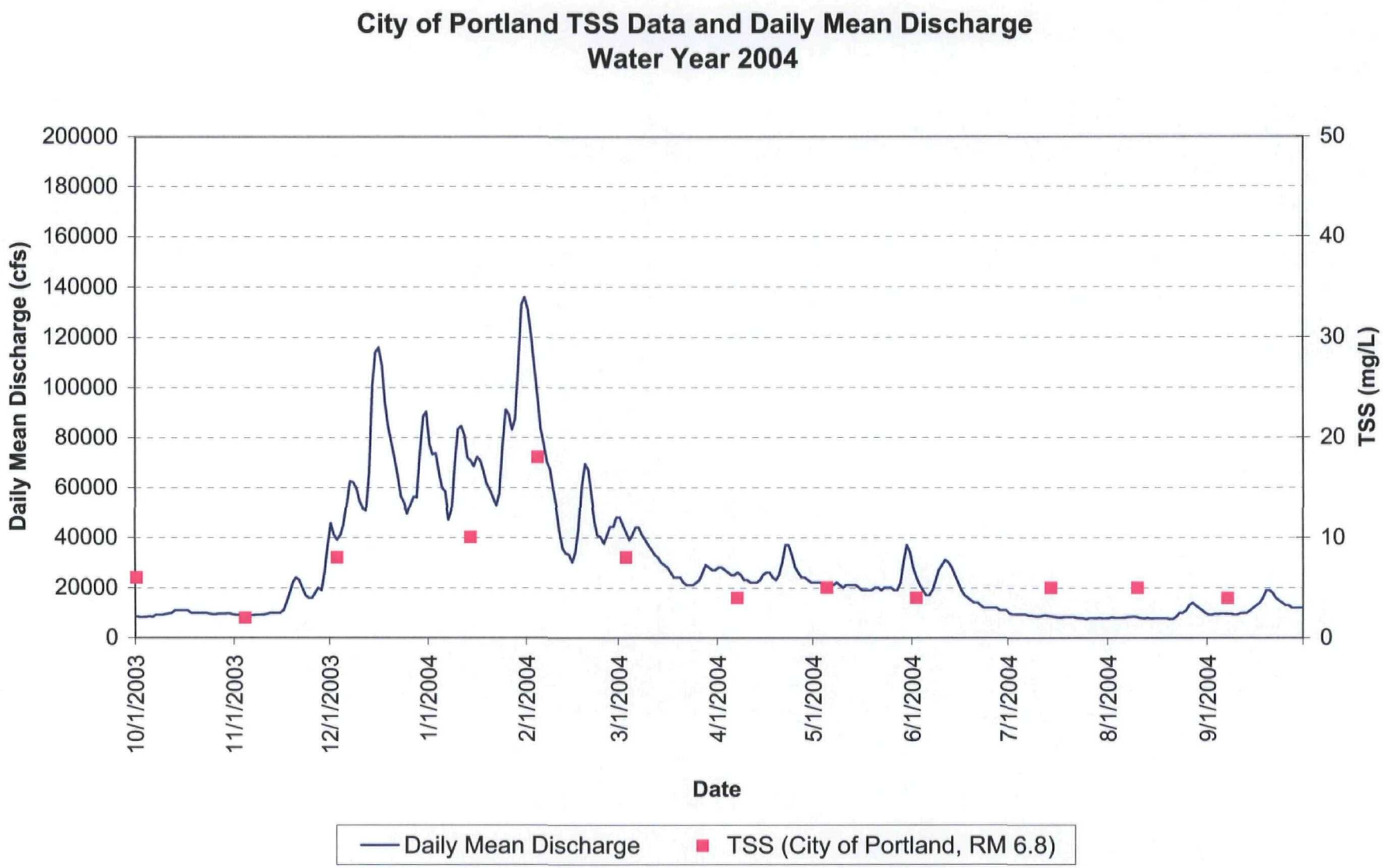

Figure 3.4-3d
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2004

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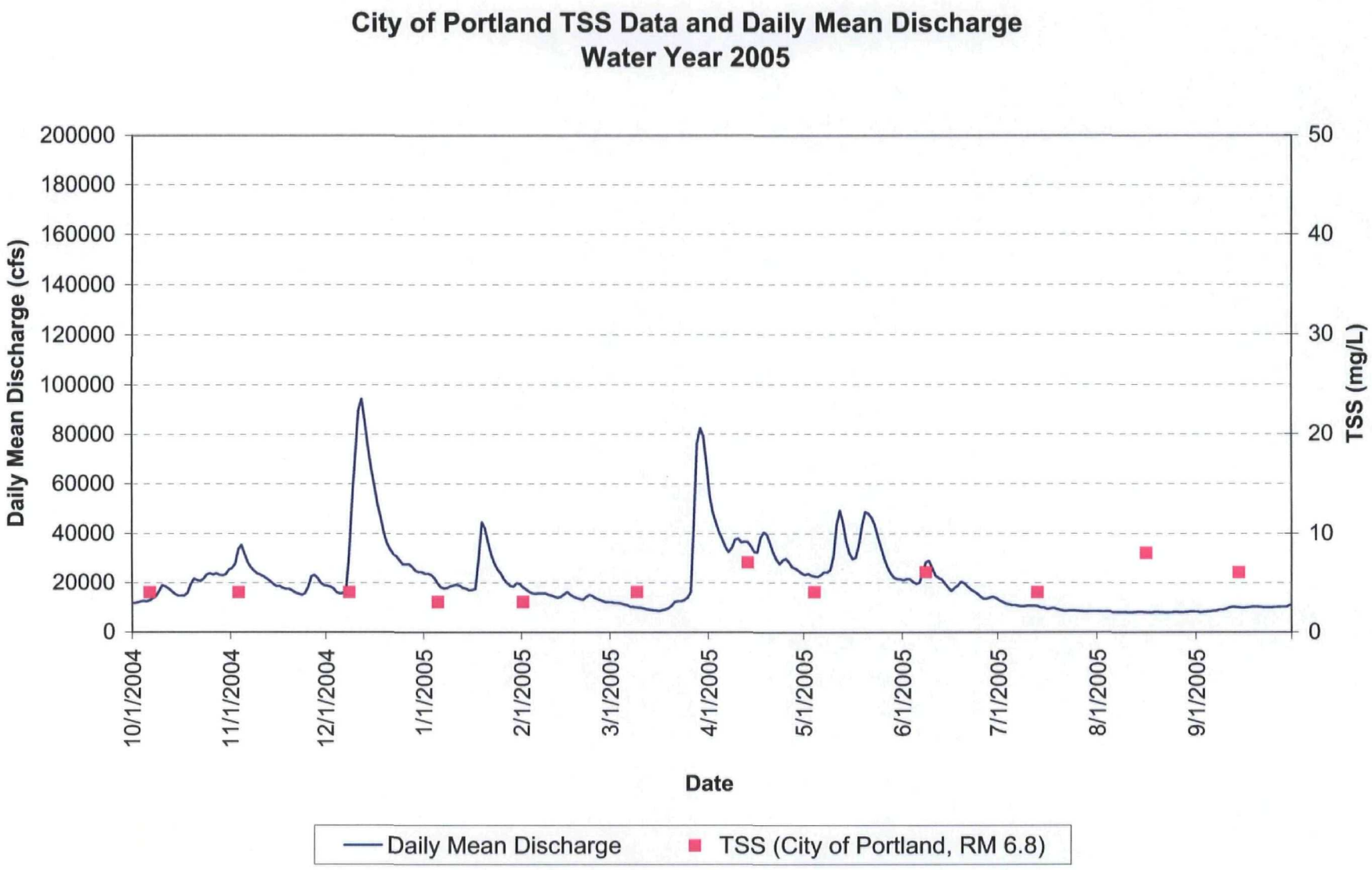

Figure 3.4-3e
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2005

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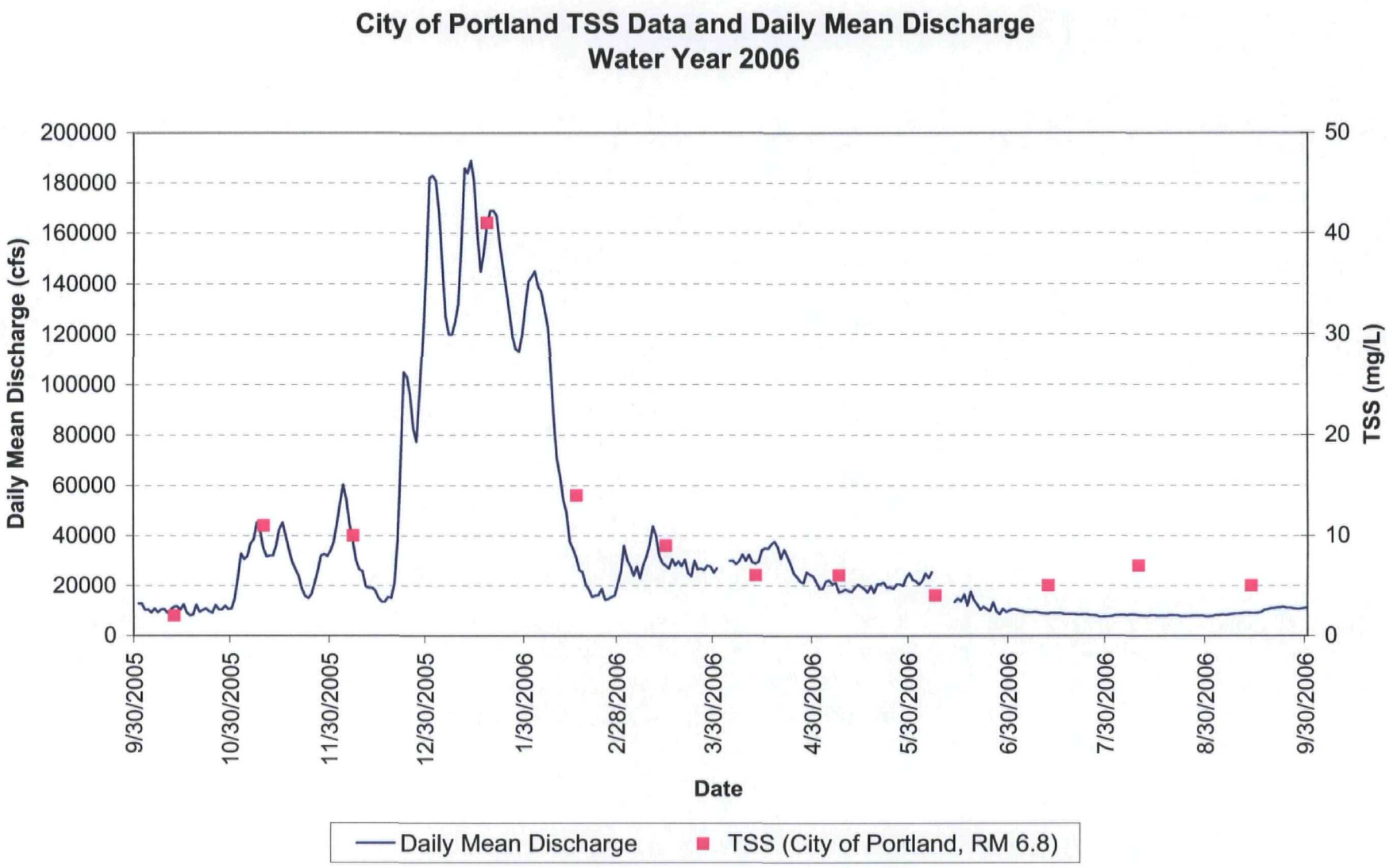

Figure 3.4-3f
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2006

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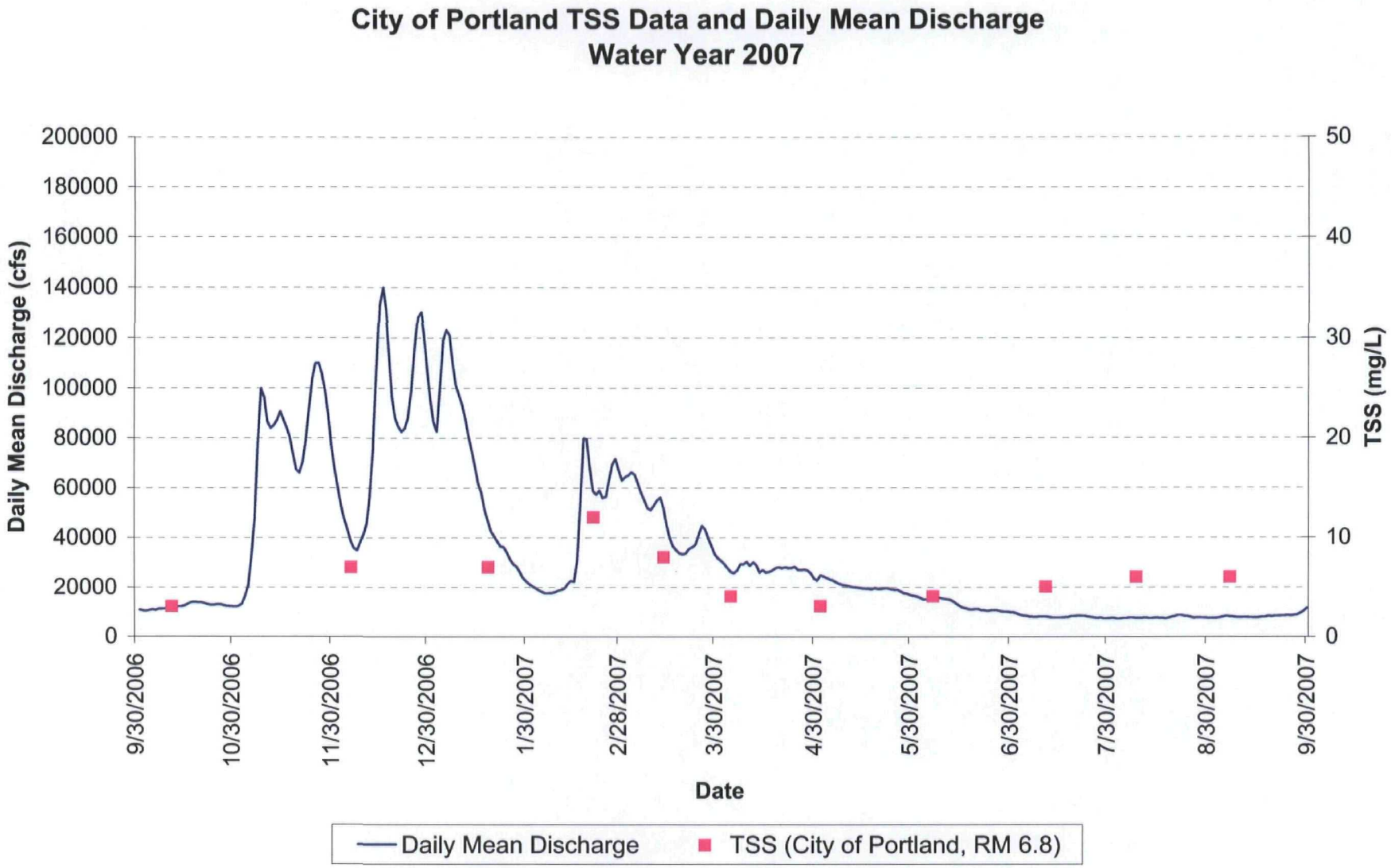

Figure 3.4-3g
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2007

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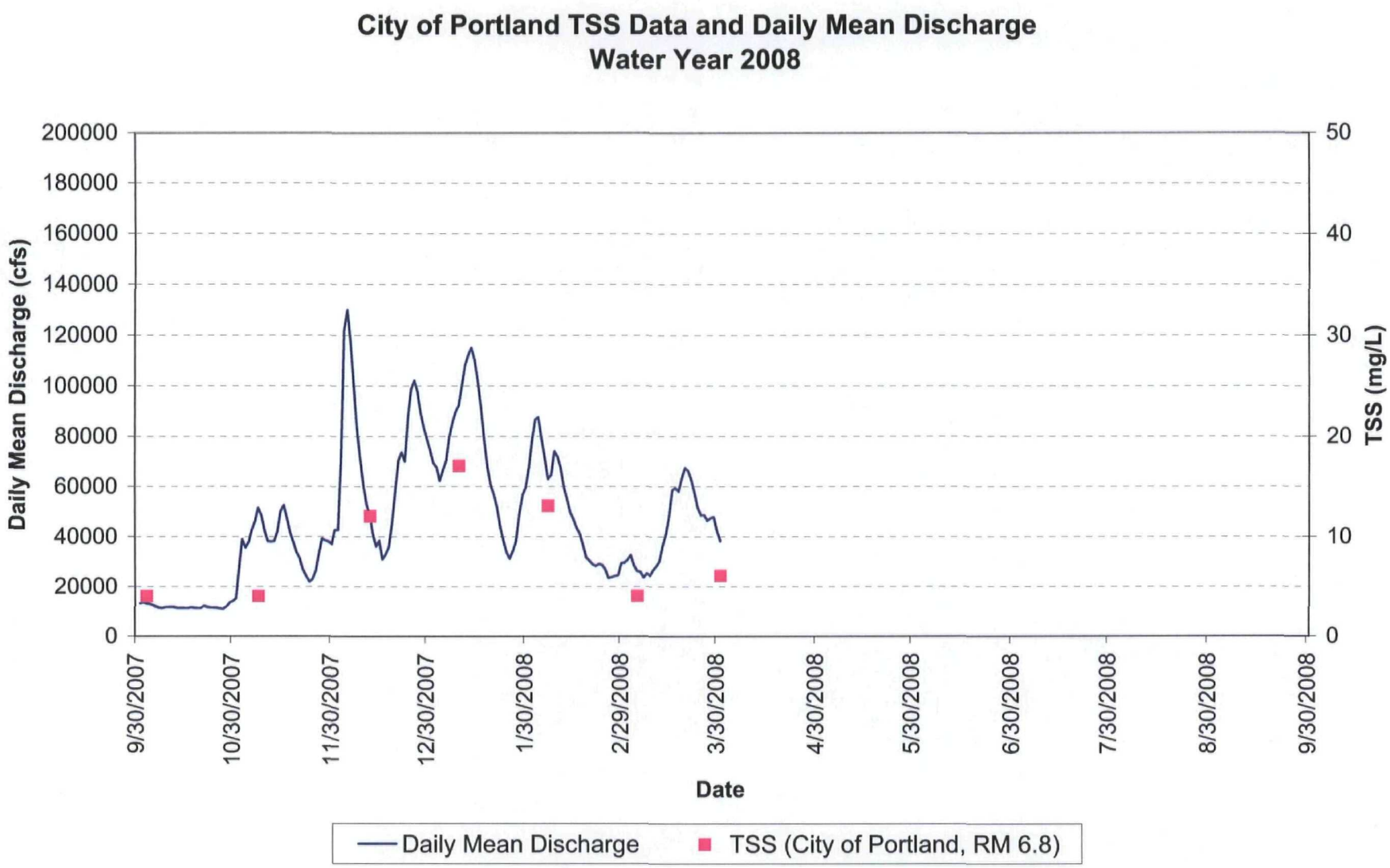

Figure 3.4-3h
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data and Daily Mean Discharge
Water Year 2008

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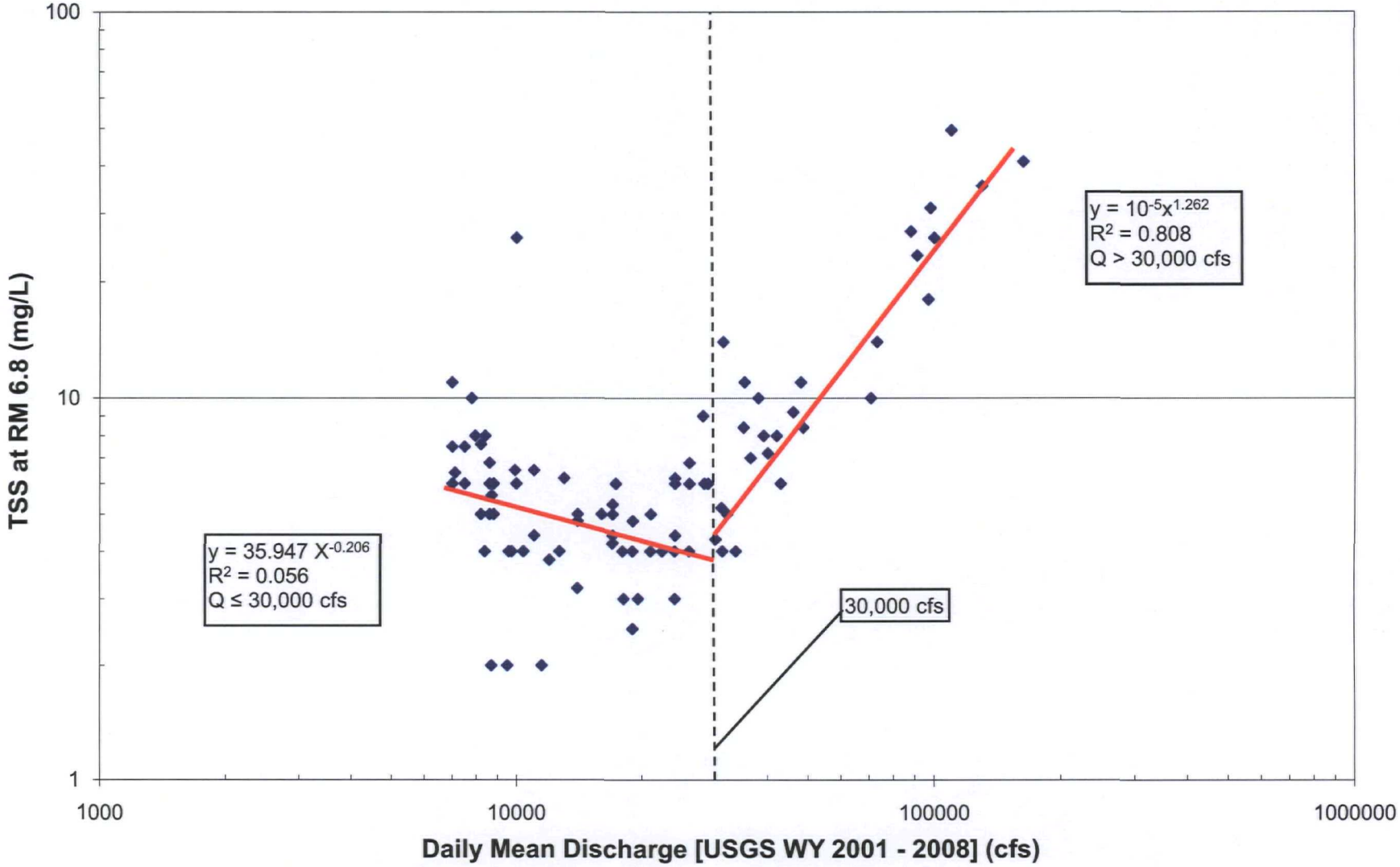

Figure 3.4-3i
Portland Harbor RI/FS
Draft Remedial Investigation Report
City of Portland TSS Data vs. Discharge
Water Years 2001-2008

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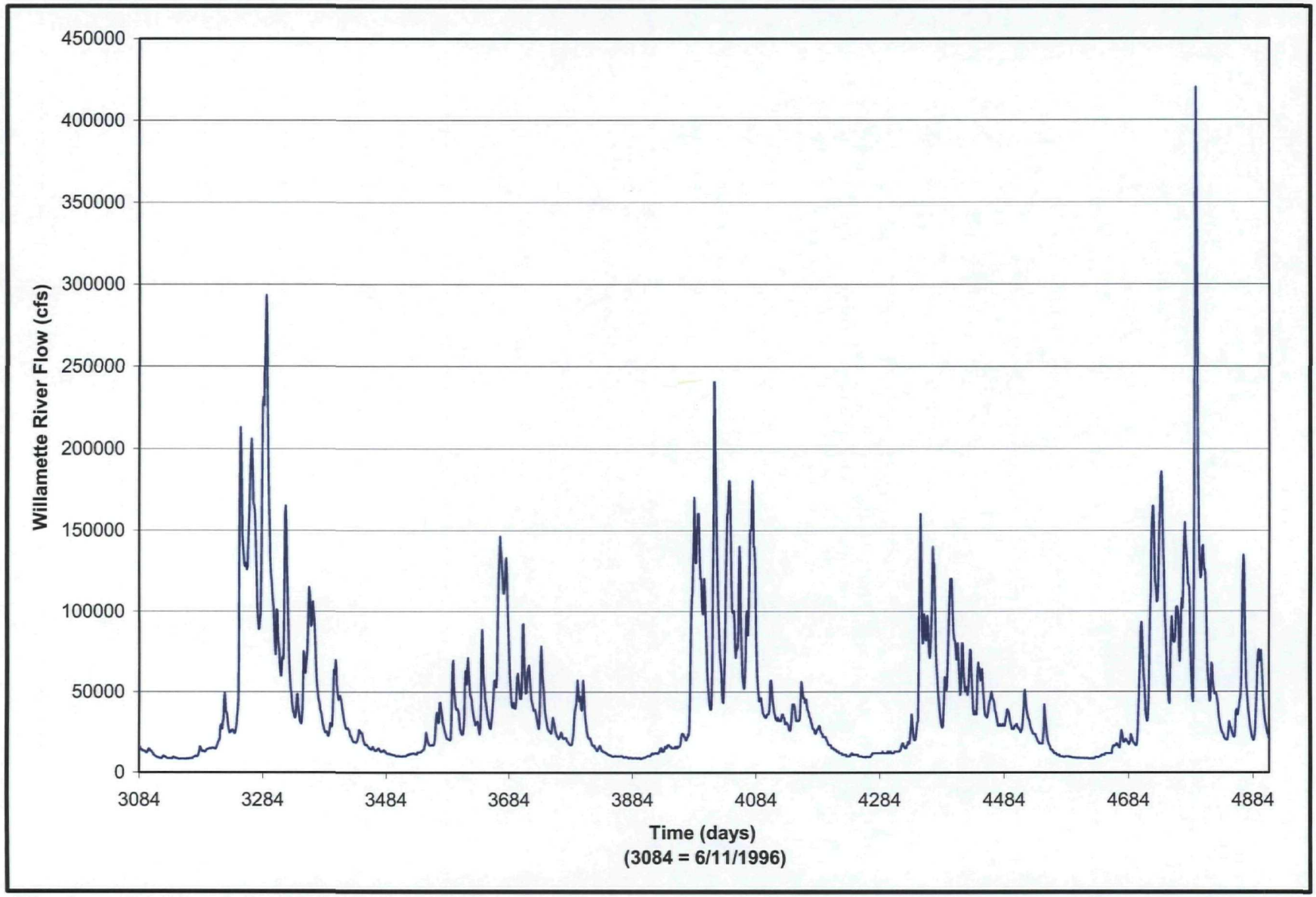

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Figure 3.4-4
Portland Harbor RI/FS
Draft Remedial Investigation Report
Five-year High-flow Flood Scenario Hydrograph

Table 3.1-1. Property Name Index (RM 1.9 - 11.8).

Property Owner (as shown in Map 3.1-2a-e)	River Mile	Other Site Names
ACF Industries, Inc.	3.8	
ADM Milling Co.	11.4	
Advanced American Construction	5.8	Marine Finance Corporation (see Hendren Tow Boats)
Albers Mill Property	11.6	
Alder Creek Lumber Co., Inc	2.8	
Anchor Park LLC	9	
Anderson Bros, Inc.	7.8	
ANRFS Holdings Inc.	9.2	
Apollo Dev., Inc.	11	former Terminal 1 South
Arkema Inc.	7.4	Atofina, Atochem North America, Elf Atochem
Armstrong Disposal Company	8.6	
Ash Grove Cement Co.	2.8	
Ash Grove Cement Co.	10	former Goldendale Aluminum
ATC Leasing Co.	8.8	
Automatic Vending	9.2	
Babcock Land Co. LLC	4.4	
Benson Industries	11.2	
Becker Land LLC	8.8	former Port of Portland
Betty Campbell Building	10.6	
Blue Lagoon - Terminal 5	2	
BNSF Railway Co.	6.8	
BP West Coast Products LLC	4.8	ARCO, BP Bulk Terminal 22T
Brazil & Co.	8.4	
Brix De Armond LLC	5.6	
Brix Maritime Co.	5.4	Foss Maritime Company
Cargill Corp/CDL Pacific Grain	11.5	
Carson Oil - NW 35th AVE	9.2	
Chevron USA, Inc.	7.6	
City of Portland	5.8, 6, 7, 9.2, 9.9, 10.6	BES Water Pollution Control Lab (RM 6), former Terminal 1 North (RM 10.6)
Columbia River Sand & Gravel Inc.	4.6	
ConocoPhillips Co.	7.8	Tosco
Consolidated Freightways Inc.	10.8	
Consolidated Metco, Inc.	3	Metco, Inc.
Container Recovery	9	
Cornerstone Property	8.8	McWhorter, Inc., Eastman Chemical, McCloskey Corporation
Crosby & Overton	9	
Dasic International Corp.	10.2	
Dolan and Co. LLC	10.4	see Sulzer Pumps
Drew Paints, Inc.	10.8	
Dura Industries	8.4	
Equilon Enterprises LLC	8.8	Shell Oil Products US, Texaco Refining/Marketing, Inc. (see Texaco Product Pipeline)
ESCO Corp. - Willbridge Landfill	7	
ESCO Plant #3	10.4	
Evraz Oregon Steel Mills	2.4	Oregon Steel Mills, Inc.
ExxonMobil Oil Corp.	5	Mobil Oil Corporation, Shore Terminals LLC, ST Services (see Shore Terminals LLC)
Flowers by Victor	10.6	
Fred Meyer - Swan Island	9	
Freightliner Corp.	8.2, 9	Freighliner TMP (North), Freighliner TMP II (South)
Frevach Land Co.	3	
Front Ave. LP (LSD CMI NW)	8.2	CMI Northwest
Front Ave. LP (LSD Tube Frdgs.)	8	Tube Forgings

Table 3.1-1. Property Name Index (RM 1.9 - 11.8).

Property Owner (as shown in Map 3.1-2a-e)	River Mile	Other Site Names
Front Ave. LP (LSD Glacier NW)	8	Glacier Northwest, Lone Star Northwest
Front Avenue MP	9.8	
Galvanizers Co.	9.6	
General Electric Co.	9.6	General Electric Decommissioning Facility
Genstar Roofing Co., Inc.	7.6	CertainTeed Corporation, GS Roofing Products
GI Trucking	9	
Glacier NW	11.3	
Guilds Lake	10	
Gunderson LLP	9	
GWC Properties LLC	7.8	Great Western Chemical Corporation, Quadra Chemical Corporation
HAJ Inc.	8.8	Christenson Oil
Hendren Tow Boats	5.6	
Henry Wong	10.4	
Hercules Inc.	9.6	
Herman, Stan	11	
Hill Investment Co.	9.2	
Industrial Battery Building	10.8	
Irvjoy 3rd Generation Corp.	9.4	
Island Holdings Inc.	9	
Jacobson & Co. Inc.	11.1	
J R Simplot Company	2.6	
Kesef Development LLC et. al.	8.4	Calbag Metals - Front Ave.
Kinder Morgan	4.2	Kinder Morgan Liquids Terminal - Linnton Petroleum Terminal, GATX Terminals Corporation
Kinder Morgan (Willbridge)	7.6	Willbridge Terminal (Kinder Morgan Liquids Terminal), GATX Terminals
King-Ries Property	10	
Koppers Industries Inc.	6.4	
Lakea Corp.	9.2	former Columbia American Plating
Lakeside Industries	8.4	
Lampros Properties LLC	4	Ryerson Steel
Langley-St. Johns Partnership	5.6	MarCom Shipyard, MarCom Holdings
Linnton Oil Fire Training Grounds	3.4	
Linnton Plywood Assn.	4.6	Linnton Plywood, Columbia Sand & Gravel
Longview City Laundry & Cleaners	9.8	
Magnus Co.	9	
McCall Oil Real Estate	8	McCall Oil Real Estate Company LLC
McCormick & Baxter Creosoting Co.	7.2	
McCormick Pier Properties	11.8	
Metco, Inc.	2.8	Consolidated Metco, Inc.
Metro	6.6	Willamette Cove - West, Central, and East Parcels
Metro Central Transfer Station	7.2	
Mill Hot	11.1	
Millican Properties LLC	3.8	Portland Container
Mogul Corp.	9.6	
Knife River Corp.	3.6	Morse Bros. Inc., Georgia-Pacific, Inc. - Linnton Fiber Terminal
Mt. Hood Chemical Property	8.4	
Multnomah County - St. Johns Site	5.8	
Nikko Materials USA, Inc.	7.2	Gould Electronics, Inc., NL Industries
Northwest Natural Gas Co.	6.4	Gasco
Northwest Pipe Co.	4	
Nudelman & Son Inc.	9.8	
Nurnberg Scientific Co.	11.2	

Table 3.1-1. Property Name Index (RM 1.9 - 11.8).

Property Owner (as shown in Map 3.1-2a-e)	River Mile	Other Site Names
ODOT - Surplus Property	10.6	
Olympic Pipe Line Portland Delivery Facility	5	
Olympic Pipeline Company	4.2	
Oregon Washington Railroad & Navigation Co. (UPRR Albina Yard)	10	United Pacific Railroad (UPRR) - Albina Yard
Owens-Corning Fiberglas Corp.	3.8	
Owens-Corning Fiberglas Corp.	9	Trumball Asphalt Plant
Paramount of Oregon, Inc.	7.8	Chevron USA Asphalt Refinery
Pacific Power & Light - Mason Substation	10.4	
Paco Pumps	9.6	
Port of Portland (P.O.P.)	10, 4.2-5.5, 1-2	Terminal 2, Terminal 4, Terminal 5
P.O.P. (leased)	1-9.8	Lessees are located at Terminal 5, South Rivergate, Terminal 4, Willbridge Terminal, Swan Iland
P.O.P. (leased) (Willbridge)	7.6	Willbridge Terminal (Chevron - North, ConocoPhillips Company - South)
PGE - Forest Park Property	8.4	
PGE Station E	10.4	
Portland General Electric Co.	3.2	
Portland Shipyard LLC	8.4	Cascade General Ship Repair Yard
Portland Terminal RR Co.(B.N.S.F Lake Yard)	8.8	Burlington Northern Santa Fe (BNSF) Railroad, Portland Terminal
R K Storage & Warehousing, Inc.	4.4	RK Storage
R L R Investments LLC	3.8	Romar Transportation Company
Ralston, Tim (Ralston, TR)	10.8-11	Timothy R Ralston (former Terminal 1 South)
Riverscape LLC	10.8	former Terminal 1 South
Roadway Express	8.8	
Ro-mar Rlty of OR Inc.	3.6	
Sakrete of Pacific Northwest	11	
Sause Bros., Inc.	9.6	
Schmitt Forge	10	
Schnitzer Investment Corp.	8.4	Schnitzer Kittridge
Schnitzer Investment Corp.	7.2	Schnitzer Doane Lake - Air Liquide
Schnitzer Investment Corp.	3.6	Burgard lessees: former Premier Edible Oils, Boydstun Metal Works, Western Machine Works, Morgan
Schnitzer Steel Industries, Inc.	4	International Terminals, Burgard lessees: Portland Blast Media, Cal Bag Metals, Northwest Pipe (storage)
Shaver Transportation Co.	8.4	
Shore Terminals LLC	5.4	ExxonMobil Oil Company, ST Services (See ExxonMobil)
Siltronic Corp.	6.6	Wacker Siltronic Corporation
Smurfit-Stone Container	3.8	Jefferson Smurfit
Southern Pacific Pipe Lines	7	
Starlink Logistics, Inc.	7.6	Rhone-Poulenc, Bayer CropScience, Aventis CropScience
States Battery Co.	10.4	
Steel Hammer Properties LLC	6.2	Crawford Street Corporation
Steelmill Warehouse LLC	2.6	Union Chemical Division of Union Oil Company and H.B. Fuller Company
Sulzer Pumps (US), Inc.	10.4	Sulzer Bingham Pumps
Sunny's Dry Cleaners - Portland	10	
Tanker Basin LLC	8	McCall Oil & Chemical Corporation
Texaco Product Pipeline	8.8	
TFA Inc.	10.9	
The Marine Salvage Consortium	8.4	Fred Devine Diving and Salvage, Inc.

Table 3.1-1. Property Name Index (RM 1.9 - 11.8).

Property Owner (as shown in Map 3.1-2a-e)	River Mile	Other Site Names
TOC Holdings	3.4	Time Oil NW Terminal, Bell Oil Terminal, Koppers Company/Beazer East
Transloader International	5.6	
Triangle Park LLC	7.4	Reidel, Zidell Triangle Park
United States of America, Moorings	6	U.S. Moorings, US Army Corps of Engineers (adjacent to Northwest Natural)
US Coast Guard	8.2	US Coast Guard Marine Safety Office/Group Portland (Swan Island Lagoon)
University of Portland	7.8	
UPRR - St. Johns Tank Farm	4.6	
V&K Service	7.6	
Van Waters & Rogers, Inc.	9	Univar Corporation, Vopak USA, Inc.
Walters, Douglas J.	3.4	
Westlink Packaging	11.2	
Willamette River Westside CSO Construction	10.6	
Williams, Cindy	9.6	
Windsor-Allen LLC	7.8	
Wirfs, Don	9.2	Chase Bag, Chase Packaging Corp., Schnitzer Investment Company - NW Yeon
Zehrung Corp. (Former)	10.8	
Zidell, Emery	8, 8.6	

Table 3.1-2. LWR Dredging Projects in and Adjacent to the Study Area (1997-2008).

Description	Fiscal Year Dredged	Dredge Location: River Mile or Channel Station Positioning	Dredge Location: Terminal	Dredge Location: Berth	Purpose	Quantity (cubic yards)
FY 97 Corps by Great Lakes #53 Clam	1997	8.5 to 10	--	--	Maintenance	346,000
POP Willamette River Dredging	1997	4.5	4	410, 411	Maintenance	5,454
Goldendale Aluminum (former)	2000[a]	10 to 10.1	--	Goldendale Dock	Maintenance	unknown
POP Willamette River Dredging	2001	1	5	503	Maintenance	1,750
Chevron Products Company	2001	7.5 to 7.8	Willbridge	Chevron Dock	Maintenance	15,000
Cargill, Incorporated	2002	11.6	Irving Elevator	Irving Elevator	Maintenance	5,556
POP Willamette River Dredging	2002	10	2	203, 206	Maintenance	8,330
POP Willamette River Dredging	2002	1 to 1.5	5	501, 503	Maintenance	3,435
POP Willamette River Dredging	2002	4.5	4	410, 411	Maintenance	2,250
POP Willamette River Dredging	2003	4.5	4	410, 411	Maintenance	500
POP Willamette River Dredging	2004	4.5	4	410, 411	Maintenance	750
Schnitzer Steel Industries	2004	3.8 to 4	International Terminals	1, 2, 3, 4, 5	Maintenance	138,000
City of Portland Fire Bureau Station 6 Dock	2005	9.7	--	Fire Boat Dock	Maintenance	4,130
POP Willamette River Dredging	2005	4.5	4	410, 411	Maintenance	4,329
POP Willamette River Grading	2005	1 to 1.5	5	501, 503	Maintenance	282
Evraz Oregon Steel Mills	*NA*	*1.9 to 2.5*	--	--	*Remediation*	*29,000*
Vigor Industrial, Inc.	*NA*	*8.2*	*Portland Shipyard*	*Pier C*	*Maintenance*	*1,100*
City of Portland, Bureau of Parks & Recreation	*NA*	*14.5*	*South Waterfront Greenway*	--	*Habitat Enhancement*	*9,338*
CLD Pacific Grain, Inc.	*NA*	*11.6*	*Irving Elevator*	*Grain O Dock*	*Maintenance*	*200 to 1,000*
CLD Pacific Grain, Inc.	*NA*	*11.8*	*Irving Elevator*	--	*Maintenance*	*8,000*
Glacier Northwest	*2004-2006*[b]	*11.3*	*Portland Cement Terminal*	*Main Dock & Barge Dock*	*Maintenance*	*3,000*
Ash Grove Cement	*NA*	*10*	--	--	*Maintenance*	*22,400*
Ash Grove Cement	*NA*	*2.9*	*Rivergate Lime Plant*	--	*Maintenance*	*2,000*
Waverly Marina Association	*NA*	*17*	*Waverly Marina*	--	*Maintenance*	*105,838*
Gunderson, Inc.	pending	8.9	--	--	Maintenance	10,000
BP West Coast Products LLC	*2008*	*4.9*	*22T*	--	*Remediation*	*163,000*
POP Willamette River Dredging	2008	10	2	205, 206	Maintenance	12,242
POP Willamette River Dredging	2008	1	5	501, 503	Maintenance	1,997
POP Willamette River Dredging	2008	4.5	4	410, 411	Maintenance	12,800
Chevron Products Company	planned for 2010	7.5 to 7.8	Willbridge	Chevron Dock	Maintenance	~20,000

Notes:

Italicized projects were obtained from USACE Public Notices.

[a] Permit authorized dredging of up to 1,500 cubic yards of material annually between September 8, 1999 to August 31, 2004.

[b] Dredging has been performed but completion date is unknown. Permit authorization in effect between June 14, 2004 and June 14, 2006.

NA - not available
FY - fiscal year
LWR - lower Willamette River
POP - Port of Portland
USACE - U.S. Army Corps of Engineers

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Table 3.1-3. Status of Combined or Combined Sewer Overflow Systems Control within Study Area.

Outfall Number	Pipe Size	Location	River Mile	Construction Date	Interceptor Diversion Date	Control Date[a]	Future CSO Potential	Notes	Status of Outfall
Outfalls Controlled Before the City's 20-Year Abatement Program									
OF-42	10-inch	East Side	11.7	~1910	1954	1954	No	Combined basin served residential properties	Previously combined, stormwater-only outfall since 1954
OF-44	72-inch	East Side	11.2	<1907	1954	1954	No	Combined basin served industrial properties	Previously combined, stormwater-only outfall since 1954
OF-51	18-inch	East Side	5.8	1906[b]	1952	NA	No	Drainage basin was diverted to OF-52 and the outfall was abandoned in mid-1970s. Industrial area closer to the river separated in 1952. From 1952 to mid-1970s, only residential area included in the CSO basin	Previously CSO, abandoned in mid-1970s
OF-16	36-inch	West Side	9.7	1930	1970	1970	No	Designated as combined system in industrial area but uncertain if any sanitary or wastewater discharged to combined system	Previously combined, stormwater-only outfall from 1930 to 1948 and from 1970 to current
OF-18	72-inch	West Side	8.8	<1945[b]	1970	1970	No	Combined area served industrial and open space. According to Stevens & Thompson (1964), many sewers were constructed by private parties and sewer connections were unknown.	Previously combined, stormwater-only outfall since 1970
OF-19/20	42-inch	West Side	8.4	1944[b]	1970	1970	No	Combined area served industrial and open space. According to Stevens & Thompson (1964), many sewers were constructed by private parties and sewer connections were unknown.	Previously combined, stormwater-only outfall since 1970. OF-20 flows redirected to OF-19 in 1949.
OF-22/21	60-inch	West Side	7.8	<1928[b]	1970	1970	No	OF21 combined area served industrial and open space. According to Stevens & Thompson (1964), many sewers were constructed by private parties and sewer connections were unknown. OF21 served only one site, an asphalt plant.	Previously combined, stormwater-only outfall since 1970. Flow from OF-21 redirected to OF-22 in 1969.
OF-45	27-inch	East Side	11	1907	1954	1974	No	Industrial area closer to the river separated in 1954. From 1954 to 1974, only residential area included in the CSO basin	Previously CSO, stormwater-only outfall since 1974
Outfalls Controlled as Part of the City's 20-Year Abatement Program									
OF-14	30-inch	West Side	10.8	1905	1953	<1986	No	Combined basin served industrial properties	Previously CSO, stormwater-only outfall since before 1986
OF-23	27-inch	West Side	5.2	<1915[b]	1972	1992	No	Combined area served primarily residential with some commercial and industrial. Combined flow diverted to local treatment plant in 1945 for primary treatment (solids removal). Controlled by sealing off diversion structure in 1992.	Previously CSO, currently abandoned
OF-52	30-inch	East Side	5.7	1920	1952	1995	Yes	Combined area served residential area. Controlled via Expanded Separation and Downspout Disconnection. Monitoring to confirm compliance of 3-year summer/4-per-winter storms by Dec. 2011.	Controlled CSO, with separated stormwater downstream of diversion

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Table 3.1-3. Status of Combined or Combined Sewer Overflow Systems Control within Study Area.

Outfall Number	Pipe Size	Location	River Mile	Construction Date	Interceptor Diversion Date	Control Date[a]	Future CSO Potential	Notes	Status of Outfall
OF-50	30-inch	East Side	5.9	1906	1952	1995	No	In 1954, industrial area closer to the river separated; remaining CSO basin served predominately residential areas. Controlled via Expanded Separation and Downspout Disconnection. System converted to stormwater-only in 1995.	Previously CSO, now stormwater only
OF-49	15-inch	East Side	6.5	1945	1952	1995	No	Combined basin drained predominately residential areas and no industrial properties. Controlled via Expanded Separation and Downspout Disconnection. Diversion sealed as of Dec. 2001.	Previously CSO, now stormwater only with end-of-pipe treatment
OF-53	48-inch	East Side	5.2	<1916	1952	1995	Yes	Combined area served residential area. Controlled via Expanded Separation and Downspout Disconnection to 3-year summer/4-per-winter storms.	Controlled CSO, with separated stormwater downstream of diversion
OF-48	30-inch	East Side	7.3	1948	1952	1996	No	Combined basin drained predominately residential areas and no industrial properties. Controlled via Expanded Separation and Downspout Disconnection. Diversion sealed as of Dec. 2001.	Previously CSO, now stormwater only with end-of-pipe treatment
OF-24	12-inch	West Side	4.3	<1915[b]	1973	2000	SSO Only	Combined area served primarily residential with some commercial and industrial. Combined flow diverted to local treatment plant in 1945 for primary treatment (solids removal). Controlled via Partial Separation & Pump Station Improvements to 3-year summer/4-per-winter storms.	Previously CSO, now emergency pump station relief point only. Only discharges to river if there is a pump station failure.
OF-47	48-inch	East Side	9.9	1910	1954	2006	Yes	Combined basin is primarily residential with some commercial. Controlled by 3-year summer/4-per-winter storms via West Side CSO Facilities	Controlled CSO, with separated stormwater downstream of diversion
OF-13	24-inch	West Side	11.1	1890	1953	2006	No	Combined area served primarily industrial land. Controlled via West Side CSO Facilities. Diversions sealed.	Previously CSO, now stormwater only
OF-12/12A	16-inch/48-inch	West Side	11.2	1888	1953	2006	No	Combined area served primarily industrial land. Controlled via West Side CSO Facilities. Diversions sealed. OF12A not a City outfall	Previously CSO, now stormwater only
OF-11	78-inch	West Side	11.4	1888	1953	2006	No	Combined area served mixed land uses (open space, industrial, residential and commercial). Controlled via West Side CSO Facilities, Stream Separation. CSO pipe to outfall sealed in 2006.	Previously CSO, now stormwater only
OF-15	102-inch	West Side	10.4	1899	1953	2006	Yes	Combined based served open space, residential, industirial and commercial. A portion of the industrial area was separated in 1975. Controlled via West Side CSO Facilities to 3-year summer/4-per-winter storms (CSO outfall only).	Controlled CSO, with separated stormwater downstream of diversion

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Table 3.1-3. Status of Combined or Combined Sewer Overflow Systems Control within Study Area.

Outfall Number	Pipe Size	Location	River Mile	Construction Date	Interceptor Diversion Date	Control Date[a]	Future CSO Potential	Notes	Status of Outfall
OF-46	80-inch	East Side	10.5	1901	1954	2011	Yes	Combined basin is primarily residential with some commercial. Will be controlled via Cornerstone and Eastside CSO facilities.	Will be controlled CSO, with no stormwater, once construction is complete
OF-44A	72-inch	East Side	11.2	1974	1974	2011	No	Combined basin is primarily residential with some commercial. Will be controlled via Cornerstone and Eastside CSO facilities. Diversions will be sealed.	All combined and stormwater flows will be diverted to the tunnel once construction is complete
OF-43	56-inch	East Side	11.4	1906	1954	2011	Yes	Industrial area closer to the river separated in 1954. Primarily residential area remained CSO basin Will be controlled via the Cornerstone and Eastside CSO facilities to 3-year summer/4-per-winter storms.	Will be controlled CSO, with separated stormwater downstream of diversion, once construction is completed
OF-17	90-inch	West Side	9.8	1921	1953	2011	No	Combined area served mixed land uses (open space, industrial and residential). About half of the industrial area was separated in 1950s-1970s. Will be controlled via the Balch Consolidation Conduit and West Side CSO Facilities. Diversions will be sealed.	Will be a stormwater-only outfall once construction is complete

Source:
Long-Term Solids and Floatables Control Plan (City of Portland 2008a).

Notes:
CSOs listed in order of year controlled.
[a] Separate sanitary and stormwater constructed and all wastewaters required to connect to City sanitary system.
[b] Outfall not originally constructed by the City.

CSO - combined sewer overflow
OF - outfall
SSO - sanitary sewer overflow

Table 3.3-1. Willamette Basin Reservoir Summary.

Dam	Total Storage acre-ft	Summer Storage acre-ft	Year Completed	Power Generators	River	Comments
Fern Ridge	116,800	93,900	1941	none	Long Tom	High recreational, not drafted for low-flow augmentation
Cottage Grove	32,900	28,700	1942	none	Coast Fork Willamette	Usually not drafted for low-flow augmentation
Big Cliff	N/A	N/A	1953	1	North Santiam	Re-regulation dam for Detroit, limited recreation
Detroit	455,100	281,600	1953	2	North Santiam	Rarely drafted for low-flow augmentation
Dorena	77,600	65,000	1949	none	Row	Usually not drafted for low-flow augmentation
Hills Creek	355,500	194,600	1961	1	Middle Fork Willamette	Drafted for low-flow augmentation
Foster	60,700	24,800	1968	2	South Santiam	Rarely drafted for low-flow augmentation
Green Peter	428,100	249,900	1968	2	Middle Santiam	Drafted for low-flow augmentation, recreational use
Lookout Point	455,800	324,200	1954	3	Middle Fork Willamette	Drafted for low-flow augmentation, limited recreational use
Dexter	N/A	N/A	1954	1	Middle Fork Willamette	Re-regulation dam for Lookout Point, some recreation
Blue River	89,500	78,800	1969	3	Blue River	Drafted for low-flow augmentation, recreational use
Cougar	219,000	143,900	1964	2	South Fork McKenzie	Drafted for low-flow augmentation, recreational use
Fall Creek	125,000	108,200	1966	none	Fall Creek	High recreational use

Source:
U.S. Army Corps of Engineers, Portland District.

Notes:
N/A - not applicable

Table 3.4-1. Summary of TSS Samples Collected by LWG, November 2005 - April 2006.

Data Need	Location	River Flow[a] (cfs)	Date Sampled	Sampling Methodology	No. Samples per Event	Total No. TSS Samples
Upstream TSS	RM 23	15,900	11/5/2005	Vertically and horizonatally integrated transect sample, peristaltic pump	1	10
		20,000	2/21/2006		1	
		28,000	4/5/2006		1	
	RM 16[b]	169,000	1/19/2006	Horizontally integrated transect sample, Nisken Bottle	1	
	RM 23	139,000	2/3/2006		1	
		108,000	2/7/2006		1	
		67,700	12/22/2005	Vertically and horizonatally integrated transect sample, peristaltic pump	1	
		54,000	2/11/2006		1	
		41,500	3/3/2006		1	
		32,300	3/1/2006		1	
TSS Study Area	RM 2 (west, mid, east)	<29,000	4/3/2006	Vertically integrated transect samples, peristaltic pump	12 samples at mid-flood tide and 12 samples at mid-ebb tide for each location	24
	Multnomah Channel (west, mid, east)					
	RM 6.3 (west, mid, east)		4/4/2006			
	RM 11 (west, mid, east)					

Flow Data Source:
http://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=14211720

Notes:

[a] Daily mean discharge as measured by USGS Gauge No. 14211720 on the upstream side of Morrison Bridge, Portland, OR, RM 12.8.

[b] TSS sample collected at RM 16 during the January 2006 high flow surface water sampling event.

LWG - Lower Willamette Group
RM - river mile
TSS - total suspended solids
USGS - U.S. Geological Survey

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Table 3.4-2. TSS and TOC Results for LW2-HMW05 Upstream Samples, November 2005-April 2006.

Sample Date	Flow Rate[a] (cfs)	River Mile	Sample ID	Y Northing	X Easting	Validated Results: Total suspended solids (mg/L)	Validated Results: Total organic carbon (mg/L)
11/22/2005	16,000	23.7	LW2-HMW05-001	EDI 1 - 632374.723 EDI 2 - 632330.845 EDI 3 - 632289.286 EDI 4 - 632245.046	EDI 1 - 7657149.114 EDI 2 - 7657037.655 EDI 3 - 7656938.180 EDI 4 - 7656828.995	8[b]	NS[b]
12/22/2005	67,700	23	LW2-HMW05-002			50	NS
01/19/2006[c]	169,000	16	LW3-W1024			49	NS
02/03/2006	139,000		LW2-HMW05-003			39	NS
02/07/2006	108,000		LW2-HMW05-004			25	NS
02/11/2006	54,000		LW2-HMW05-005	EDI 1 - 734734.993	EDI 1 - 7550380.627	20	NS
02/21/2006	20,000		LW2-HMW05-106	EDI 2 - 734911.609	EDI 2 - 7549367.197	7	NS
02/21/2006		23	LW2-HMW05-206	EDI 3 - 735054.443	EDI 3 - 7548551.139	7	NS
03/01/2006	32,300		LW2-HMW05-007	EDI 4 - 735133.139	EDI 4 - 7548046.806	9	NS
03/03/2006			LW2-HMW05-108			22	2.4
03/03/2006	41,500		LW2-HMW05-208			22	2.2
03/03/2006			LW2-HMW05-308			21	2.2
04/05/2006	28,000		LW2-HMW05-009			9	2.4

Notes:

[a] Daily mean discharge as measured by USGS Gauge No. 14211720 on the upstream side of Morrison Bridge, Portland, OR, RM 12.8.
[b] Result from EDI composite sample.
[c] TSS sample collected at RM 16 during January surface water event.

EDI - equal discharge increment
NS - not sampled
RM - river mile
TOC - total organic carbon
TSS - total suspended solids
USGS - U.S. Geological Survey

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Table 3.4-3. TSS and TOC Results for LWR Samples, April 2006.

Sample Date	Flow Rate[a] (cfs)	River Mile	Station ID	Sample ID	Y Northing	X Easting	Validated Results TSS (mg/L)	Validated Results TOC (mg/L)	Tide	Location
04/03/06	<29,000	2	LW2-HMW01	LW2-HMW01-001-C	725492.6198	7616888.2723	8	1.9	rising	channel
			LW2-HMW01	LW2-HMW01-002-C	725490.4907	7616889.2330	9	1.8	falling	channel
			LW2-HMW01	LW2-HMW01-001-E	725109.6955	7617420.7472	9	1.8	rising	east
			LW2-HMW01	LW2-HMW01-002-E	725096.2397	7617408.5067	9	1.8	falling	east
			LW2-HMW01	LW2-HMW01-001-W	725906.2974	7616337.2681	8	1.8	rising	west
			LW2-HMW01	LW2-HMW01-002-W	725901.5942	7616335.9179	7	1.8	falling	west
04/04/06	<29,000	6.3	LW2-HMW03	LW2-HMW03-001-C	706119.3953	7624281.1149	8	1.9	rising	channel
			LW2-HMW03	LW2-HMW03-002-C	706120.6197	7624270.2138	8	2.1	falling	channel
			LW2-HMW03	LW2-HMW03-001-E	706501.7279	7624501.4206	7	1.9	rising	east
			LW2-HMW03	LW2-HMW03-002-E	706501.3909	7624506.7571	8	2.1	falling	east
			LW2-HMW03	LW2-HMW03-001-W	705683.0457	7624028.5994	9	1.8	rising	west
			LW2-HMW03	LW2-HMW03-002-W	705683.1730	7624020.1468	9	2.1	falling	west
04/04/06	<29,000	11	LW2-HMW04	LW2-HMW04-001-C	690102.1837	7642525.0915	8	2.1	rising	channel
			LW2-HMW04	LW2-HMW04-002-C	690107.6296	7642524.1304	9	2.2	falling	channel
			LW2-HMW04	LW2-HMW04-001-E	689784.8742	7642209.8672	8	2.1	rising	east
			LW2-HMW04	LW2-HMW04-102-E	690301.8370	7642736.8674	9	2.2	falling	east
			LW2-HMW04	LW2-HMW04-202-E[b]	690302.6549	7642737.8484	9	2.3	falling	east
			LW2-HMW04	LW2-HMW04-302-E[c]	690302.6549	7642737.8484	11	2.2	falling	east
			LW2-HMW04	LW2-HMW04-001-W	690298.0377	7642743.6438	12	2.0	rising	west
			LW2-HMW04	LW2-HMW04-102-W	689795.9499	7642217.0371	9	2.4	falling	west
			LW2-HMW04	LW2-HMW04-202-W[b]	689785.5972	7642202.9812	10	2.2	falling	west
			LW2-HMW04	LW2-HMW04-302-W[c]	689785.5972	7642202.9812	10	2.2	falling	west
04/03/06	<29,000	Multnomah Channel	LW2-HMW02	LW2-HMW02-001-C	719997.5289	7614816.7273	8	1.9	rising	channel
			LW2-HMW02	LW2-HMW02-002-C	720003.4937	7614816.5317	8	1.9	falling	channel
			LW2-HMW02	LW2-HMW02-001-E	720396.0370	7614846.2195	8	1.9	rising	east
			LW2-HMW02	LW2-HMW02-002-E	720392.9609	7614848.6009	7	1.9	falling	east
			LW2-HMW02	LW2-HMW02-001-W	719778.5360	7614805.6372	7	1.9	rising	west
			LW2-HMW02	LW2-HMW02-102-W	719783.4178	7614801.7639	9	1.8	falling	west
			LW2-HMW02	LW2-HMW02-202-W[b]	719790.9055	7614796.0088	9	1.9	falling	west
			LW2-HMW02	LW2-HMW02-302-W[c]	719790.9055	7614796.0088	10	1.8	falling	west

Notes:

[a] Daily mean discharge as measured by USGS Gauge No. 14211720 on the upstream side of Morrison Bridge, Portland, OR, RM 12.8.

[b] Field Replicate

[c] Field (Homogenate) Split

LWR - lower Willamette River
TOC - total organic carbon
TSS - total suspended solids
USGS - U.S. Geological Survey

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This document is currently under review by US EPA and its federal, state, and tribal partners, and is subject to change in whole or in part.

Table 3.5-1. Summary of Sediment Transport Characteristics, RM 0 - 26.

Reach ID	RMs	Estimated Average Cross-Sectional Area	Bathymetric Change 2001-2009[a]	Average Bed Shear (high flow)	Percentage Fine-Grained Surface Sediment Area[b]
Upriver	15.3 - 26	NA	NA	5.8 N/m^2	NA
Downtown Reach	11.8 - 15.3	34,000	Net deepening in areas of the main channel, primarily ≤ 30 cm ft; no change or small-scale deepening dominant in nearshore areas, primarily ≤30 cm; some limited nearshore depositional areas.	3.4 N/m^2	NA
Study Area	10 - 11.8	49,000	Nearly equal proportion of small scale deepening, shallowing, and no-change portions in nearshore area. Predominantly minor net deepening≤30 cm in the channel. Several feet of deposition in the deep areas (dredged holes/borrow pits) on western side of channel.	5.0 N/m^2	46
Study Area	9.2 - 10	63,000	A broad western portion of the channel shows widespread net deposition ranging from 60 to 150 cm. Areas of no change and scour occur along the eastern portion of the channel and nearshore area.	2.7 N/m^2	54
Study Area	6.9 - 9.2	68,000	Majority of reach is depositional. Some areas, e.g., center of channel from RM 6.9 to 7.7, Swan Island Lagoon, show little or no change. Deepening/scour due to anthropogenic factors such as dredging and propwash is evident in some berthing areas.	1.7 N/m^2 [c] 0.5 N/m^2 (Swan Island Lagoon)	60
Study Area	5.0 - 6.9	57,000	Mosaic of no change, net deepening (≤30 cm), and shoaling (low lying areas) in the channel. Sand wave migration evident in the channel from RM 5 to 6. Eastern nearshore generally shows scour; western nearshore sediment accumulation.	4.2 N/m^2	41

Table 3.5-1. Summary of Sediment Transport Characteristics, RM 0 - 26.

Reach ID	RMs	Estimated Average Cross-Sectional Area	Bathymetric Change 2001-2009[a]	Average Bed Shear (high flow)	Percentage Fine-Grained Surface Sediment Area[b]
Study Area	3.0 - 5.0	65,000	Main channel area shows widespread net seidment accumulation, mostly small-scale (≤30 cm), but more signficant accumluation along the east and west channel margins. Deepening in some nearshore areas appears to be due to anthropogenic factors such as dredging and propwash.	1.4 N/m^2	53
Study Area	1.9 - 3.0	68,000	Widespread shoaling up to and exceeding 60 cm in extent in channel and broad eastern nearshore area. Little or no riverbed elevation change west of the channel line.	0.7 N/m^2	57
Downstream	0.0 - 1.9	70,000	Some minor shoaling in channel and east of channel to RM 1; apparently natural deepening (to 60 cm) along western shoreline; more dynamic from RM 0 to 1.	1 N/m^2	50

Notes:

[a] Descriptions based on visual examination of 2002-2009 bathymetric change data shown on Map 3.4-5.

[b] Estimated based on silt and clay content from grain-size data in the Nature and Extent database.

[c] Outside of Swan Island Lagoon.

NA - not available
RM - river mile