EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY
FINAL INITIAL SOURCE EVALUATION AND DATA GAPS MEMORANDUM

For submittal to

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

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1,4-DCB	1,4-Dichlorobenzene
2LAET	second lowest apparent effects threshold
AET	apparent effects threshold
Anchor QEA	Anchor QEA, LLC
AQS	(EPA) Air Quality System
ARAR	Applicable or Relevant and Appropriate Requirements
ASAOC	Administrative Settlement Agreement and Order on Consent
AWQC	Washington State surface water marine ambient water quality criteria
BBP	butylbenzylphthalate
BEHP	bis(2-ethylhexyl)phthalate
BTEX	benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
City	City of Seattle
County	King County
CSL	Cleanup Screening Level
CSM	Conceptual Site Model
CSO	combined sewer overflow
DPM	diesel particulate matter
dw	dry weight
EBI	Elliott Bay Interceptor
Ecology	Washington State Department of Ecology
EISR	Existing Information Summary Report
EOF	emergency overflow
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
EW	East Waterway
EWG	East Waterway Group (Port of Seattle, City of Seattle, and King County)
FPM	fine particulate matter
FS	feasibility study
GIS	geographic information systems
HPAHs	high molecular weight polycyclic aromatic hydrocarbons
I-5	Interstate 5
ICP/MS	inductively coupled plasma mass spectrometer

KCIA	King County International Airport
LAET	lowest apparent effects threshold
LC50	Lethal concentration for 50 percent of a test population
LDW	Lower Duwamish Waterway
LOAEL	lowest observed adverse effect level
LPAHs	low molecular weight polycyclic aromatic hydrocarbons
LUST	leaking underground storage tank
MDL	method detection limit
MTCA	Model Toxics Control Act
NAPL	nonaqueous phase liquid
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTR	National Toxics Rule
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Port	Port of Seattle
ppt	parts per thousand
PRGs	preliminary remediation goals
PSCAA	Puget Sound Clean Air Agency
PSD	particle size distribution
PSDDA	Puget Sound Dredged Disposal Analysis
PSMAF	Puget Sound Maritime Air Forum
QA	quality assurance
QA/QC	quality assurance/quality control
RI	remedial investigation
RM	River Mile
ROD	Record of Decision
ROW	right-of-way
SCE	Source Control Evaluation
SCEAM	Source Control Evaluation Approach Memorandum
SD	storm drain
SMS	Sediment Management Standards

SPU	Seattle Public Utilities
SQS	Sediment Quality Standards
SRI	Supplemental Remedial Investigation
SRI/FS	Supplemental Remedial Investigation/Feasibility Study
STE	Sediment Transport Evaluation
SVOC	semivolatile organic compound
TOC	total organic carbon
TPH	total petroleum hydrocarbons
tpy	tons per year
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VCP	(Washington State Department of Ecology) Voluntary Cleanup Program
VOC	volatile organic compound
Windward	Windward Environmental, LLC
WSDOH	Washington State Department of Health
WW	West Waterway

1 INTRODUCTION

This Initial Source Evaluation and Data Gaps Memorandum (Memorandum) has been prepared on behalf of the Port of Seattle (Port) and the cooperating parties participating in the cleanup evaluation for the East Waterway (EW) Operable Unit (OU). These cooperating parties include the City of Seattle (City) and King County (County) and, together with the Port, they have formed the East Waterway Group (EWG). The EWG is supporting the Port on the preparation of the Supplemental Remedial Investigation and Feasibility Study (SRI/FS) for the EW, as required under the Administrative Settlement Agreement and Order on Consent (ASAOC) and Statement of Work (SOW; EPA 2006) between the Port and the U.S. Environmental Protection Agency (EPA).

This Memorandum is part of a series of deliverables intended to address the EPA's Source Control Evaluation (SCE) requirements for the SRI/FS. The overall SCE requirements were defined in the SRI/FS Workplan (Anchor and Windward 2007). The evaluation is specifically focused on EW sources that may be ongoing and that could potentially cause or contribute to future sediment recontamination within the waterway after cleanup actions are completed.

Specific details on the approach for source control are described in the EPA-approved Source Control Evaluation Approach Memorandum (SCEAM; Anchor and Windward 2008a). This Memorandum has been prepared in general accordance with the SCEAM. Existing information potentially relevant to the SCE was described in the Existing Information Summary Report (EISR; Anchor and Windward 2008b).

1.1 Project Background

The EW is bound on the west shore by Harbor Island and on the east shore by multiple properties, the largest of which are Terminal 25 (T-25) and Terminal 30 (T-30). The southern boundary of the EW is approximately in line with the southern end of Harbor Island, and the northern boundary extends from the northern end of Harbor Island to just north of Slip 36 (on the east side of the EW) (Figure 1-1).

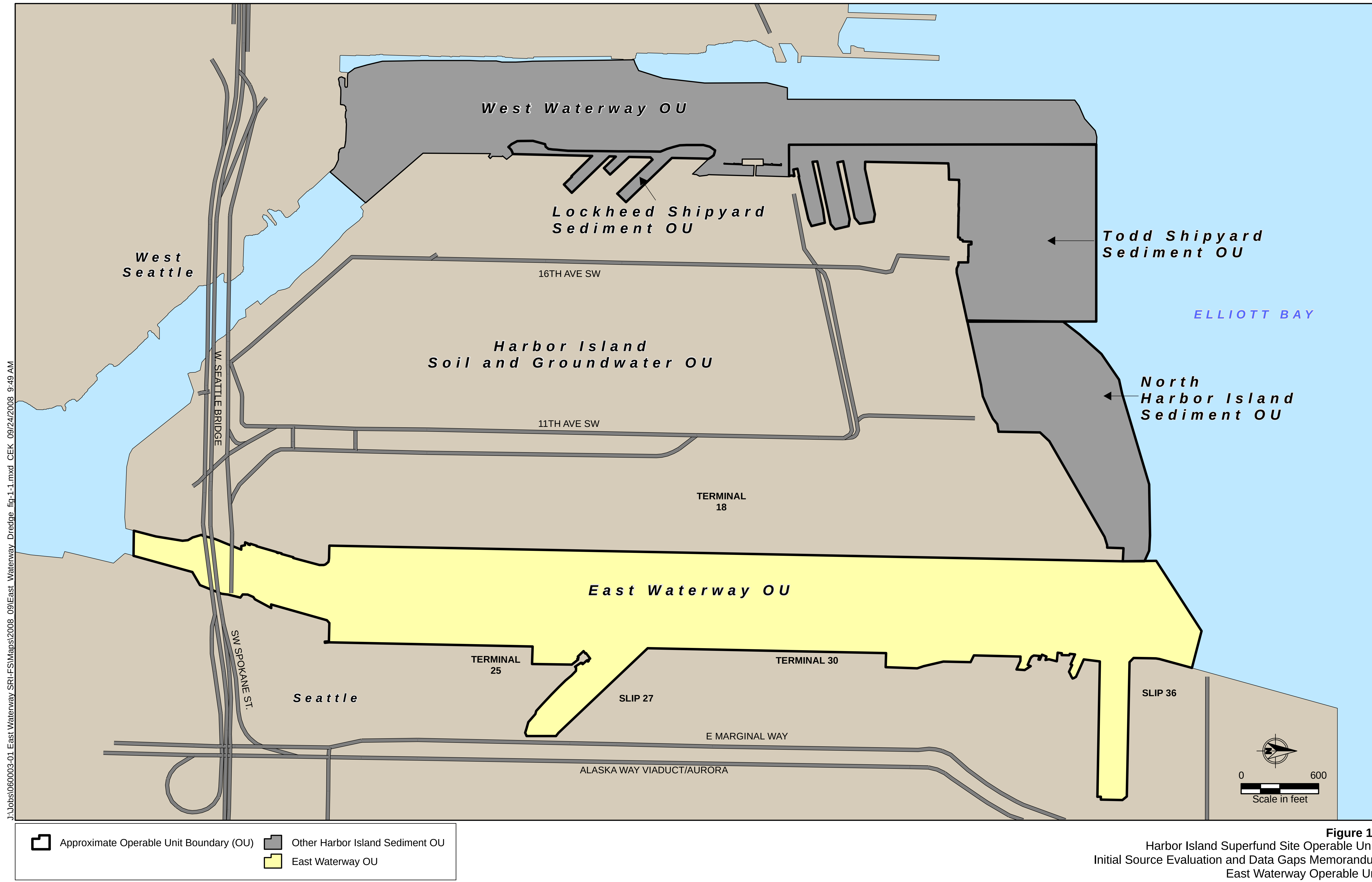

Figure 1-1
Harbor Island Superfund Site Operable Units
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The EW has been identified as an OU of the Harbor Island Superfund Site. The Soil and Groundwater OU encompasses a majority of the Harbor Island shoreline along the west side of the EW site and addresses the cleanup of soil and groundwater within that OU.

SRIs were carried out for Harbor Island OU sediments under previous ASAOCs with EPA, beginning in 1994. Three marine sediment OUs, which have already received Records of Decision (RODs), were separated from the Harbor Island Marine Sediment OUs. The North Harbor Island Sediment area of interest was separated from the Harbor Island Sediment OU, leaving the EW Sediment OU as the only unfinished sediment OU. The current work in the EW is to establish a cleanup decision for the OU.

The EISR (Anchor and Windward 2008b) provided a discussion of previous sediment dredging and remediation activities, previous environmental investigations, information related to completed and current EW source control activities, figures illustrating the EW and vicinity (including EW stormwater and combined sewer drainage areas and locations of nearshore cleanup sites), and other relevant information.

1.2 Document Organization

The content of the current Memorandum is consistent with the SCEAM (Anchor and Windward 2008a). This Memorandum uses existing source characterization data, including data presented in the EISR (Anchor and Windward 2008b) and certain other data obtained subsequent to completion of that document, to perform an initial evaluation of potential sources of sediment recontamination in the EW. Data gaps relevant to the SRI/FS SCE are then defined. The document is organized as follows:

- **Section 2**: Presents the goals of the SCE, and identifies the types of sources and the general data needs that are the subject of this Memorandum.
- **Section 3**: Identifies the different lines of evidence that may be used to characterize the locations, quantity, and quality of ongoing source inputs to the EW, and reviews existing sediment and recontamination monitoring data to identify a preliminary list of chemicals that warrant focused analysis during the SCE.
- **Sections 4 through 8**: Present the existing data, ongoing data collection activities, and remaining data gaps for each of the source types that are the primary subject of this Memorandum, including stormwater, combined sewer overflows (CSOs),

nearshore cleanup sites, atmospheric deposition, and spills, respectively. Waterway areas with remaining creosote-treated pilings and structures are also identified as part of Section 6.

- **Section 9:** Presents a summary of ongoing data collection activities and data gaps for the EW SRI/FS.
- **Section 10:** Lists references that are cited in this Memorandum.

2 SOURCES CONCEPTUAL MODEL

This section presents the goals of the SRI/FS SCE process, and describes the types of ongoing sources that may be relevant to the EW Conceptual Site Model (CSM). The different lines of evidence that may be used to support the SCE process (i.e., to characterize the locations, quantity, and quality of source inputs to the EW) are then discussed in Section 3.

2.1 Goals of the Source Control Evaluation

The overall goal of the EW SRI/FS SCE is to understand the potential for sources to cause future sediment recontamination after completion of remedial actions within the EW. Specific goals of the evaluation were defined in the SRI/FS Workplan (Anchor and Windward 2007). Those goals included the following:

1. Identifying potential sources of contamination to EW sediments
2. Understanding the potential for these sources to recontaminate the EW sediments
3. Assessing the role of ongoing sources on the CSM for the EW
4. Defining a process for identifying source control data gaps relevant to SRI/FS conclusions, and identifying a process for collecting relevant field data, if necessary
5. Providing a basis for evaluating recommendations for managing sources through efforts such as inspections, investigation, or other actions and identifying the processes and authorities for source control activities to continue post-ROD in the EW area
6. If applicable, a prediction of potential recontamination and its effect on a cleanup decision

Table 2-1 provides a concise summary of how these six evaluation goals are being addressed during the SRI/FS. The table documents the key SRI/FS deliverables in which the goals are addressed, consistent with the process defined in the SRI/FS Workplan (Anchor and Windward 2007) and in the SCEAM (Anchor and Windward 2008a). The SCE activities are being coordinated with ongoing source identification and source control activities being performed by EWG members and regulatory agencies.

This Memorandum most directly supports Goal 4, by identifying source control data gaps relevant to SRI/FS conclusions, and by discussing how data needed for the completion of the SRI/FS SCE are to be collected.

Table 2-1
Relationship Between EW SRI/FS Deliverables and the Goals of the Source Control Evaluation

	Goals of SRI/FS SCE	Role of Key SRI/FS Documents in Addressing Source Control Evaluation Goals								Relevant Activities in Ongoing Source Control Programs (by EWG or Others)
		SRI/FS Workplan [1]	EISR [2]	SCEAM [3]	This Data Gaps Memorandum [4]	STE Report [5]	SRI Report [5]	FS [5]	Description	
1	Identify potential sources of contamination to EW sediments		X		X		X		The EISR and this Data Gaps Memorandum inventory potential sources of sediment recontamination for further evaluation during the SRI/FS. The SRI will contain the information compiled for each source.	EWG members and regulatory agencies maintain ongoing source identification and source control programs as described in the Workplan and EISR.
2	Understand the potential for these sources to recontaminate the EW sediments						X	X	The SRI will summarize characterization data available for each source. These data will then be used in the FS to assess the potential of each source to sediment recontamination.	
3	Assess the role of ongoing sources on the CSM for the EW					X	X		The STE report will describe how solids inputs from ongoing sources affect the physical CSM. The SRI report will summarize the updated CSM, including a review of available characterization data for each source category.	
4	Define a process for identifying source control data gaps relevant to SRI/FS conclusions, and identify a process for collecting relevant field data, if necessary	X		X	X				The SRI/FS Workplan and the SCEAM define the process for the SRI/FS SCE. This Data Gaps Memorandum identifies data gaps relevant to the SRI/FS and discusses how those gaps are being addressed to support the SRI/FS evaluation.	Some SRI/FS SCE data gaps are being addressed by ongoing source characterization work performed by EWG members.
5	Provide a basis for evaluating recommendations for managing sources through efforts such as inspections, investigation, or other actions and identify the processes and authorities for source control activities to continue post-ROD in the EW area							X	The recontamination predictions contained in the FS will provide a point of reference that may assist source control leads within the EWG or regulatory agencies with their ongoing control programs in evaluating what types of source control measures may reduce potential recontamination risks basis (e.g., by targeting particular chemicals or drainage areas) to determine the magnitude of source control needs which will allow the source control programs to assess activities that may be relevant to managing potential sources of sediment recontamination.	Source control programs and authorities will continue post-ROD. Where applicable, these may be used to manage potential sources of sediment recontamination.
6	If applicable, predict potential recontamination and its effect on a cleanup decision							X	The FS will develop recontamination predictions based on data available at the time of the SRI. The FS will discuss how potential sediment recontamination could affect the cleanup decision for EW sediments.	

Notes:

This table provides summary information only. Refer to the referenced documents for further detailed information.

1. Final Supplemental Remedial Investigation/Feasibility Study (SRI/FS) Workplan dated July 2007
2. Existing Information Summary Report (EISR) dated March 2008 .
3. Final Source Control Evaluation Approach Memorandum (SCEAM) dated June 2008.
4. Refer to Section 3 of the current Memorandum for a discussion of the types of data relevant to the SRI/FS Source Control Evaluation (SCE), and to Sections 4 through 9 for a discussion of the existing data, gaps in the data relevant to the SRI/FS SCE, and how those data gaps are being addressed.
5. The Sediment Transport Evaluation (STE) report, SRI report, and FS are future deliverables to be prepared consistent with the SRI/FS Workplan.

2.2 Types of Sources and Pathways Evaluated

The EISR (Anchor and Windward 2008b) summarized existing information and source control efforts related to a comprehensive list of ongoing sources and pathways potentially relevant to the CSM and the evaluation of sediment recontamination. Historical sources are assessed primarily through the SRI/FS analysis of existing surface and subsurface sediment contamination within the EW. In contrast, the SCE is focused primarily on potential current and ongoing sources that may result in recontamination of EW sediments following the final sediment cleanup decision.

The general source/pathways categories applicable to industrial rivers/estuary systems are shown in Figure 2-1. Those that are the focus of this Memorandum include the following:

- **Stormwater Discharges:** Municipal and private storm drains have been installed in urban areas to collect and convey stormwater runoff or snowmelt runoff from developed areas to surface water discharge points. These discharge points can include outfalls, as well as sheet flow discharge points (especially at EW bridges and any adjacent uplands without drainage systems such as terminal aprons). Stormwater can entrain pollutants from the atmosphere, and can become contaminated through contact with pollutants on the ground. Stormwater discharges are regulated by local and state authorities. City code (SMC 22.800) covers stormwater discharges in Seattle and includes requirements for pollution source control, as well as treatment for new and redevelopment projects. Washington State National Pollution Discharge Elimination System (NPDES) stormwater permits cover municipal stormwater discharges and certain industrial stormwater discharges. NPDES permits include requirements relating to pollution prevention and monitoring.
- **Combined Sewer Overflows:** Combined sewer systems carry both stormwater and residential/commercial/industrial wastewater in a single pipe. Under normal conditions, stormwater and wastewater are conveyed to King County's West Point Wastewater Treatment Plant for treatment and disinfection prior to discharge to Puget Sound. However, during large storm events, the volume of stormwater runoff can exceed the pipe capacity. Therefore, combined sewer systems are equipped with an overflow structure to prevent stormwater and wastewater from backing up into homes and businesses by allowing flow from these large storm events to be

discharged directly to the waterway. During a combined sewer overflow event, a mixture of untreated stormwater and residential/commercial/industrial wastewater is discharged directly to the receiving water body. CSO structures are regulated by state NPDES permits. City and County CSO control programs are intended to ultimately reduce overflow discharge frequency and severity.

- **Emergency Sewer Overflows:** Some sewer components include other permitted emergency overflow (EOF) structures that can, under certain emergency conditions, discharge stormwater and wastewater to the EW. These structures are discussed further in Section 4.2.1 of this Memorandum.
- **Cleanup Sites:** In some cases, contaminated sites requiring or undergoing cleanup (cleanup sites) can result in recontamination of adjacent sediments through one of three mechanisms. All three mechanisms are relevant for cleanup sites located in nearshore areas. The third mechanism is also relevant to cleanup sites located in areas distant from the EW. First, where the shoreline or non-armored banks are actively eroding, contaminated soils may enter the water body directly, potentially resulting in localized areas of sediment contamination. At most locations within the EW, the existing sea walls and armoring of shorelines minimize the potential for this type of contamination by controlling shoreline erosion (additional evaluations of bank stability will be completed as part of the SRI). The second potential mechanism is the discharge of contaminants via groundwater, either as dissolved contaminants or as product seeps in locations where nonaqueous phase liquids (NAPLs) may be present in proximity to the shoreline. The third mechanism by which cleanup sites can affect sediment quality is through discharge of soil-adsorbed pollutants through overland flow, into stormwater, or through seepage of contaminated groundwater into damaged storm drainage systems.

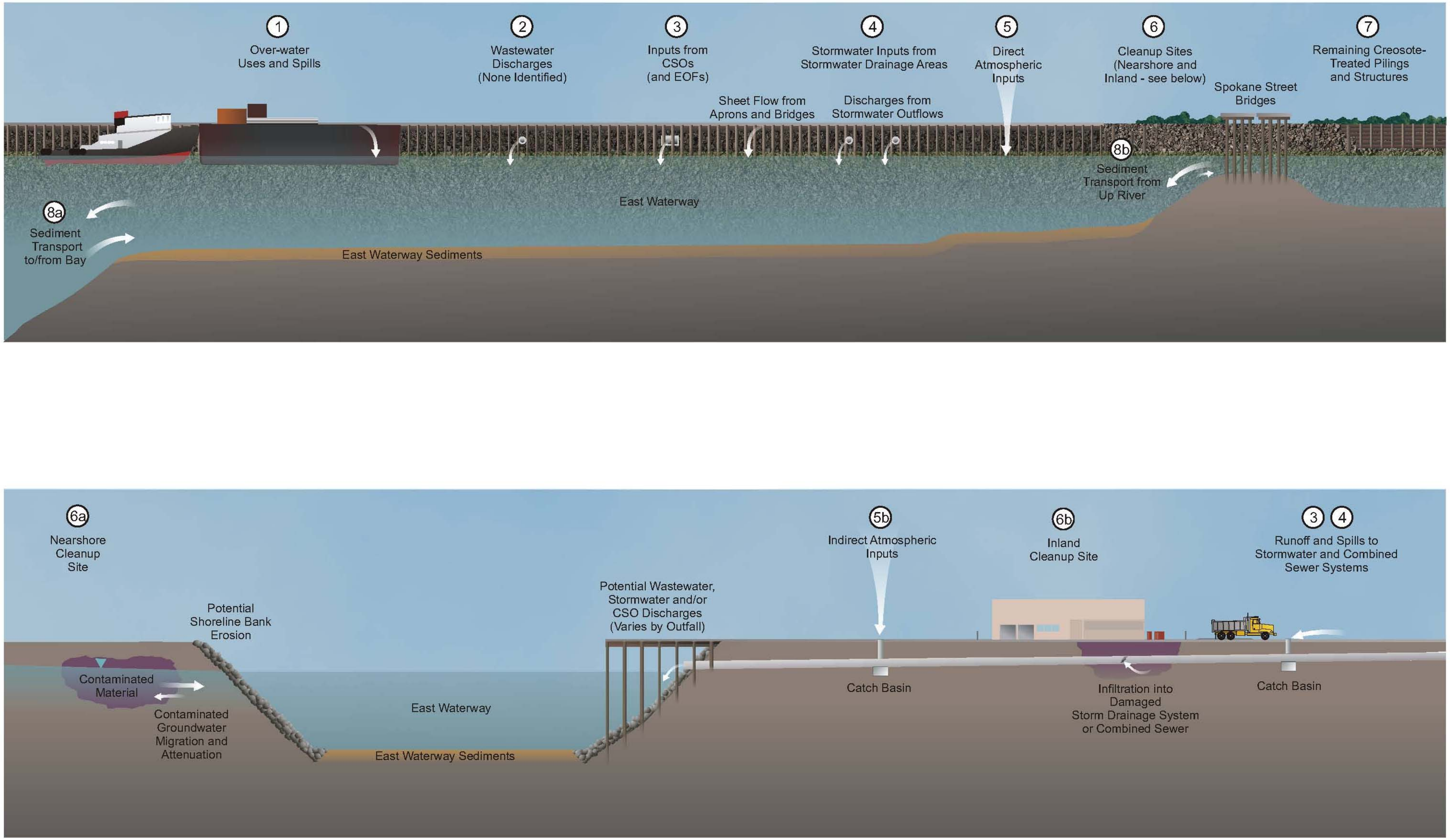

Figure 2-1
Types of Potential Ongoing Sources and Transport Pathways Evaluated
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East Waterway Operable Unit

- **Atmospheric Deposition:** Airborne pollutants can reach sediments through the deposition of airborne particulate matter directly onto the water or onto surfaces within the drainage basin. This can occur directly (e.g., settling of dust onto the water body or entrainment of dust into precipitation that falls on the water body) or indirectly (e.g., transport of atmospheric contaminants to the water body through stormwater).
- **Over-water Uses and Spills:** Sediment contamination can occur through direct discharge of pollutants to the water body from over-water uses and spills. The potential for spills and unintentional discharges from over-water uses have been generally reduced through improved material and cargo handling technologies and methods; centralizing of fuel/product transfers at specialized and controlled facilities; spill contingency planning and spill prevention and countermeasure regulations managed by various federal, state, and local regulatory programs; and pollution control measures implemented by industries. These measures require reporting of spill events and implementation of cleanup measures after spills are reported.
- **Creosote-Treated Structures:** Historically, creosote-treated pilings and wooden structures were commonly used as part of navigation (e.g., pier and wharf structures, fender systems, and dolphins) and structural improvements (e.g., wooden bulkheads). Some of the creosote within such structures can be released to sediments through abrasion or leaching. Wooden creosote-treated sources are largely historical, because the installation of new creosote-treated structures is restricted by permitting requirements, and most creosote-treated structures have been removed from the waterway during waterfront facility upgrades. The types and locations of remaining creosote-treated pilings and structures are shown on Figures 6-2 and 6-3 in this Memorandum.

In addition to the above-listed source categories, wastewater discharges and sediment transport can be significant to sediment recontamination. The term “wastewater” is used here to describe industrial or other discharges that are not part of a CSO or stormwater discharge. Currently, based on a database survey conducted in support of the EISR (Anchor and Windward 2008b), there are no reported permitted municipal or industrial wastewater outfalls within the EW. An updated database search will be conducted as part of the SRI. If new wastewater sources are identified, then information regarding the location, quantity, and quality of the wastewater inputs will be obtained based on available permit and monitoring data for the identified sources.

Sediment transport in the EW is being evaluated as part of the SRI/FS, consistent with the SRI/FS Workplan (Anchor and Windward 2007) and the Sediment Transport Evaluation Approach Memorandum (STEAM; Anchor and Battelle 2008). The STE addresses sediment resuspension, transport, redeposition, and accumulation, which can result through a combination of processes. Sediments can be disturbed, resuspended in the water column, and then carried by currents and waves to redeposit in new locations. For the EW, sediment transport includes consideration of transport of upriver sediments into the EW from the Green/Duwamish River system, from the Lower Duwamish Waterway (LDW), or inshore from Elliott Bay during flood tides. Similarly, sediments could potentially be transported from the EW to Elliott Bay. The STE findings will be summarized in the SRI report, and will provide an understanding of the physical transport processes. The implications of such transport on sediment recontamination will be documented as part of the recontamination predictions to be prepared in the FS. The coordination of the SCE with the STE is further discussed in Section 3.

2.3 Data Useful for Evaluating Recontamination Potential

This Memorandum is intended to evaluate existing data and to identify any potential data gaps specifically relevant to the SCE being performed in coordination with the SRI/FS. Table 2-2 complements Figure 2-1 and provides a concise summary of how pollutants from each source can potentially enter the EW. Understanding the locations, quantity, and quality of these potential pollutant inputs is necessary to permit the completion of the SCE and to develop estimates of potential sediment recontamination.

Table 2-2
Summary of Sources and Potential Transport Pathways to the East Waterway(1, 2)

Source	Stormwater	CSOs	Wastewater	Cleanup Sites [3]	Atmospheric Deposition	Spills [4]	Creosoted Structures [5]	Sediment Transport [6, 7]
Source & Pathway Description	Runoff from roadways and upland activities (industrial, commercial, residential, and transportation) that deposit pollutants on the land surface	Discharges of stormwater, wastewater, and entrained pollutants from properties and right-of-ways within combined sewer service areas	Not applicable [8]	Releases to soils and groundwater at cleanup sites	Local, regional, and global air emissions	Spills from hazardous material uses over and adjacent to the EW	Creosote-treated pilings and structures within the EW	Suspended sediments and associated pollutants from upstream areas (e.g., LDW) and from Elliott Bay
Transport Pathways	Movement of stormwater and solids through storm drainage conveyances and via sheet flow	Movement of combined sewer effluent and solids through system conveyances	Not applicable [8]	Groundwater migration toward and through the EW nearshore areas; potential leakage into damaged storm drain or sewer lines; or erosion of unstable banks[9] at nearshore cleanup sites	Movement of air and entrained particulates and chemicals within EW airshed; stormwater runoff	Spills direct to the EW and overland flow from spills to adjacent properties	Release of creosote via abrasion/ damage or by leaching	Transport of suspended sediments by river flows and tidal currents
Point of Initial Entry to EW	Discharge of stormwater and solids to the EW at storm drain outfalls and by sheet flow from bridges and terminal aprons	Discharge to the EW at CSO outfalls during CSO discharge events	Not applicable [8]	Discharge of nearshore groundwater to sediments or to the EW in seeps; discharges of groundwater at stormwater or CSO outfalls; or unstable bank erosion at nearshore cleanup sites	Direct deposition of chemicals onto the EW surface; and discharge at outfalls that convey stormwater to the EW	Direct entry to the EW at the spill location; or indirect entry via storm drain or CSO outfalls	Locations of remaining creosote-treated pilings and structures within the EW [5]	Movement of suspended sediments into the EW and potential deposition onto the EW sediments

Notes:

1. This table provides a concise summary of each source type under evaluation, including the transport pathways by which source-associated materials may be transported to and enter the EW. As described in Section 3, different lines of evidence are appropriately used to identify the locations, quantity, and quality of solids and pollutant inputs to the EW as necessary to support the evaluation of potential sediment recontamination.
2. Sanitary sewer systems (pump stations) also include emergency overflow (EOF) structures at two locations that may discharge to the EW under certain circumstances. EW discharge locations from EOFs are identified in Section 4.2.1 of this Memorandum.
3. Groundwater from upland cleanup sites may contribute groundwater to some stormwater or combined sewer conveyances.
4. Spills to upland properties may contribute chemicals to stormwater or combined sewer conveyances.

5. Most creosote-treated pilings and structures have been removed from the EW. Remaining creosote-treated structures are identified in Figures 6-1 through 6-3 of this Memorandum.
6. Refer to the CSM and Data Gaps Analysis Report (Anchor, Windward and Battelle 2008) for a summary of physical hydrodynamic processes and natural sediment transport processes that may affect sediment transport within the EW. Sediment transport processes (including both the potential movement of sediments into the EW and the potential disturbance of sediments already within the EW) are the subject of the STE; the results of which will be summarized in the STE report and the SRI report.
7. In addition to evaluating sediment transport processes that may introduce new solids and chemicals into the EW, the STE also evaluates the resuspension of sediments and associated chemicals that may occur within the EW, due to factors such as propeller wash.
8. No permitted wastewater discharges to the EW (other than stormwater and CSO discharges) were identified during an information review conducted as part of the EISR (Anchor and Windward 2008b). An updated information review will be conducted and summarized as part of the SRI report.
9. Most EW shorelines are armored. Areas of potentially unstable shorelines (e.g., those that are not armored) will be documented in the SRI report along with any information regarding the quality of sediments and bank soils in these areas.

Identification of source inputs to the EW can be conducted using a variety of characterization approaches. The use of different lines of evidence is appropriate to characterize different types of sources and develop the location, quantity, and quality information for source inputs needed for the SCE. No single approach can uniformly address the different characterization needs of disparate source types. Multiple lines of evidence, which incorporate a variety of sampling and investigation techniques, may be appropriately applied as part of the overall source characterization effort.

Because the factors that influence the fate and transport of solids and associated chemicals within the EW itself can be complex, it is important to consider the characterization data for each source along with the sediment transport processes and sediment sampling data (surface and subsurface) for the receiving water body. The sediment transport processes within the EW may significantly affect whether and to what extent a source input results in sediment recontamination. In some cases these processes, including sediment transport, initial settling, resuspension, and redistribution, may significantly affect recontamination potential. Section 3 discusses the data needs associated with the EW SRI/FS SCE, and how the source information are to be evaluated as part of the STE, SRI, and FS.

One of the limitations of any empirically-based source control evaluation is uncertainty in the ability to estimate potential recontamination from future pollutant sources that do not exist at this time (e.g., new waterfront industrial uses or potential future wastewater discharges to the EW) or potential reductions in current source concentrations or volumes. The discussion of contaminant sources in the SRI report and the analysis of recontamination potential in the FS will acknowledge this limitation, and will discuss how existing regulatory authorities and source control programs affect or may be affected by such changes in area land uses.

3 EVALUATION METHODS

This section provides an introduction to the different lines of evidence that may be used to address the data needs for the SRI/FS SCE, and identifies chemicals that warrant focused study based on the results of previous surface sediment data (i.e., available from previous studies prior to the SRI/FS) and recontamination monitoring data within the EW. Detailed discussions of data needs for the different types of sources are then provided in Sections 4 through 8.

3.1 Coordination of SRI/FS and Source Control Evaluation

As described in the SCEAM (Anchor and Windward 2008a), the SCE is closely coordinated both with the SRI/FS and with source control programs conducted under non-Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) authorities by EWG members and other parties. Figure 3-1 supplements Table 2-1 and illustrates the relationship between the SCE, including the current Memorandum, and planned SRI/FS activities. Key linkages between the SCE and other SRI/FS or source control activities include the following:

- **Sediment Transport Evaluation:** The STE provides an understanding of where source-related suspended solids may initially distribute upon entering the EW, and provides a basis for understanding sediment transport and mixing processes that may affect sediment recontamination potential. The SCE process provides data inputs (e.g., quantities and characteristics of suspended solids discharged to the EW) that are required by the STE.
- **Supplemental Remedial Investigation and Feasibility Study:** The SCE data are intended to fulfill information needs of the SRI/FS related to the characterization of ongoing sources that may affect sediment recontamination potential. The SRI will define the risk thresholds. The FS will define the preliminary remediation goals (PRGs) against which recontamination processes will be measured. Recontamination estimates will be developed in the FS, integrating the results of the SCE, the STE, and the SRI. The FS will include an analysis of the significance of sediment recontamination to the EW cleanup decision.
- **Ongoing Source Control Activities:** As described in the SCEAM (Anchor and Windward 2008a), the SCE process considers existing and newly generated data developed as part of multiple ongoing source control programs conducted by individual EWG members and other parties under non-CERCLA authorities. Where

existing and ongoing data collection activities are insufficient to meet the needs of the SCE, additional sampling activities may be recommended. Additional sampling activities may be conducted by EWG members or coordinated group action if critical for addressing SRI/FS data gaps or for better understanding potential recontamination mechanisms for EW sediments.

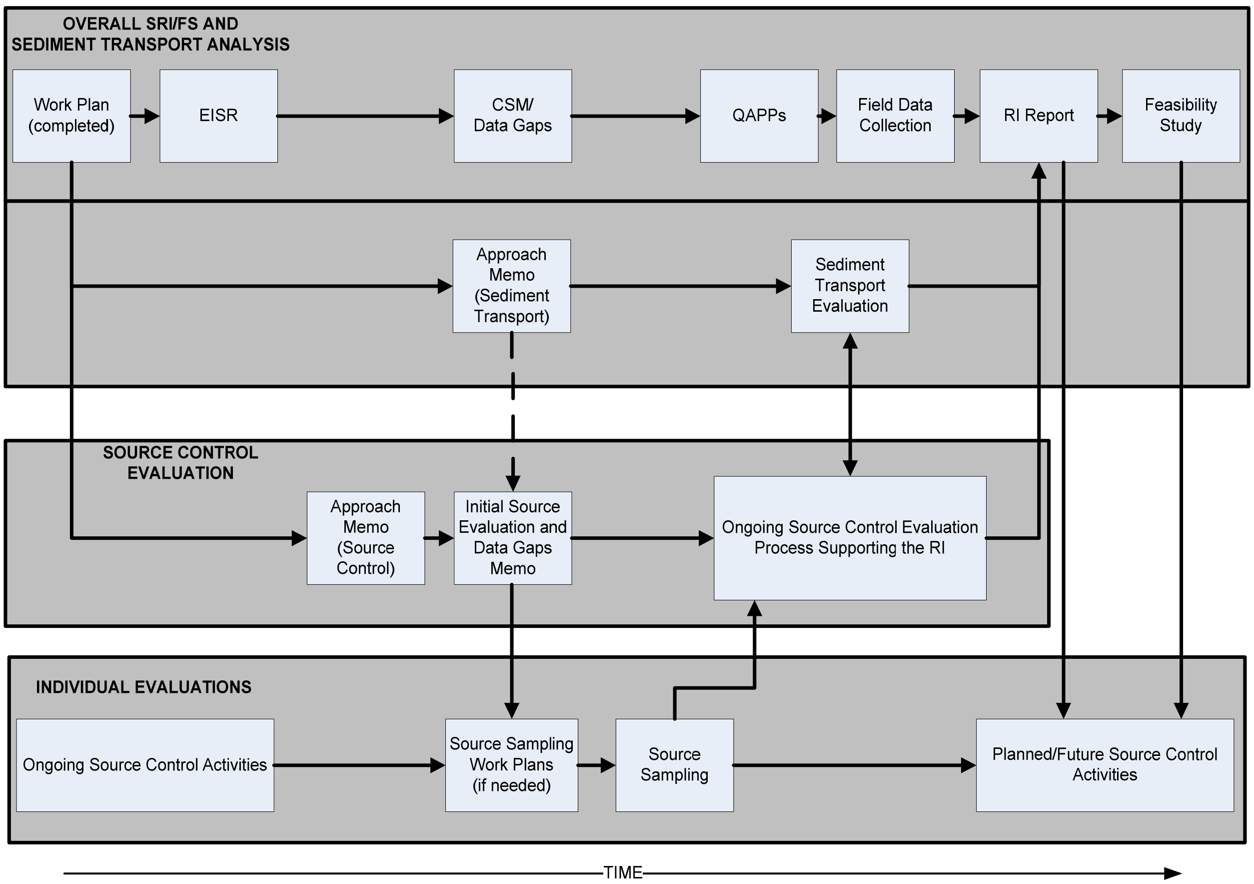


Figure 3-1 Source Control Evaluation and Relationship to East Waterway SRI/FS Activities

Notes:

EISR: Existing Information Summary Report – A large amount of work has already been conducted to characterize conditions in the EW and the status of source control efforts. This information, together with newly-identified data, was compiled in the EISR (Anchor and Windward 2008b).

STEAM: Sediment Transport Evaluation Approach Memorandum – The SRI activities included development of an approach memorandum for sediment transport and associated physical processes. The STEAM (Anchor and Battelle 2008) and related deliverables design information needs associated with source-related inputs including SD and CSO discharges, and other inputs.

Work Plans: Work Plans exist for some ongoing data collection activities and new ones may need to be prepared, including appropriate sampling and quality assurance procedures, for new sampling efforts intended to fill identified data gaps. It is anticipated that each field study used to fill a data gap will result in draft and final data reports. Work Plans or Sampling Plans for source control-related field work or modeling will be developed and implemented by the EW source control team members.

3.2 Source Control Data Needs and Lines of Evidence

Table 3-1 provides an introduction to the different lines of evidence that may be used to satisfy the information needs for the SRI/FS SCE. The table describes potential lines of evidence for each of six source/pathway categories discussed in Section 2.2—stormwater, CSOs, cleanup sites (including groundwater transport and bank erosion), atmospheric deposition, creosote structures, and spills.

Lines of evidence for wastewater discharges are not presented in Table 3-1 because there are no reported industrial or other wastewater discharges (an additional database search will be conducted as part of the SRI to verify that conditions have not changed). Data needs relevant to the evaluation of sediment transport processes are only partially discussed in Table 3-1 because these information needs are being addressed through the STE process under the SRI/FS.

Table 3-1 discusses the specific types of data that may be used to satisfy the information needs for each source category. In many cases, the data may be developed from multiple lines of evidence:

- **General Source Characterization Needs:** For each of the source/pathway categories, it is necessary to describe the locations of inputs to the EW, and to define the quantity and quality of these inputs. These information needs are common to all five of the source/pathway categories, though the specific methods of data collection vary with type. Further information on the lines of evidence to be used to characterize each potential input is provided in Sections 4 to 8 of this document.
- **Sediment Transport Data Needs:** For sources/pathways that may introduce significant quantities of sediment/solids into the EW, additional information is required to support the STE analysis of physical transport properties of these solids once they enter the EW. This case applies primarily to stormwater and CSOs. The data needs are introduced in Table 3-1 and are further discussed in Sections 4 through 8 of this Memorandum. For information regarding other data needs for the STE (those not specifically related to potential ongoing contaminant sources), please refer to the STEAM (Anchor and Battelle 2008).

- **Data from Ongoing Source Control Programs:** Ongoing source control programs involve inspections, source-tracing activities, and other source control activities that are beyond the scope of the SRI/FS analysis of sediment recontamination potential. However, some source control activities may generate data potentially useful to the SRI/FS (e.g., chemical sampling within localized portions of a drainage system under evaluation). Types of source control activities that have been reviewed for potentially relevant data are listed in Table 3-1.

As discussed in the SCEAM (Anchor and Windward 2008a), the information needs for the SCE may be satisfied using a combination of site-specific and surrogate data. Considerations of the applicability of the source characterization data set must be taken into account both when using site-specific data (i.e., data generated within the drainages or airsheds of the EW) and when using surrogate data (i.e., datasets generated outside of the drainage basins or airsheds of the EW).

Table 3-1
Information Needs and Lines of Evidence
East Waterway SRI/FS Source Control Evaluation (1)

Information Need and SRI/FS Application	Lines of Evidence Used to Satisfy Information Needs					
	Stormwater Discharges (Section 4)	**CSO Discharges (Section 5)**	**Cleanup Sites (Section 6)**	**Creosote-Treated Structures (Section 6)**	**Atmospheric Deposition (Section 7)**	**Spills (Section 8)**
General Source Characterization Data Needs						
Source Descriptions – Information describing the source and useful for evaluating source-specific data needs	Locations and characteristics (e.g., drainage basin boundaries, land use, types of sources present, and condition of the drainage system such as extent of sewer separation) of storm drain basins	Locations and characteristics of combined sewer service areas associated with EW CSO discharges	Information identifying the location and type of cleanup sites, and the status of cleanup activities at nearshore and distal cleanup sites. More detailed information will be developed for nearshore cleanup sites to assess groundwater and bank erosion pathways.	Locations, types, and ongoing uses of creosote-treated pilings or structures in or adjacent to the EW	Information about the airshed and local monitoring stations that may provide relevant monitoring data for the EW	Recent reported releases of hazardous materials to the EW
Location data – Definition of pathways by which source materials can reach the EW sediments	Locations of storm drain outfalls and sheet flow discharge within the EW. For larger drainage systems, information on drainage patterns and sub-basins	Locations of CSO discharge outfalls within or immediately adjacent to the EW	Locations of cleanup sites relative to drainage infrastructure. Information on groundwater gradients and potential migration pathways between cleanup areas and the EW. Soil and sediment quality data in areas of potentially erodible shorelines	Locations of creosote-treated structures relative to the EW sediments and sediment data	Estimates of the exposed surface of the EW for use in estimating the inputs associated with direct atmospheric deposition)	Spill locations (especially for larger spills)
Quantity Information – Data used to estimate the volume of discharge and the quantity of solids associated with the discharge from the source pathway to the EW	Estimates of typical stormwater runoff quantities and associated stormwater solids loads for each of the basins or outfalls	Estimates of the typical quantity and frequency of CSO discharges and estimates of the quantities of associated suspended solids	Hydrogeologic properties useful for estimating net groundwater flow rates or that may affect the mixing or attenuation of groundwater prior to entry into the EW	Condition of creosote-treated structures, including factors that may limit potential EW inputs (e.g., piling wraps; planned removals)	Flux values or flux correction factors useful for evaluating the rate of deposition for specific contaminants (flux of total particulates to the EW may not correlate with individual contaminants)	Records describing quantities of spilled materials discharged directly to the EW
Chemical Quality Data – Information on the chemical quality of source material discharged to the EW	Ranges of chemical concentrations in stormwater solids entering the EW including data collected at the point of discharge as well as data collected within the storm drain system (e.g., catch basins/maintenance holes located within the right-of-way and upland properties)	Ranges of chemical concentrations in CSO discharges or CSO solids entering the EW, including analyses of CSO effluent and sediments from within the combined sewer lines	Testing data for nearshore groundwater quality (data may be collected from nearshore sampling locations or from locations along the groundwater transport pathways, depending on the site)	Review of SRI/FS sediment quality data in the vicinity of creosote-treated structures	Chemical quality data for atmospheric deposition (data may be collected using air deposition studies or using air quality data)	Data or descriptions of the type of materials spilled directly to the EW
Additional Information Needs for Sediment Transport Evaluation [2]						
Particle Size Distribution – Size distribution data for suspended solids that may be discharged to the EW (particle size affects settling rate and sediment transport properties)	Estimates of particle size distribution for stormwater suspended solids	Particle size distribution estimates (available from settling rate measurements) for suspended CSO solids	Not applicable (groundwater is not a significant source of suspended solids) [2]	Not applicable (creosote-treated structures are not a significant source of suspended solids) [2]	Not applicable (atmospheric deposition is not a significant source of suspended solids) [2]	Not applicable to spills of liquids. Potentially applicable to large-quantity spills of solid materials [2]
Activities Associated with Ongoing Source Control Programs [3]						
Localized Testing – Inspections or sampling focused on identification and analysis of specific localized source inputs may, in some instances, provide information relevant to the SRI/FS source characterization effort	Facility and system inspections may, in some instances, provide information on localized source contributions located within a storm drainage system, and some of this information may be useful in interpreting source characterization data	Facility and system inspections or associated sampling may, in some instances, provide information on localized source contributions located within a combined sewer system, and some of this information may be useful in interpreting source characterization data	Follow-up evaluations of potential inputs from cleanup sites that may exhibit complete pathways to EW sediments (e.g., more detailed review of cleanup sites in concert with stormwater and CSO source control inspections).	Piling and structure removals as part of ongoing source control and waterfront improvement projects by the Port, the Department of Natural Resources, or other parties; Material substitutions as part of new construction.	Air quality monitoring within the EW airshed	Facility inspections associated with spill control programs

Notes:

1 This table provides a summary of information required for the EW SRI/FS Source Control Evaluation (SCE). Refer to the indicated sections of the Initial Source Evaluation and Data Gaps Memorandum for a detailed discussion of the different types of site-specific and surrogate data that may address the SRI/FS information needs.

2 Information needs are defined as those associated with the development of an EW sediment transport model incorporating regional sediment inputs (e.g., Green River and Lower Duwamish Waterway) and significant sediment lateral loads entering the EW.
3 These additional activities are associated with ongoing source tracing and source control activities, but may generate data useful for the SRI/FS SCE.
CSO – combined sewer overflow
EW – East Waterway
SRI/FS – Supplemental Remedial Investigation/Feasibility Study

As discussed in the SCEAM (Anchor and Windward 2008a), the initial source evaluation conducted in this Memorandum uses preliminary reference values pending the completion of the SRI and human health and ecological risk assessments.

- For evaluation of solid-phase inputs (e.g., storm drain sediment), reference values used in this Memorandum are the Washington State Sediment Management Standards (SMS), Sediment Quality Standard (SQS), and the Cleanup Screening Level (CSL). Where total organic carbon (TOC) concentrations are outside the range 0.5 to 4.0 percent, the lowest apparent effects threshold (LAET) or second lowest apparent effects threshold (2LAET) values established by the Washington State Department of Ecology (Ecology) are used in this evaluation. While these criteria may not apply directly to the source media, the criteria provide a basis for evaluating the potential for sediment impacts and prioritizing further evaluation.
- Measurements of aqueous chemical concentrations in source inputs (e.g., existing aqueous measurements of stormwater or CSO discharges) cannot be directly compared to the solid-phase reference values listed above. Further data evaluation beyond that conducted in this Memorandum would be required in order to estimate solids-associated chemical concentrations based on these data. In some cases, these aqueous data may provide an additional line of evidence for evaluating potential source inputs. Available aqueous source characterization data are discussed in this Memorandum and are carried forward for potential use as part of the SRI/FS activities.
- For groundwater data for nearshore cleanup sites, groundwater quality is evaluated using both site-specific cleanup levels established in the site cleanup documents, and using alternate methods that consider groundwater and sediment interactions and applicable ambient water quality criteria. These alternate evaluation methods are described further in Section 6 of this Memorandum.

It is possible that the risk assessments being developed as part of the SRI/FS may identify additional source characterization data needs or alternative reference values applicable to the EW site conditions and source characterization effort. The need for additional source characterization data and/or the use of alternative reference values will be reviewed as part of the regular EPA source control and SRI/FS briefings. This could affect both SMS (e.g., metals, polychlorinated biphenyls [PCBs], and semivolatile organic compounds [SVOCs]) and non-SMS (e.g., dioxins and tributyltin) chemicals. As part of the EWG stormwater and CSO characterization activities, excess quantities of solids samples (where available) are being archived for potential analysis in the future, should analysis for other parameters such as dioxins be deemed appropriate in response to SRI and risk assessment findings.

Where applicable, source characterization data will be re-evaluated using alternative reference values as part of the SRI/FS. As discussed in the SCEAM (Anchor and Windward 2008a), the final evaluation of source impacts and potential for sediment recontamination will be performed during the SRI (summary of source characterization data) and FS (estimates of potential sediment recontamination and impact on final cleanup decision for the EW) reports. This ensures that the evaluation of potential sediment recontamination may consider the outputs of the risk assessment, the PRGs and remedial action objectives for the site, and the findings of additional source characterization efforts completed in parallel with the SRI/FS.

The source data evaluation performed in this Memorandum is conducted for all compounds for which existing data are available. However, additional discussion is included in this Memorandum for the preliminary focus compounds, as described in Section 3.3.

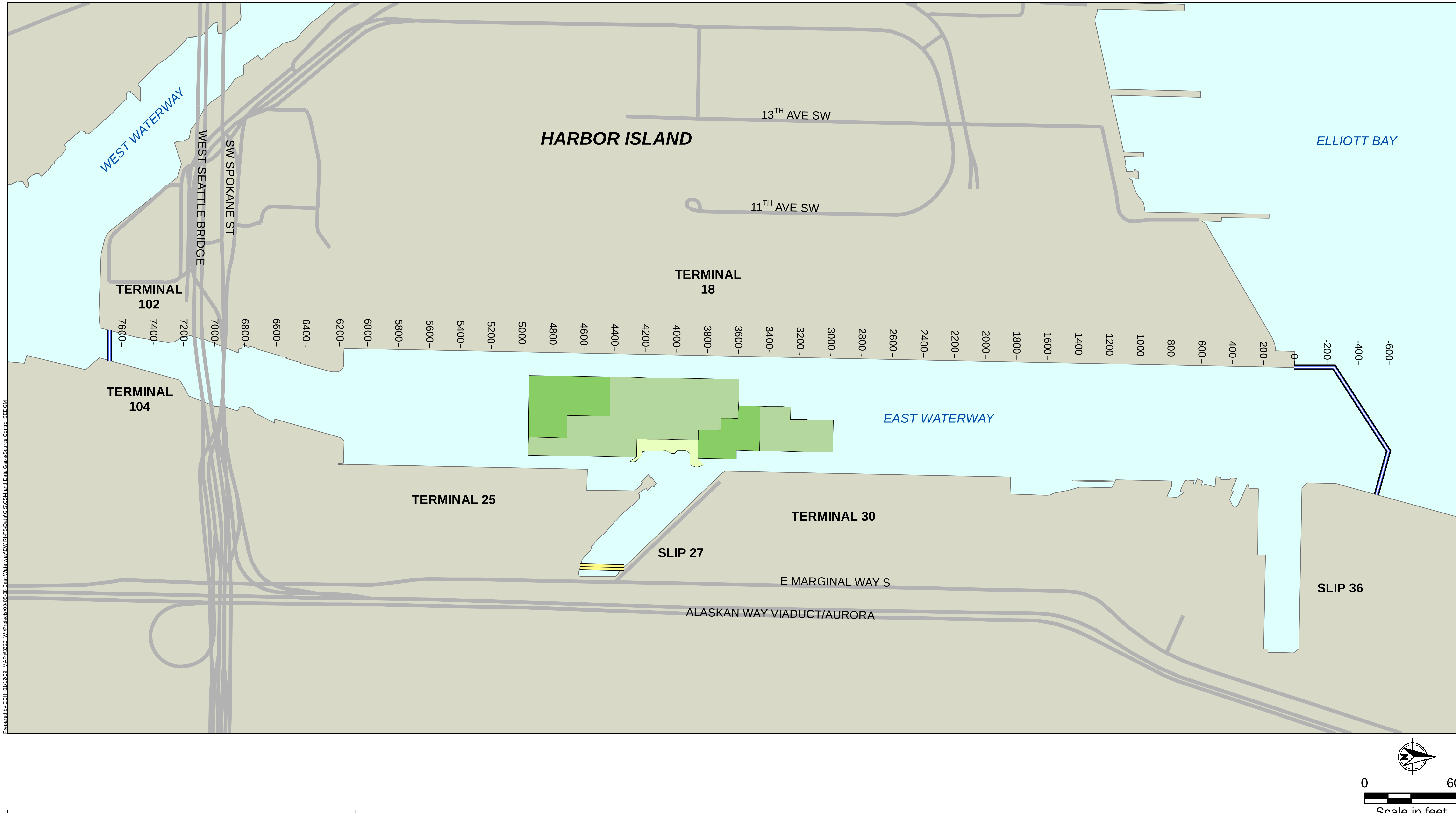
3.3 Preliminary Focus Compounds for Source Control Evaluation

Prior to the completion of the SRI/FS, data review and analysis associated with the SCE must be sufficiently broad to address the range of potential outcomes, and will not prematurely screen out specific sources from further evaluation. Nevertheless, the extensive existing data for the EW can be used to focus attention on certain chemicals on which there is scientific evidence that the potential for recontamination is greater than for other chemicals. For these compounds, a greater degree of data gathering may be warranted during the SCE process. The process of focusing the list of chemicals with the highest potential for recontamination includes review of both EW data (e.g., sediment quality data and ongoing recontamination monitoring data), as well as review of source characterization data for each source category.

Chemicals that have been frequently observed at elevated concentrations in these datasets, and that may warrant additional focus during the SCE process, are discussed in Sections 3.3.1 and 3.3.2, below.

3.3.1 Review of Recontamination Monitoring Data

During 2005, an interim sand cover was placed over residual impacted sediments in certain portions of the EW that were dredged as part of the Phase 1 Removal Action. The location of the Phase 1 Removal Action and the locations within which a sand cover was placed are shown in Figure 3-2. Since the chemical quality of the sand cover was known at the time of placement, subsequent monitoring during 2006, 2007, and 2008 (Windward 2006, 2007a, and 2008; Appendix A) allows for evaluation of changes in quality of the cover material over time.



- Area Dredged – No Sand Cover Placement
- Area Dredged – Subsequent Sand Cover Placement
- Slope Area – Gravel Cover Placement
- Slip 27 Bridge
- Proposed East Waterway Operable Unit Boundary

Refer to Figure 1-6 of the EISR for locations of other recent EW dredging projects. Recontamination monitoring was performed within the Phase 1 Removal area during 2006, 2007 and 2008 after completion of dredging and cover material placement.

Figure 3-2
Phase 1 Removal Action Dredging and Sand Cover Placement Areas
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

Increases in chemical concentrations observed during this monitoring may be indicative of sediment recontamination from external sources, or the result of other processes such as sediment resuspension from other areas of the EW and deposition on the sand cover.

Table 3-2 provides a synopsis of the SQS and CSL exceedances that have been noted during recontamination monitoring. The table shows the number of exceedances observed during each monitoring event, and differentiates between samples collected within the sand cover placement areas and those in other areas without initial sand cover placement.

Chemicals that were observed to exceed their respective SQS or CSL values in the sand cover placement areas during multiple years included the following compounds:

- Total PCBs
- 1,4-Dichlorobenzene (1,4-DCB)
- Bis(2-ethylhexyl)phthalate (BEHP)
- Butylbenzylphthalate (BBP)
- Mercury

Phenol was observed in excess of the SQS in three samples (out of 15 analyzed) during the first year of recontamination monitoring, but no exceedances have been noted since that time.

Table 3-2
Summary of 2006-2008 Recontamination Monitoring Data

Chemical	2006 Monitoring of Surface Sediments (0-10 cm)			2007 Monitoring of Surface Sediments (0-10 cm)			2008 Monitoring of Surface Sediments (0-10 cm)[b]		
	Detection Frequency	No. of Samples Beweeh the SQS and CSL	No. of CSL Exceedances	Detection Frequency	No. of Samples Between the SQS and CSL	No. of CSL Exceedances	Detection Frequency	No. of Samples Between the SQS and CSL	No. of CSL Exceedances
Areas with Sand Cover Placement									
Total PCBs	13/15	5	1	16/17	9	1	10/11	8	1
1,4-Dichlorobenzene	10/15	5 [a]	0	17/17	0	4	9/11	3	4
Bis(2-ethylhexyl) phthalate	14/15	0	1	17/17	0	0	10/11	0	2
Butylbenzylphthalate	3/15	0	0	17/17	1	0	7/11	3	0
Phenol	12/15	3	0	2/17	0	0	8/11	0	0
Copper	15/15	0	0	17/17	0	0	11/11	0	0
Mercury	10/15	0	2	16/17	1	0	10/11	1	0
Zinc	15/15	0	0	17/17	0	0	11/11	0	0
Areas without Sand Cover Placement									
Total PCBs	5/5	4	1	5/5	4	1	ns	ns	ns
1,4-Dichlorobenzene	5/5	0	0	5/5	3	0	ns	ns	ns
Bis(2-ethylhexyl) phthalate	5/5	0	0	5/5	0	0	ns	ns	ns
Butylbenzylphthalate	1/5	0	0	5/5	0	0	ns	ns	ns
Phenol	5/5	4	0	2/5	0	0	ns	ns	ns
Copper	5/5	0	0	5/5	0	0	ns	ns	ns
Mercury	5/5	0	0	5/5	0	0	ns	ns	ns
Zinc	5/5	0	0	5/5	0	0	ns	ns	ns

Notes:

Sources: Windward 2006, 2007a, and 2008

ns Not sampled

a Two additional samples were non-detect with detection limits slightly greater than the SQS.

b One sample (Station EW-RM-42) was sampled at a depth of 0-8 cm, and one sample (Staton EW-RM-15) was sampled at a depth of 0-9 cm.

CSL Cleanup Screening Level

SQS Sediment Quality Standards

3.3.2 Review of Sediment Quality Data from the EW

Section 3.3 of the EISR (Anchor and Windward 2008b) included a review of surface sediment quality data representative of the existing sediment bioactive zone (0 to 10 centimeters [cm]). The existing dataset was summarized in Table 3-6 of the EISR, and included a summary of results for between 72 and 176 samples (the number varies depending on the specific parameter). The need for additional source characterization data will be re-evaluated based on the findings of surface and subsurface sediment sampling, porewater or seep testing, and risk evaluations being conducted during the SRI process.

Table 3-3 provides a summary of compounds that were present in multiple locations above the corresponding SQS or CSL values. As discussed in the SCEAM, the SQS and CSL are used for initial evaluation of SCE data pending development of information from the site risk assessments and the SRI/FS. Table 3-3 lists those compounds that exceeded either the SQS or CSL in five or more surface sediment samples, along with the frequency of those exceedances. Compounds that exceeded the CSL more than five times included the following compounds:

- Total PCBs
- Select polycyclic aromatic hydrocarbon (PAH) compounds (i.e., acenaphthene, indeno(123-cd)pyrene)
- BEHP
- Mercury

Additional compounds that were present in excess of the SQS more than five times included the following compounds:

- Multiple additional PAH compounds (see Table 3-3)
- 1,2,4-Trichlorobenzene
- 1,4-DCB
- Phenol
- BBP
- Zinc

Table 3-3
Preliminary Focus Compounds for Source Control Evaluation
Based on Surface Sediment Sampling and Recontamination Monitoring Data

Chemical	Preliminary Focus Compound? Basis for Identification (Surface Sampling Exceedances / Recontamination Monitoring Exceedances)	Frequent Exceedances in Surface Sediment (0-10 cm)[a]				SMS Exceedances During Recontamination Monitoring in Sand Cover Areas (0-10 cm)[b]							
		Frequent Detections Between the SQS and CSL[a]		Frequent CSL Exceedances[a]		Detections Between the SQS and the CSL				CSL Exceedances			
		Greater than 5[a] (y/n)	Frequency	Greater than 5[a] (y/n)	Frequency	Observed Multiple Years?	2006	2007	2008[b]	Observed Multiple Years?	2006	2007	2008[b]
Polychlorinated Biphenyls													
Total PCBs	**Yes** (CSL/CSL)	**Yes**	125/176	**Yes**	26/176	**Yes**	5/15	9/17	8/11	**Yes**	1/15	1/17	1/11
LPAH													
Acenaphthene	**Yes** (CSL/ **)	**Yes**	8/152	**Yes**	7/152	--	--	--	--	--	--	--	--
Phenanthrene	**Yes** (SQS/ **)	**Yes**	12/152	No	3/152	--	--	--	--	--	--	--	--
Fluorene	**Yes** (SQS/ **)	**Yes**	8/152	No	3/152	--	--	--	--	--	--	--	--
Total LPAH (calc'd)	**Yes** (SQS/ **)	**Yes**	5/152	No	3/152	--	--	--	--	--	--	--	--
HPAH													
Benzo(a)anthracene	**Yes** (SQS/ **)	**Yes**	7/152	No	2/152	--	--	--	--	--	--	--	--
Benzo(a)pyrene	**Yes** (SQS/ **)	**Yes**	6/152	No	2/152	--	--	--	--	--	--	--	--
Benzo(ghi)perylene	No (**/ **)	No	3/152	No	2/152	--	--	--	--	--	--	--	--
Benzofluoranthenes (total, calc'd)	**Yes** (SQS/ **)	**Yes**	5/152	No	4/152	--	--	--	--	--	--	--	--
Chrysene	**Yes** (SQS/ **)	**Yes**	10/152	No	1/152	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	**Yes** (SQS/ **)	**Yes**	10/152	No	3/152	--	--	--	--	--	--	--	--
Fluoranthene	**Yes** (SQS/ **)	**Yes**	14/152	No	3/152	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	**Yes** (CSL/ **)	**Yes**	9/152	**Yes**	5/152	--	--	--	--	--	--	--	--
Total HPAH (calc'd)	**Yes** (SQS/ **)	**Yes**	11/152	No	2/152	--	--	--	--	--	--	--	--
Other SVOCs													
1,2,4-Trichlorobenzene	**Yes** (SQS/ **)	**Yes**	6/163	No	4/163	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	**Yes** (CSL/ **)	**Yes**	16/163	No	4/163	**Yes**	5/15	0/17	3/11	**Yes**	--	4/17	4/11
Dibenzofuran	**Yes** (SQS/ **)	**Yes**	6/152	No	3/152	--	--	--	--	--	--	--	--
Phenol	**Yes** (SQS/ **)	**Yes**	6/139	No	4/139	No	3/15	--	--	--	--	--	--
Phthalates													
Bis(2-ethylhexyl)phthalate	**Yes** (CSL/CSL)	**Yes**	10/139	**Yes**	8/139	No	--	--	--	**Yes**	1/15	--	2/11
Butylbenzylphthalate	**Yes** (SQS/SQS)	**Yes**	6/138	--	--	**Yes**	--	1/17	3/11	--	--	--	--
Heavy Metals													
Arsenic	No (* / **)	No	--	No	2/127	--	--	--	--	--	--	--	--
Copper	No (* / **)	--	--	--	--	--	--	--	--	--	--	--	--
Lead	No (* / **)	No	1/127	--	--	--	--	--	--	--	--	--	--
Mercury	**Yes** (CSL/SQS)	**Yes**	44/175	**Yes**	36/175	**Yes**	--	1/17	1/11	No	2/15	--	--
Zinc	**Yes** (SQS/ **)	**Yes**	16/127	No	1/127	--	--	--	--	--	--	--	--

Notes:

-- Compound has been analyzed, but no exceedances of reference value in indicated dataset or sampling period.

* Compound was not present above the SQS or CSL in five or more of the EW surface sediment samples.

** Compound was not present above the SQS or CSL in any of the recontamination monitoring locations during two or more sampling events.

a Refer to Table 3-6 of the EISR (Anchor and Windward 2008b). The data referenced in that table represent surface sediments that have not been dredged or capped and that were considered in the EPA-approved EISR to represent current surface sediment quality. A "yes" is indicated for those parameters that were noted as exceedances (at the SQS or CSL levels) at five or more locations within the EW.

b Refer to Table 3-3 of this Memorandum for a summary of recontamination monitoring data. During 2008, one sample (Station EW-RM-42) was sampled at a depth of 0-8 cm, and one sample (Station EW-RM-15) was sampled at a depth of 0-9 cm.

CSL Cleanup Screening Level

SMS Sediment Management Standards

SQS Sediment Quality Standards

3.3.3 Summary of Preliminary Focus Compounds

Table 3-3 summarizes the preliminary focus compounds identified through review of the recontamination monitoring and EW surface sediment data review. Focus compounds that were identified in Table 3-3 based on exceedances in either the surface sediment data or in the recontamination monitoring data at the preliminary screening, CSL level included the following:

- Total PCBs
- Selected PAH compounds (i.e., acenaphthene, indeno(1,2,3-cd)pyrene)
- BEHP
- 1,4-DCB
- Mercury

Focus compounds that were were identified in Table 3-3 based on exceedances in either the surface sediment data or in the recontamination monitoring data at the preliminary screening, SQS level (but not at the CSL level) included the following:compounds:

- Selected PAH compounds (i.e., benzo(a)anthracene, benzo(a)pyrene, , benzofluoranthenes, chrysene, dibenzo(a,h)anthracene, dibenzofuran, fluoranthene, fluorine, phenanthrene, total low molecular weight polycyclic aromatic hydrocarbons [LPAHs], total high molecular weight polycyclic aromatic hydrocarbons [HPAHs])
- 1,2,4-Trichlorobenzene
- Phenol
- BBP
- Zinc

The SCE process is not limited to the above-listed focus compounds. However, the existing data suggest that a greater degree of data gathering and evaluation is warranted during the SCE process for these chemicals.

4 STORMWATER

Based on the City's review of available storm drainmaps and geographic information systems (GIS) information, the EW is served by both separated and partially separated drainage systems. A separated area is one in which all runoff from roadways and properties adjacent to the roadways discharges to a separate storm drain system or via sheet flow directly to the waterway. A partially separated area is one in which the storm drains serve only a portion of the area (usually the roadways), while some properties adjacent to the roadways may continue to drain to the combined sewer system. In either case, storm drains collect and convey only stormwater. Municipal and industrial wastewater is not discharged to the storm drain system.

Stormwater discharges include sheet flow discharges, as well as discharges from storm drain systems. Storm drain systems can include networks of interconnected public and private storm drains. Public storm drains are those that are owned/operated by the City, the Port, or the County. These public storm drains are required to have coverage under an NPDES municipal stormwater permit. Private storm drains are those owned by private parties. Some of these private storm drains may be regulated by the general industrial NPDES permit, individual stormwater permits, or other site-specific requirements governing discharge to surface water bodies.

In the EW, the City and the Port operate storm drain conveyance systems that are covered under Ecology's NPDES Phase 1 Municipal Stormwater Permit, which was revised on June 17, 2009, and became effective on July 19, 2009. Both jurisdictions are working to comply with the new permit requirements. The work being conducted to identify, characterize, and control sources in the EW is being driven by the Superfund investigation is much more extensive and specific to the EW than the NPDES requirements.

Storm drain systems may discharge to surface waters via dedicated storm drain outfalls (SD outfall). However, in some cases, storm drain systems may share an outfall with a CSO or with an EOF. An EOF is an overflow point on a combined or sanitary sewer, generally located at a pump station (discharges from an EOF occur as a result of mechanical failure, pipe obstruction, or power failure, and are not storm related; pump stations in the EW are equipped with generators to prevent overflows resulting from power system failures). Where applicable, shared outfalls are described in this document as CSO/SD outfalls or EOF/SD outfalls for clarity.

Stormwater can also enter the EW without a conveyance system by means of sheet flow, in which the stormwater flows to the EW instead of into a conveyance system. Discharges of stormwater to the EW via sheet flow typically occur from terminal aprons or bridge areas.

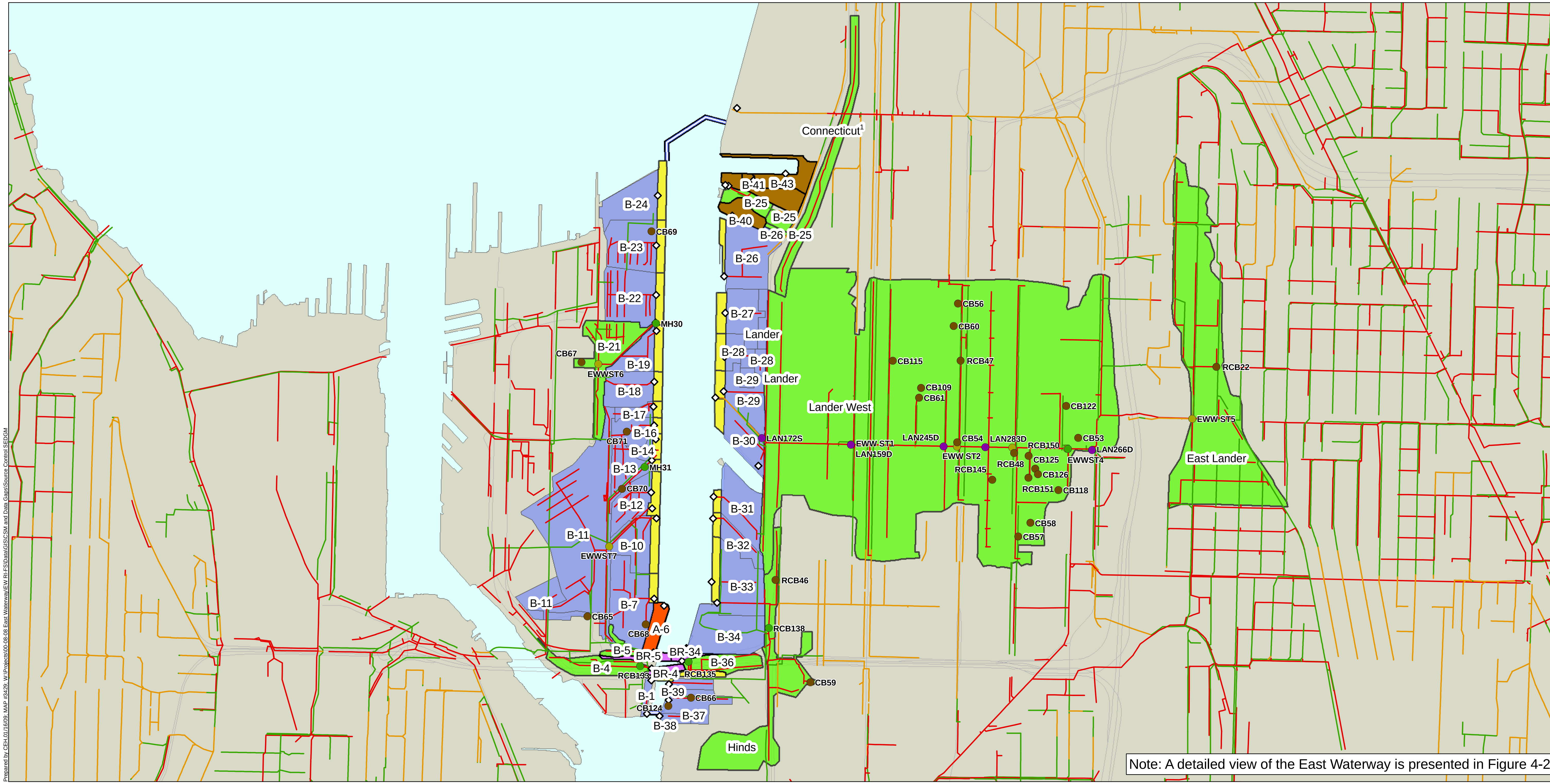
Stormwater can contain chemicals from spills, illicit discharges, automotive sources, atmospheric deposition, improper handling and storage of pollutants, contaminated soil on properties and right-of-ways (ROWs) from which the stormwater originates, and groundwater pollutants infiltrating into stormwater collection/conveyance systems.

This section describes existing data, ongoing data collection, and data gaps relevant to the SRI/FS SCE.

4.1 General Stormwater Basin Descriptions

As discussed in the EISR (Anchor and Windward 2008b), the EW storm drain basins include two general areas: the Lander SD basin (a 448-acre area extending from the EW to as far away as Beacon Hill), and the nearshore SD basins located in areas along the EW (approximately 357 acres including storm drain basins, terminal aprons, and bridges located immediately adjacent to the EW) (Figure 4-1).

The Lander SD basin is a partially separated SD basin that collects stormwater from a predominantly industrial area extending from the EW to Interstate 5 (I-5) and a small residential area on Beacon Hill. A single 90-inch-diameter CSO/SD outfall discharges both stormwater from the separated drainage system, as well as CSOs from the combined sewer system. Prior to 1989, the Lander outfall functioned only as a CSO discharge point. However, King County (formerly Metro) constructed a separation project in 1989 to reduce the amount of overflows at its Lander CSO. The separation project created the Lander SD basin. Portions of the Lander SD basin (mostly areas outside the ROW) remain connected to the combined sewer system.



◇ Outfall[2]
● Catch basin sample location
● Inline sediment sample location
● Sediment trap sample location
● Lander Separated System locator

CB = catch basin
RCB = right-of-way catch basin
MH = manhole
ST = sediment trap
Note: The six ST samples and the CB and RCB samples with IDs greater than 100 are ongoing; data is not available at this time.

Sanitary line
Storm water line
Combined sewer line
Road
Proposed East Waterway Operable Unit Boundary

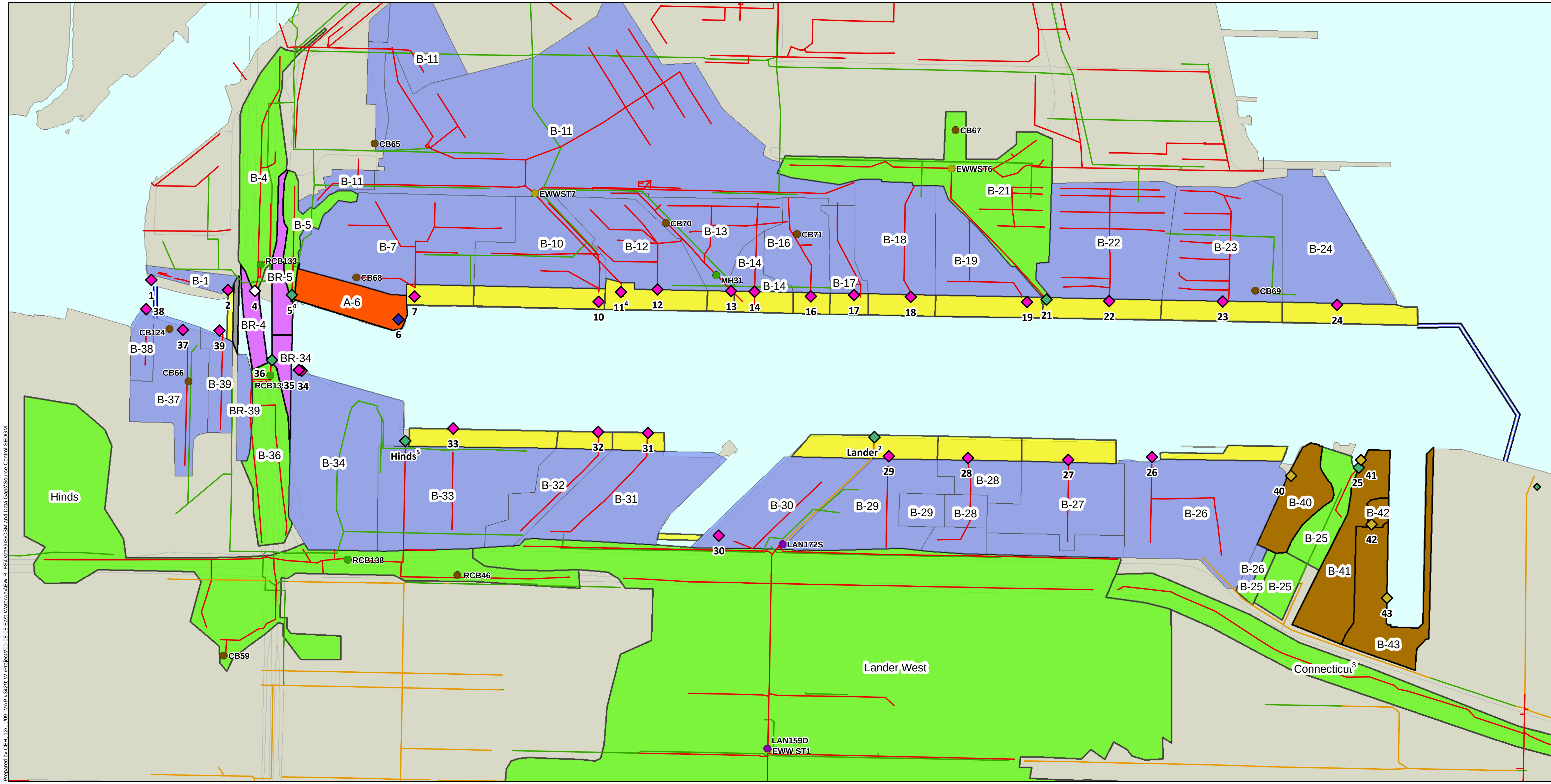
Basin/sub-basin
Labeled with sub-basin ID

Port of Seattle basin
Port of Seattle apron or bridge
SPU basin
SPU apron or bridge
Olympic Tug & Barge basin
Coast Guard basin

0 1,200
Scale in feet

[1] Only a portion of the Connecticut separated storm drain system is shown pending further basin delineation.
[2] Only outfalls with active stormwater discharges from separated storm drain basins are shown on this figure.

Figure 4-1
Updated Map of EW Separated Storm Drain Basins, Storm Drain Sampling Locations, and Associated Outfalls - Overview
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit



Outfall by owner[1]
- Port of Seattle
- City of Seattle
- US Coast Guard
- Private
- Unknown

- Catch basin sample location
- Inline sediment sample location
- Sediment trap sample location
- Lander Separated System locator

- Sanitary line
- Storm water line
- Combined sewer line
- Road
- Proposed East Waterway Operable Unit Boundary

Basin/sub-basin
Labeled with sub-basin ID
- Port of Seattle basin
- Port of Seattle apron or bridge
- SPU basin
- SPU apron or bridge
- Olympic Tug & Barge basin
- Coast Guard basin
- Other bridge

CB = catch basin
RCB = right-of-way catch basin
MH = manhole
ST = sediment trap
Note: The six ST samples and the CB and RCB samples with IDs greater than 100 are ongoing; data is not available at this time.

[1] Only outfalls with active stormwater discharges from separated storm drain basins are shown on this figure unless otherwise noted.
[2] The Lander separated storm drain basin discharges to the Lander CSO/SD outfall owned by the City of Seattle.
[3] The Connecticut separated storm drain basin discharges to the Connecticut CSO/SD outfall owned by the City of Seattle.
[4] Outfalls 5 and 11 provide discharge points for both separated storm drain basins and emergency overflows (EOF) operated by the City of Seattle.
[5] The Hinds CSO/SD is owned by the City of Seattle.

0 600
Scale in feet

Figure 4-2
Updated Map of EW Separated Storm Drain Basins, Storm Drain Sampling Locations, and Associated Outfalls - Outfall Detail
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

The second general drainage area consists of the nearshore SD basins. These basins consist of the land that is located along the west side (approximately the eastern one-third of Harbor Island) and along the east side of the EW and that is not included in the Lander storm drain system (see Figure 4-1). The majority of this area consists of nearshore properties owned by the Port, where the storm drains discharge to the EW via small SD outfalls. The remainder consists of primarily industrial properties served by smaller City or private storm drain systems. About half of the nearshore area is located on Harbor Island, and about half is located along the east side of the EW. Most of the properties located within the nearshore drainage areas consist of container terminals and associated transportation facilities.

Additional storm drain outfalls are located just north of the northern proposed EW OU study boundary, at Terminal 42 (T-42) and Terminal 46 (T-46). The Connecticut outfall is located at the northern edge of the EW on T-46. Prior to 1998, the Connecticut outfall, which is owned by the City, served as a CSO discharge point only. But in 1998, a stormwater separation project was conducted. Now, this CSO/SD outfall services both the Connecticut Street storm drain basin, and also provides the discharge point for the County's Kingdome CSO. The Connecticut Street storm drain basin conveys runoff from a small area immediately adjacent to the EW and a separated area in the general vicinity of Safeco Field and Qwest Field and Event Center. The boundaries of the Connecticut storm drain system are under review by the City and are not fully shown in Figure 4-1. Some of the stormwater from the separated Connecticut storm drain basin is discharged to the combined sewer system due to the operation of a low-flow diversion structure, which diverts a portion of the stormwater to the combined sewer for treatment at West Point Treatment Plant.

4.2 Existing Data Analysis

As described in Section 3, stormwater-related information needs for the SRI/FS SCE include the following:

- Locations of active SD outfalls in and immediately adjacent to the EW
- Locations and characteristics of the SD basins associated with the active SD outfalls
- Estimates of stormwater discharge quantities
- Stormwater total suspended solids (TSS) concentrations
- Particle size distribution (PSD) for the stormwater solids

- Chemical characteristics of stormwater solids

The existing data addressing these information needs are described in Sections 4.2.1 through 4.2.4, below. These data include both site-specific data collected from EW SD basins, and surrogate data collected from other drainage basins, including stormwater catch basins in nearby combined sewer service areas.

4.2.1 Drainage Areas and Outfalls

Information regarding SD basins and outfalls along the EW has been updated since the EISR (Anchor and Windward 2008b). Table 4-1 presents an updated estimate of the EW SD basins. These SD basins and the associated SD outfalls are shown in Figures 4-1 and 4-2.

Stormwater basins, pipes, and outfall details were acquired from Port and City GIS files. Additional stormwater details were also verified from the Port's Outfall Verification Report (Phoinix 2007), the City's Phase 1 Outfall Inspection (Herrera 2004a) Terminal 18 (T-18) and T-25 stormwater pollution prevention plans (SSA 2006a and 2006b), and T-30 and Terminal 102 (T-102) stormwater inspection reports (Phoinix 2006a and 2006b). Outfalls along the EW have been visually inspected and verified (by boat or land) by both the City in 2006 and the Port in 2007 (Phoinix 2007; Herrera 2006).

Two of the outfalls associated with the SD basins along the west side of the waterway (at SW Hanford and SW Spokane Street) also function as outfalls for EOFs for sanitary sewer pump station 73. These outfalls are known as the SW Hanford PS 73 EOF/SD (outfall 11 on Figure 4-1) and SW Spokane PS 73 EOF/SD (outfall 5 on Figure 4-1). The Port owns/operates the storm drain system at the SW Hanford St outfall and the City owns/operates the EOF. At the SW Spokane St outfall, the City owns/operates both the storm drain and the EOF.

Table 4-1
Updated Acreage Estimates for EW Stormwater Drainage Basins[1]

Basin Type	Water-way Side	SD Basin No. or Name	Outfall Name[a]	Owner	Basin Area (acres)
Bridges/Aprons (34.3 acres; multiple discharge points)					
Bridges	Both	BR-4, BR-5, BR-34	Multiple bridge deck drains	SPU	3.8
Bridges	Both	BR-2	Multiple bridge deck drains	Port	0.3
Aprons	East	A-26 through A-33	Multiple apron deck drains	Port	12.5
Aprons	West	A-7 through A-24, BR-39	Multiple apron deck drains	Port	17.7
Lander Storm Drain Basin (447.6 acres; 1 outfall)					
Lander	East	Lander	Lander CSO/SD	SPU	447.6
Nearshore Basins – East Side of Waterway (157.9 acres; 20 outfalls)					
Connecticut	East	Connecticut	Connecticut CSO/SD	SPU	13.6[b]
Nearshore	East	B-25, B-36	S Massachusetts SD, S Spokane SD	SPU	8.3
Nearshore	East	B-25, B-26, B-27, B-28, B-29, B-30, B-31, B-32, B-33, B-34, B37, B-38, B-39	Individual outfalls not named	Port	94.5
Nearshore	East	B-40, B-41, B-42, B-43	Individual outfalls not named	Other	15.1
Hinds	East	Hinds	Hinds CSO/SD (107)	SPU	26.4
Nearshore Basins – West Side of Waterway (164.8 acres; 18 outfalls)					
Nearshore	West	B-4, B-5, B-21	SW Florida SD, SW Spokane SD, SW Spokane PS 73 EOF/SD	SPU	22.2
Nearshore	West	B-1, B-7, B-10, B-11[c], B-12, B-13, B-14, B-16, B-17, B-18, B-19, B-22, B-23, B-24	Except for B-11 (Hanford PS 73 EOF/SD), individual outfalls not named	Port	139.4[c]
Nearshore	West	A-6	Individual outfalls not named	Other	3.2
Total SD Basin Acreage					***804.6***

Notes:

a. The City names its outfalls by the nearest street for ease in identifying location.

b. Does not include areas outside the roadway that drain to the separated Connecticut storm drain system. The City is conducting a review of this basin, and the acreage estimate will be updated after completion of that review.

c. The Port and City are conducting additional review of Basin B-11. A small portion of this basin (less than 6 acres) is believed to drain to the West Waterway. The Basin B-11 acreage estimate will be updated after completion of the Port and City review.

- **Lander Drainage Basin:** The largest of the EW SD basins discharges through the Lander CSO/SD outfall. This outfall serves a partially separated SD basin approximately 448 acres in size. Most of the runoff originates from the industrial area located west of I-5. However, approximately 76 acres represents the commercial and residential area east of I-5. Runoff from most roadways in the

Lander basin discharge to the storm drain system, but some onsite drainage systems are still connected to the combined sewer system.

- **Nearshore Drainage Basins:** The nearshore drainage basins have been further delineated since production of the EISR (Anchor and Windward 2008b). The localized areas that are serviced by active outfalls along the EW have been defined using SD information obtained from the Port and Seattle Public Utilities (SPU). Each of the smaller SD basins and active outfalls has been assigned a number for use during the SRI/FS. These numbers are shown in Figure 4-2. For example, outfall “5” discharges stormwater from SD basin “B-5.” Available information indicates that approximately 322. acres of upland property within the nearshore drainage basins are serviced by 38 active outfalls. Approximately half of this area is located on Harbor Island, to the west of the EW. This area has been inspected recently as part of the Port’s outfall mapping program, in addition to other inspections that may be conducted periodically by the Port as part of system operations, maintenance, repairs or upgrades (e.g., post-earthquake inspections by the Port following Nisqually earthquake). The other half of this area is located along the east side of the EW. A small portion (less than 6 acres) of upland property on Harbor Island (westernmost portion of basin B-11) may discharge to the WW. The B-11 SD basin is under ongoing evaluation by the Port and the City as described in Section 4.3, and the final basin size may be slightly lower than that shown in Table 4-1. The City is also reviewing the boundaries of the Connecticut SD basin located on the eastern short of the EW. The acreage associated with the Connecticut SD basin is likely to be greater than that shown in Table 4-1 (13.6 acres). The City is also conducting ongoing evaluations of the S Hinds Street SD basin and combined sewer service areas. As described in Section 4.3, these basin delineations will be completed prior to initiation of the STE.
- **Apron Areas:** Apron areas are the portions of the Port terminals that are located over the EW (i.e., the wharf areas). Significant apron areas are located along both the east and the west sides of the EW. These apron areas are contiguous with the nearshore drainage basins, but the stormwater from the aprons does not discharge to the EW via the SD outfalls. Rather, the aprons discharge stormwater to the EW through a series of deck drains located within the aprons.

The apron drainage areas are shown in Figure 4-2, and have been given numbers for use during the SRI/FS. The apron drainage areas share the same numbers as the basins that they are adjacent to, but the numbers are preceded by a letter "A" instead of a "B." The total apron area located along the west side of the EW is estimated at approximately 17.7 acres, and the apron area located along the east side of the EW is estimated at approximately 12.5 acres.

- **Bridge Areas:** Several bridges cross the southern portion of the EW, including the West Seattle Bridge, the Spokane Street Bridge, a BNSF railroad bridge, and a small bridge providing emergency access to the Harbor Marina Corporate Center. There is also a public access bridge located adjacent to the Spokane Street Bridge. Portions of the bridges discharge stormwater to the EW using deck drain systems. The bridge drainage areas are shown in Figure 4-2 and have been given numbers for use in the SRI/FS. The bridge drainage areas are preceded by the letters "BR." The total of these bridge areas is approximately 4.1 acres.
- **Land Use:** Land use/cover information for each of the 44 outfalls was developed using current King County parcel data. Basin areas and land use are summarized in Table 4-2.

Table 4-2
Land Use in Areas Draining to the East Waterway

Land Use	Lander CSO/SD	Nearshore Drainage Areas[a]	Apron Areas	Bridge Areas	Total
Commercial	71.8				71.8
Industrial	185.1	239.6	30.5		455.2
Multi-family	18				18
Parks/open space/ vacant	8.9	17.9			26.8
Right-of-way	147.2	65.2		3.8	216.2
Single-family	16.6				16.6
Total	**447.6**	**322.7**	**30.5**	**3.8**	**804.6**

Note:

a. Land use analysis is based on the basin delineations shown in Table 4-1. This analysis will be updated if the basin sizes are updated following completion of Port and City basin review.

4.2.2 Stormwater Discharge Volumes

Gould and Hartley (2008) is working with under contract with the City to develop estimates of stormwater runoff volumes from areas draining to the EW for use in support of the STE and the SRI/FS. Runoff estimates are being developed for the years 2000 through 2007 plus typical dry (1993), wet (2002), and average rainfall (1986) years. Annual runoff volumes are being estimated from land use, soil type, slope, and rainfall using a simplified Hydrologic Simulation Program-Fortran (HSPF) model. The model calculates runoff volumes per unit area for individual land use, slope, and soil combinations based on regional Puget Sound input parameters and local rainfall data. The area draining to the EW was broken into subbasins representing different outfalls and other drainage catchments (e.g., bridge and pier aprons). Data from City rain gage #15 located at E Marginal Way S and Diagonal Avenue S are used in the model. Soil data were obtained from Goetz et al. (2006).

Preliminary stormwater discharge volumes as estimated by Gould and Hartley (2008) for a wet, dry, and average year are provided in Table 4-3. Because the stormwater basins are under ongoing evaluation, some updates to this analysis are anticipated. The final stormwater runoff analysis will be provided as part of the STE and SRI documentation.

Table 4-3
Summary of Estimated Stormwater Discharge Volumes

Contributing Area	Runoff[1]		
	Dry WY (Mgal/yr)	Average WY (Mgal/yr)	Wet WY (Mgal/yr)
SPU Lander CSO/SD			
Low[2]	112	133	166
High[3]	191	228	283
SPU nearshore basins[4]	32	38	48
SPU bridges/aprons[5]	2	2	3
Total SPU			
Low	146	173	217
High	225	268	334
Port nearshore basins[6]	142	170	209
Port aprons[7]	7	9	11
Total Port	149	179	220
Other basins[8]	10	12	15
Total area draining to EW			
Low	305	364	452
High	384	459	569

Notes:

Mgal = Million gallons

WY = water year

1. Some basin areas have been revised or are under revision since the preliminary runoff estimates were prepared by Gould and Hartley (2008). Runoff estimates will be revised when basin delineations are complete. Revisions will be completed for the STM.
2. For partially separated areas in the Lander SD basin. Low runoff estimate for calculated from SPU GIS maps and includes only those areas where mapping is available and shows the onsite drainage connected to the public separated storm drain system in the right-of-way.
3. For partially separated areas in the Lander SD basin. High runoff estimate calculated assuming that half of the remaining parcels that are either not currently mapped or are currently shown as connected to the combined sewer system will be re-plumbed to the storm drain system in the future as redevelopment occurs.
4. Nearshore areas outside the Lander SD basin that drain to City-owned outfalls. Includes 13.6 acres in Connecticut separated storm drain system. Includes stormwater discharges from the Hinds CSO/SD. The acreage from the S Hinds Street storm drain basin is still being evaluated.
5. Over-water structures (e.g., West Seattle Bridge)
6. Port property draining to the EW via Port- or City-owned storm drains.
7. Over-water aprons that drain to the EW via apron drains.
8. Areas draining to EW via privately-owned storm drains.

As mentioned earlier, the Lander SD system is partially separated. In these areas, runoff from properties/parcels outside the ROW is discharged to either the combined sewer or the SD system. The exact discharge location is often unknown and can only be determined in the field by dye testing. To evaluate uncertainty, low and high runoff estimates were performed using SPU GIS data for private onsite drainage systems, where available. For the low end, it was assumed that only the parcels shown in GIS as connected to the public SD are separated, and the rest (those where onsite data are unavailable or where data show onsite drains connected to the combined sewer) are connected to the combined sewer. For the high end, it was assumed that half of the parcels currently plumbed to the combined system would be replumbed to the SD system as redevelopment occurs in the future.

The effects of the low flow diversion structures on the Lander SD system and the Connecticut SD system were not taken into account in the Table 4-3 estimates of stormwater volume discharged to the EW. In the caseof the Lander SD, the diversion system is not currently in operation and the hydraulics are not well understood. For the purposes of the solids loading estimates, it was assumed that all stormwater that enters in the Lander SD system discharges to the EW. This is a conservative assumption, especially if the low flow diversion system were to be re-activated.

The low-flow diversion structure for the Connecticut SD basin is currently operational. However, the runoff estimates in Table 4-3 do not take the flow diversion into account because additional work would be required to estimate the flow diversion system performance. Historical flow monitoring data are available from the County for this system, and may be useful in conjunction with runoff modeling to refine the estimates of discharge from this system.

4.2.3 Stormwater Solids Data

Data regarding the typical quantity and size fractions of suspended solids contained in stormwater are required for use in the STE. These data will also be required in order to estimate the potential for sediment recontamination from stormwater during the SRI/FS.

4.2.3.1 Suspended Solids Concentrations

Stormwater TSS concentration data are available from both site-specific and surrogate data sources.

Table 4-4 presents a summary of both site-specific and surrogate TSS data available for use in the SRI/FS. The site-specific data are those collected from the Lander separated SD system between 1997 and 2002.

Table 4-4
Comparison of Site-Specific and Surrogate Stormwater TSS Concentrations

EW Basin Type	Summary Statistic	Estimated TSS Concentration (mg/L)
Site-Specific TSS Data – Storm Flow (Lander Separated System) [1]	Sample Count	22
	25th Percentile	45
	Median	65
	Mean	73
	75th Percentile	91
Site-Specific TSS Data – Base Flow (Lander Separated System) [2]	Sample Count	23
	25th Percentile	5.2
	Median	7.6
	Mean	10
	75th Percentile	11
Surrogate TSS Data – All Samples (SPU 2008) [3]	Sample Count	522
	25th Percentile	32
	Median	52
	Mean	77
	75th Percentile	96
Surrogate TSS Data – Industrial Samples (SPU 2008) [3]	Sample Count	79
	25th Percentile	48
	Median	68
	Mean	83
	75th Percentile	108

Notes:

1 – Samples were collected during storm events when no CSO discharges occurred.
2 – Samples were collected during dry weather.
3 – Summary statistics for 522 stormwater samples collected at 24 sites in Seattle, Bellevue, Tacoma, Issaquah, and Everett (SPU 2008).

The Lander TSS data included in Table 4-4 have been reviewed by the City and County and this dataset was determined to be usable in this report and for the SRI. Samples collected during storm events and base flow are included in Table 4-4.

Only the data collected from 1997-2002, after the separation project was completed, have been included for the purposes of this Memorandum. Earlier data were not included because these samples contained a mixture of sanitary sewage and stormwater and, therefore, are not considered to be representative of stormwater TSS concentrations. This TSS dataset includes 22 stormwater samples collected from two locations, as shown on Figure 4-1, in the Lander SD system (on main trunkline at Utah Avenue S and at the bus tunnel access road on 5th Avenue S).

The 22 stormwater samples were also analyzed for field conductivity and fecal coliform bacteria. Conductivity ranged from 42 to 460 uhmo/cm, which indicates that samples were largely free of tidal influence and are, therefore, representative of storm flow conditions. Fecal coliform numbers ranged from 900 to 1,300,000 colony-forming units per milliliter (cfu/mL), which suggests that samples may have included some sanitary flow.

The Lander dataset also includes 23 base flow samples. The base flow samples are not representative of stormwater because the flow inputs may consist of groundwater, tidal infiltration, or possible illicit connections to the SD system.

Table 4-4 also includes surrogate TSS concentration data from more than 500 stormwater samples collected at 24 different locations in Seattle, Bellevue, Tacoma, Issaquah, and Everett. These data were compiled and analyzed as part of the solids load analysis conducted for the LDW sediment transport model to determine representative suspended solids concentrations in urban stormwater (SPU 2007, 2008). Land use-weighted average suspended solids estimates were calculated by proportioning TSS concentrations based on the percentage of land use (single-family residential, multi-family residential, commercial, industrial, open space, and ROW) within each of the sample areas (Table 4-5).

Table 4-5
Land Use-weighted Average TSS

Land Use	TSS (mg/L)
Single-family residential	62
Multi-family residential	79
Commercial	79
Industrial	83
Open space	69
Right-of-way	85

Notes:
References: SPU 2007, 2008

The site-specific stormwater TSS data are similar to the TSS concentrations that would be predicted using the surrogate TSS data for similar land uses. The Lander

SD system services predominantly industrial areas and the associated ROWs. The surrogate TSS concentrations reported for these land uses (82 and 85 milligrams per liter [mg/L], respectively) are very similar to the site-specific TSS measurements (mean of 73 mg/L) summarized in Table 4-4.

4.2.3.2 TSS Particle Size Distribution Data

No site-specific monitoring has been conducted to evaluate TSS PSD fractions in stormwater. As described in the EISR (Anchor and Windward 2008b), surrogate TSS PSD data are available from work conducted by SPU for the LDW. These data were developed for use in the LDW sediment transport model (QEA 2008). TSS PSDs are necessary for estimating solids transport properties, because solids settling rates vary with particle size.

Surrogate PSD data were compiled from 18 sites across the country to characterize PSD in stormwater. As part of the analysis, the surrogate stormwater PSD were evaluated along with PSD sediment samples collected within SDs discharging to the LDW (catch basins, inline grabs, and sediment traps). The resulting PSD values used as part of the LDW sediment transport work are summarized in Table 4-6.

Table 4-6
Typical Stormwater Particulate Size Fractions Reported by SPU[1]

Particle Size Fractions for Stormwater Solids as Estimated in LDW Sediment Transport Modeling	Percent of Total Suspended Solids
Clay and fine silt	55
Medium/coarse silt	18
Fine sand	23
Medium/coarse sand	4

Notes:
1 – Data Source: QEA 2008

4.2.3.3 Estimated Solids Quantity Estimates

As part of their work in support of the SRI/FS, Gould and Hartley (2008) have developed preliminary estimates of solids quantities associated with stormwater discharges to the EW. Solids loads were calculated as the product of the stormwater discharge volume at each SD basin or outfall (see Section 4.2.2) and an average land use-weighted TSS concentration based on land use/cover conditions in each of the subbasins evaluated. For the solids loading estimates, Gould and Hartley (2008) used the surrogate TSS dataset compiled for the LDW lateral load analysis (SPU 2008). This dataset, which contains more than 500 samples from 25 sites in Bellevue, Everett, Issaquah, Tacoma, and Seattle, provides a robust characterization of TSS in urban runoff for a wide range of land use conditions. As shown in Table 4-4, TSS concentrations in the surrogate dataset are comparable to the concentrations measured in the Lander SD samples. Preliminary solids loading estimates for a typical dry, wet, and average year are summarized in Table 4-7. These estimates will be updated for use in the STE and SRI/FS after the SD basin boundaries are finalized as described above.

Table 4-7
Ranges of Solids Estimates for Stormwater Solids Discharges

Contributing Area	TSS Quantity (MT/yr)[1]		
	Dry WY	Average WY	Wet WY
SPU Lander CSO/SD			
Low[2]	35	42	52
High[3]	59	71	88
SPU nearshore basins[4]	10	12	15
SPU bridges/aprons[5]	0.6	0.7	0.9
Total SPU			
Low	46	54	68
High	70	83	104
Port nearshore basins[6]	44	53	65
Port aprons[7]	2	3	3
Total Port	47	56	68
Other basins[8]	3	4	5
Total area draining to EW			
Low	96	114	141
High	120	143	177

Notes:

WY = water year

1. Some basin areas have been revised or are under revision since the preliminary runoff and solids discharge estimates were prepared by Gould and Hartley (2008). Solids discharge estimates will be revised when basin delineations are complete. Revisions will be completed for the STM.
2. Areas draining to City-owned outfalls (excludes portions of Port property that drain to the Lander SD)

3. For partially separated areas in the Lander SD basin. Low runoff estimate calculated from SPU GIS maps and includes only those areas where mapping is available and shows the onsite drainage connected to the public separated storm drain system in the right-of-way.
4. For partially separated areas in the Lander SD basin. High runoff estimate calculated assuming that half of the remaining parcels that are either not currently mapped or are currently shown as connected to the combined sewer system will be re-plumbed to the storm drain system in the future as redevelopment occurs. Includes 13.6 acres for the Connecticut separated storm drain system.
5. Over-water structures (e.g., West Seattle Bridge)
6. Port property draining to the EW via Port- or City-owned storm drains.
7. Over-water aprons that drain to the EW via apron drains.
8. Areas draining to EW via privately-owned storm drains.

4.2.4 Chemical Characteristics

Information regarding the chemical characteristics of stormwater is available from sampling of stormwater system solids, and also from sampling of stormwater from within the Lander drainage system.

4.2.4.1 Sampling of Storm Drain Sediments

Chemical characterization data for storm drain sediment were presented in the EISR (Anchor and Windward 2008b). These data were collected by SPU between 2003 and 2005.

SPU has been focusing on sampling sediment that accumulates or is transported within the SD system to provide a direct measure of the sediment-bound contaminants that could affect sediment in the EW. Solid material in the drainage system can be transported in the water column as suspended solids or can move along the bottom of the pipe as bedload material. Because of these different transport mechanisms, no one sampling technique is capable of collecting a representative sample of storm drain sediment. SPU uses a variety of different samples to characterize SD sediment. Each type of sample represents either a different fraction of the sediment in the system or a different geographic scale. Between 2003 and 2005, SPU collected the following types of samples:

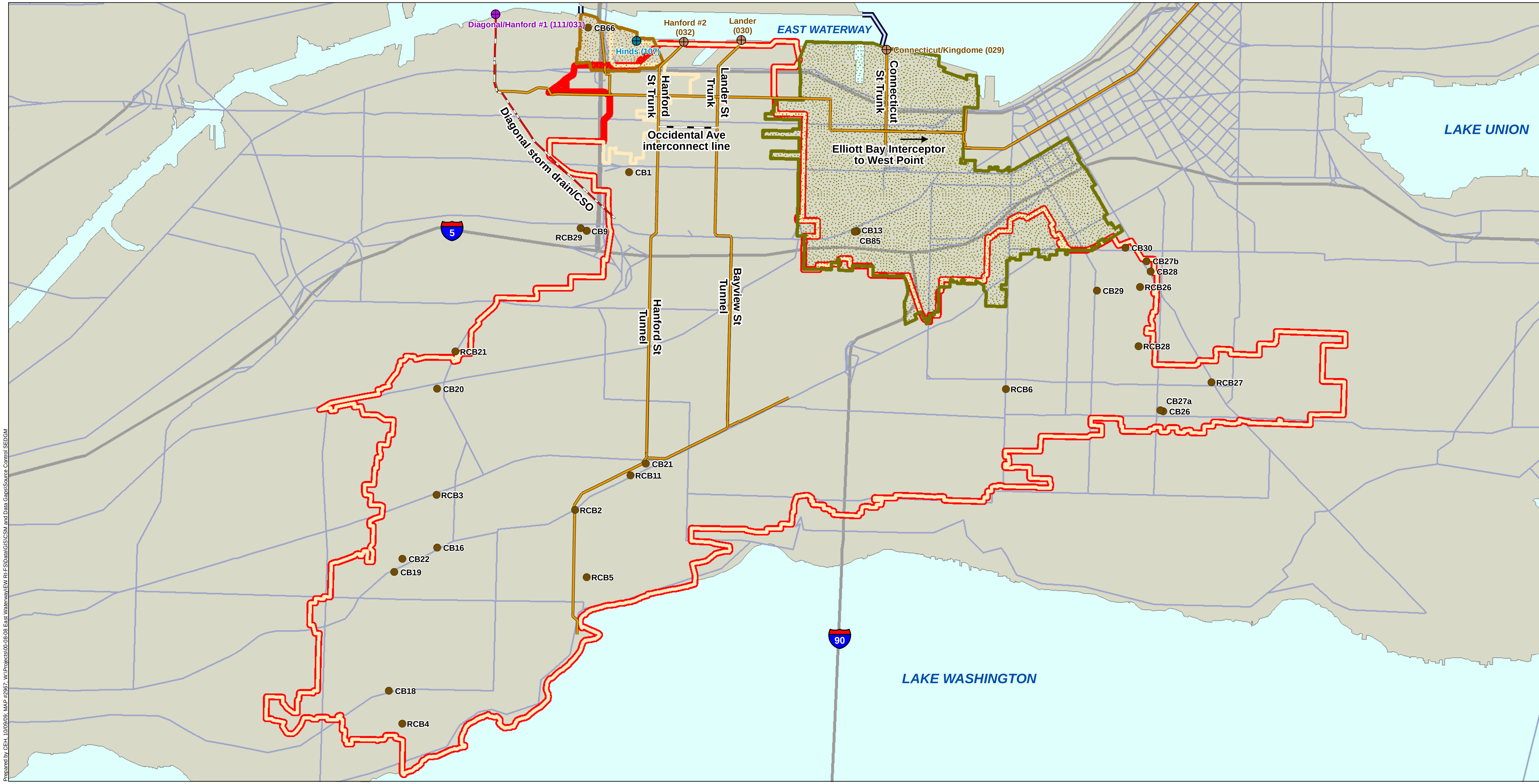
- **Inline Sediment Grabs:** Inline samples are collected from maintenance holes in the main trunklines of the SD system wherever enough sediment has accumulated for sampling. These samples represent contributions from the entire drainage basin upstream of the sampling site (anywhere from greater than 1 acre to hundreds of acres). Inline samples are typically used to identify specific problem areas within a drainage system.

- **Catch Basin Sediment:** Sediment samples are collected from catch basins located in the public ROW and in private drainage systems identified during business inspections (onsite catch basins). Samples are generally composited from three to four grabs collected from multiple locations in the catch basin structure. These samples represent contributions from areas that drain areas immediately adjacent to the catch basin, generally less than 1 acre in size. These samples are used to characterize the sediment derived from runoff from that specific location in the drainage basin.

Sampling procedures employed by the City generally followed Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1986; Herrera 2004b). Samples were collected using either a stainless steel spoon or long-handled scoop (Herrera 2004b). Samples were analyzed for PCBs, total petroleum hydrocarbons (TPH), SVOCs, metals, grain size, total solids, and TOC according to EPA-approved methods. Analytical results were validated by a third party and followed EPA's Contract Laboratory Program National Functional Guidelines for Data Review (EPA 1999, 2002).

Subsequent to the EISR (Anchor and Windward 2008b), the available SPU source tracing data were reviewed to verify that all sampling data potentially relevant to the EW were included. The updated dataset (Table 4-8) includes 20 site-specific storm drain sediment samples that were collected from within the Lander and nearshore SD basins. The site-specific sampling locations are shown in Figure 4-2.

Surrogate storm drain sediment data are available from 30 catch basins that characterize storm drain sediment from within the combined sewer service areas associated with the Hanford #2 and Lander Street CSOs. Sampling locations for the surrogate data set are shown on Figure 4-3. The chemical data for the site-specific dataset are summarized in Table 4-9. Table 4-10 summarizes the data for the combined dataset, including both site-specific and surrogate storm drain sediment.



- Catch basin samples from the combined sewer service areas[1]
  - CB = catch basin
  - RCB = right-of-way catch basin
- CSO discharge points
  - (###) Outfall number as per permit
- City of Seattle CSO discharge point
- King County CSO discharge point
- City of Seattle and King County CSO discharge point
- Combined sewer trunk line
- Diagonal storm drain
- Hinds combined sewer service area[1]
- Kingdome combined sewer service area[2]
- Lander combined sewer service area[2]
- Hanford #2 combined sewer service area[2]
- Proposed East Waterway Operable Unit Boundary

[1] Source: City of Seattle. The City's Hinds CSO discharges to the Hinds CSO/SD outfall owned by the City of Seattle.
[2] Source: King County. The Lander and Hanford #2 combined sewer service areas are largely coincident. The Lander CSO discharges to a CSO/SD outfall owned by the City of Seattle. The Hanford #2 CSO discharges to a CSO outfall owned by King County. The Kingdome CSO discharges to the Connecticut CSO/SD outfall owned by the City of Seattle.
Note: Service area boundaries have not been completely validated. Sample locations CB9, CB13, CB85, RCB21, and RCB29 were included due to uncertainty in the service area boundaries.

0 2,400
Scale in feet

Figure 4-3
Combined Sewer Service Areas and Catch Basin Sampling Locations in the Vicinity of the East Waterway
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Table 4-8
Summary of Storm Drain Sediment Characterization Data

Sample Type	Drainage Basin			
		Site-specific		
	Surrogate[a]	Lander SD Basin	Nearshore SD Basin	Total
Inline grab	na	0	2	**2**
Onsite catch basin	19	7	7	**33**
ROW catch basin	11	3	1	**15**
Total	**30**	**10**	**10**	**50**

Notes:
a Surrogate storm drain sediment data were collected from catch basins within the combined sewer service areas associated with the Hanford #2 and Lander Street CSOs.
na Not applicable. Inline grab samples from within the combined sewer service areas were not collected for characterization of storm drain sediments because inline grabs from the combined sewer would be representative of combined inputs from both sanitary system and stormwater. If in-line grabs were available from stormwater-only lines, then they would respresent stormwater solids.

Tables 4-9 and 4-10 present the detection frequency, ranges of detected concentrations of the focus compounds, other frequently detected (greater than or equal to 5 percent) constituents, TOC, and PSD. Non-detected results are not included in the data summaries provided in Tables 4-9 and 4-10. The mean, median, 25th, and 75th percentiles are presented when the number of samples for which a particular chemical is detected is greater than or equal to five samples, and when the detection frequency is greater than 10 percent of the dataset.

Consistent with the evaluation process described in Section 3, the data in Tables 4-9 and 4-10 have been compared to SMS reference values, including the SQS and the CSL. While these criteria may not apply directly to these media, the criteria provide a basis for evaluating the potential for sediment impacts and prioritizing further evaluation. Because the TOC concentrations of most of the samples are elevated above 4 percent, the concentrations for organic compounds are presented as dry weight (dw) and are compared to dry weight SMS criteria or to the apparent effects threshold (AET) equivalents of SMS for the chemicals with carbon-normalized SMS criteria.

Table 4-9
Site-Specific Storm Drain Sediment Data

Parameter	Detected Concentrations								Comparative Criteria		Count of Detects Relative to Criteria		Percent of Detects Relative to Criteria	
							Percentile							
	Detects[a] (#)	Detection Frequency	Min	Max	Mean	Median	25th	75th	SQS/ LAET	CSL/ 2LAET	Between the SQS or LAET and the CSL or 2LAET	Above the CSL or 2LAET	Between the SQS or LAET and the CSL or 2LAET	Above the CSL or 2LAET
Metals (mg/kg DW)														
Arsenic[b]	15	75%	7	14	11	10	10	12	57	93	0	0	0	0
Copper[b]	20	100%	44	5010	464	197	126	325	390	390	3	3	15	15
Lead[b]	20	100%	33	600	159	127	67	178	450	530	1	0	5	0
Mercury[b]	16	80%	0.060	0.34	0.15	0.12	0.088	0.20	0.41	0.59	0	0	0	0
Zinc[b]	20	100%	152	2,730	896	821	416	1,145	410	960	15	6	75	30
LPAH (µg/kg DW)														
Acenaphthene	1	5%	150	150	na	na	na	na	500	730	0	0	0	0
Fluorene	5	25%	160	1,700	650	310	160	940	540	1,000	3	2	15	10
Phenanthrene	18	90%	100	4,200	1430	850	475	1,780	1,500	5,400	6	0	30	0
Total LPAH	18	90%	100	25,200	4,090	1,100	500	3,300	370	780	16	10	80	50
HPAH (µg/kg DW)														
Benzo(a)anthracene	12	60%	81	4,000	620	290	180	420	1,300	1,600	1	1	5	5
Benzo(a)pyrene	11	55%	89	4,800	740	240	190	500	1,600	3,000	1	1	5	5
Benzo(g,h,i)perylene	7	38%	140	1,300	460	320	200	550	670	720	2	2	10	10
Total Benzofluoranthenes	16	80%	120	12,800	1,500	610	370	1,000	3,200	3,600	1	1	5	5
Chrysene	17	85%	170	6,200	1,100	690	500	1,100	1,400	2,800	3	1	15	5
Dibenzo(a,h)anthracene	1	5%	660	660	na	na	na	na	230	540	1	1	5	5
Fluoranthene	17	85%	220	12,000	2,170	1,500	980	2,300	1,700	2,500	9	3	45	15
Indeno(1,2,3-c,d)pyrene	4	20%	140	1,900	na	na	na	na	600	690	1	1	5	5
Total HPAH	18	90%	120	49,680	7,130	4,430	3,060	7,130	960	5300	17	7	18	35
Phthalates (µg/kg DW)														
Bis(2-ethylhexyl)phthalate	20	100%	420	160,000	19,000	10,500	5,530	19,000	1,300	1,900	19	19	95	95
Butylbenzylphthalate	19	95%	160	34,000	3,260	1100	665	1,500	63	900	19	19	95	65
Other organic compounds (µg/kg DW)														
1,4-Dichlorobenzene[c]	0	0%	nd	nd	nd	nd	nd	nd	110	120	0	0	0	0
Phenol[b]	5	25%	460	8,400	2,770	1,300	590	3,100	420	1,200	5	3	25	15
Total PCBs (µg/kg DW)	17	85%	20	2,110	254	87	51	174	130	1,000	5	1	25	5
Total Organic Carbon (%)	20	100%	1.4	17	7.8	7.3	5.5	9.5	na	na	na	na	na	na
Particle Size Distribution[d]														
Clay and fine silt	18[e]	100%	2.1	32.0	11.9	9.9	6.0	16.7	na	na	na	na	na	na
Medium/coarse silt	18[e]	100%	2.6	30.1	14.4	14.6	7.7	21.3	na	na	na	na	na	na
Fine sand	18[e]	100%	19.7	34.1	24.3	24.9	21.2	26.7	na	na	na	na	na	na
Medium/coarse sand	18[e]	100%	17.6	73.9	48.8	51.1	38.7	58.4	na	na	na	na	na	na

Notes:

a – Total sample count is 20 as indicated by basin and type in Table 4-8; data include site-specific data from the Lander and nearshore SD basins.

b – Indicates chemical compared to Sediment Management Standards (SMS) since SMS criteria is dry weight-based.

c – MDLs of 1,4 dichlorobenzene samples are between 78 and 1,800 µg/kg dw. The LAET and 2LAET for 1,4 dichlorobenzene are 110 and 120 µg/kg dw, respectively.

d – Clay and fine silt represents fraction <16 µm, medium/coarse silt = 16 µm > 63 µm, fine sand = 63 µm > 250 µm, and medium/coarse sand = 250 µm > 2,000 µm.

e– PSD was not analyzed from the inline grab samples.

SQS/CSL dry weight AET equivalent is shown for organic chemicals normally expressed as organic carbon-normalized values.

2LAET – second lowest apparent effects threshold

CSL – Cleanup Screening Level

LAET – lowest apparent effects threshold

na – not applicable

nd – not detected

SQS – Sediment Quality Standards

Table 4-10
Combined Site-Specific and Surrogate Storm Drain Sediment Data

Parameter	Detected Concentrations								Comparative Criteria		Count of Detects Relative to Criteria		Percent of Detects Relative to Criteria	
	Detects (#)[a]	Detection Frequency	Min	Max	Mean	Median	Percentile 25th	Percentile 75th	SQS/ LAET	CSL/ 2LAET	Between the SQS or LAET and the CSL or 2LAET	Above the CSL or 2LAET	Between the SQS or LAET and the CSL or 2LAET	Above the CSL or 2LAET
Metals (mg/kg DW)														
Arsenic	28	56%	7	30	14	11	10	16	57	93	0	0	0	0
Copper[b]	50	100%	38	5,010	346	157	84	259	390	390	9	9	18	18
Lead[b]	50	100%	33	2,010	233	129	94	205	450	530	5	4	10	8
Mercury[b]	35	70%	0.06	1.820	0.324	0.190	0.105	0.300	0.41	0.59	5	4	10	8
Zinc[b]	50	100%	85	2,730	680	494	299	922	410	960	29	12	58	24
LPAH (µg/kg DW)														
Acenaphthene	4	8%	45	400	na	na	na	na	500	730	0	0	0	0
Fluorene	9	18%	47	1,700	499	310	160	630	540	1,000	3	1	6	2
Phenanthrene	42	84%	93	7,800	1,190	640	405	1,275	1,500	5,400	9	1	18	2
Total LPAH	44	88%	93	25,200	2,251	820	395	1,918	370	780	34	22	68	44
HPAH (µg/kg DW)														
Benzo(a)anthracene	30	60%	43	4,400	586	270	153	503	1,300	1,600	2	2	4	4
Benzo(a)pyrene	28	56%	47	4,800	624	250	188	503	1,600	3,000	2	2	4	4
Benzo(g,h,i)perylene	19	38%	40	2,900	424	220	130	320	670	720	3	3	6	6
Total Benzofluoranthenes	38	76%	90	12,800	1,441	635	400	1,295	3,200	3,600	3	2	6	4
Chrysene	43	86%	97	7,900	1,016	520	360	845	1,400	2,800	8	3	16	6
Dibenzo(a,h)anthracene	2	4%	630	660	na	na	na	na	230	540	2	2	4	4
Fluoranthene	43	86%	170	26,000	2,205	1,100	635	2,150	1,700	2,500	14	7	28	14
Indeno(1,2,3-c,d)pyrene	14	28%	55	3,200	579	225	123	308	600	690	3	3	6	6
Total HPAH	45	90%	120	68,000	6,790	3,670	2,090	6,110	960	5300	40	15	80	30
Phthalates (µg/kg DW)														
Bis(2-ethylhexyl)phthalate	50	100%	410	160,000	21,807	11,000	4,025	19,750	1,300	1,900	47	46	94	92
Butylbenzylphthalate	44	88%	130	34,000	3,170	930	333	1,825	63	900	44	23	88	46
Other organic compounds (µg/kg DW)														
1,4-Dichlorobenzene	3	6%	310	520,000	na	na	na	na	110	120	3	3	6	6
Phenol[b]	13	26%	52	8,400	1,825	590	170	3,100	420	1,200	8	5	16	10
Total PCBs (µg/kg DW)	39	78%	18	3,200	333	88	43	230	130	1,000	17	3	34	6
Total Organic Carbon	50	100%	1.2	26	8.4	7.3	5.2	11	na	na	na	na	na	na
Particle Size Distribution[c]														
Clay and fine silt	48[d]	100%	0.9	32.0	5.9	8.8	5.6	12.0	na	na	na	na	na	na
Medium/coarse silt	48[d]	100%	1.7	32.4	7.4	9.2	6.5	12.5	na	na	na	na	na	na
Fine sand	48[d]	100%	5.6	44.4	22.0	21.6	19.3	24.1	na	na	na	na	na	na
Medium/coarse sand	48[d]	100%	17.6	82.5	60.1	66.5	40.6	70.2	na	na	na	na	na	na

Notes:

a – Total sample count is 50 as indicated by basin and type in Table 4-8 data include site-specific data from the Lander and nearshore SD basins.

b – Indicates chemical compared to Sediment Management Standards (SMS) since SMS criteria is dry weight-based.

c – Clay and fine silt represents fraction <16 µm, medium/coarse silt = 16 µm < 63 µm, fine sand = 63 µm < 250 µm, and medium/coarse sand = >250 µm.

d– PSD was not analyzed from the inline grab samples.

SQS/CSL dry weight AET equivalent is shown for organic chemicals normally expressed as organic carbon-normalized values.

2LAET – second lowest apparent effects threshold

CSL – Cleanup Screening Level

LAET – lowest apparent effects threshold

MDL – method detection limit. A non-detected concentration is reported at this value.

na – not applicable

SQS – Sediment Quality Standards

Based on the site-specific data presented in Tables 4-9 and 4-10, heavy metals, phthalates, PAHs, and PCBs are frequently detected in source tracing samples.

- **Phthalates:** Two phthalate compounds, BEHP and BBP, were the compounds most frequently detected above the listed reference values. These compounds exceeded the 2LAET values in the majority of the samples. Both of these compounds are focus compounds for the EW SCE. Other phthalates only infrequently exceeded the 2LAET values.
- **Heavy Metals:** Some exceedances of SMS values were noted for copper, lead, and zinc. None of these compounds have been detected above SQS or CSL criteria during EW recontamination monitoring. Mercury concentrations exceeded the SQS and CSL in some (10 and 8 percent, respectively) of the surrogate samples, but not in any of the site-specific samples. Arsenic did not exceed the SQS or CSL in either the site-specific or surrogate samples.
- **PAH Compounds:** Fluoranthene, total LPAH, and total HPAH exceeded the 2LAET values in many of the site-specific samples, and exceeded the LAET values in the majority of samples. Several other PAH compounds were detected above the 2LAET/LAET values less frequently, including benzo(a)anthracene, benzo(a)pyrene, total benzofluoranthenes, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, and phenanthrene. None of the PAH compounds have been detected above the SQS or CSL criteria during EW recontamination monitoring.
- **Total PCBs:** PCBs exceeded the 2LAET values in only one of the 20 site-specific samples, and exceeded the LAET values in 5 of 20 site-specific samples.
- **Labile Organic Compounds:** Phenol was present above SQS values in some of the source tracing samples. Phenol has been observed above the SQS in EW recontamination monitoring.
- **Other Focus Compounds:** No exceedances were noted in site-specific solids samples for the focus compound 1,4-DCB. However, 1,4-DCB was detected in three of the surrogate samples, all of which exceeded the 2LAET.

4.2.4.2 Source Tracing Box Plots

Figures 4-4a through 4-4i summarize the site-specific and surrogate storm drain sediment data using "box plots." The box plots present the full range of concentrations, the mean, the median, and the 25th and 75th percentiles for copper, mercury, total PCBs, BEHP, BBP, phenol, total LPAH, and total HPAH. Since the concentration ranges can vary by more than an order of magnitude the vertical axis of the box plots are in a log scale. The datasets are presented in full, including potential "outlier" data points that may not be representative of typical storm drain sediment quality within the basins.

The data are presented based on type of sample (onsite catch basin, ROW catch basin (RCB), or inline sediment grab) and by drainage basin (Lander SD, nearshore SD, and surrogate data from the Lander and Hanford combined sewer service areas). These datasets are also presented as a pooled data set, which includes all of the data types and drainage basins together and also pools the data by type regardless of basin designation.

The samples from the Lander and Hanford combined sewer service areas are referred to as a surrogate dataset in the box plots since drainage and storm drain sediment inputs from this area typically goes to the combined sewer and only enters the EW during a CSO overflow event. This dataset also includes some samples that overlap with the Duwamish/ Diagonal and Connecticut combined sewer service areas.

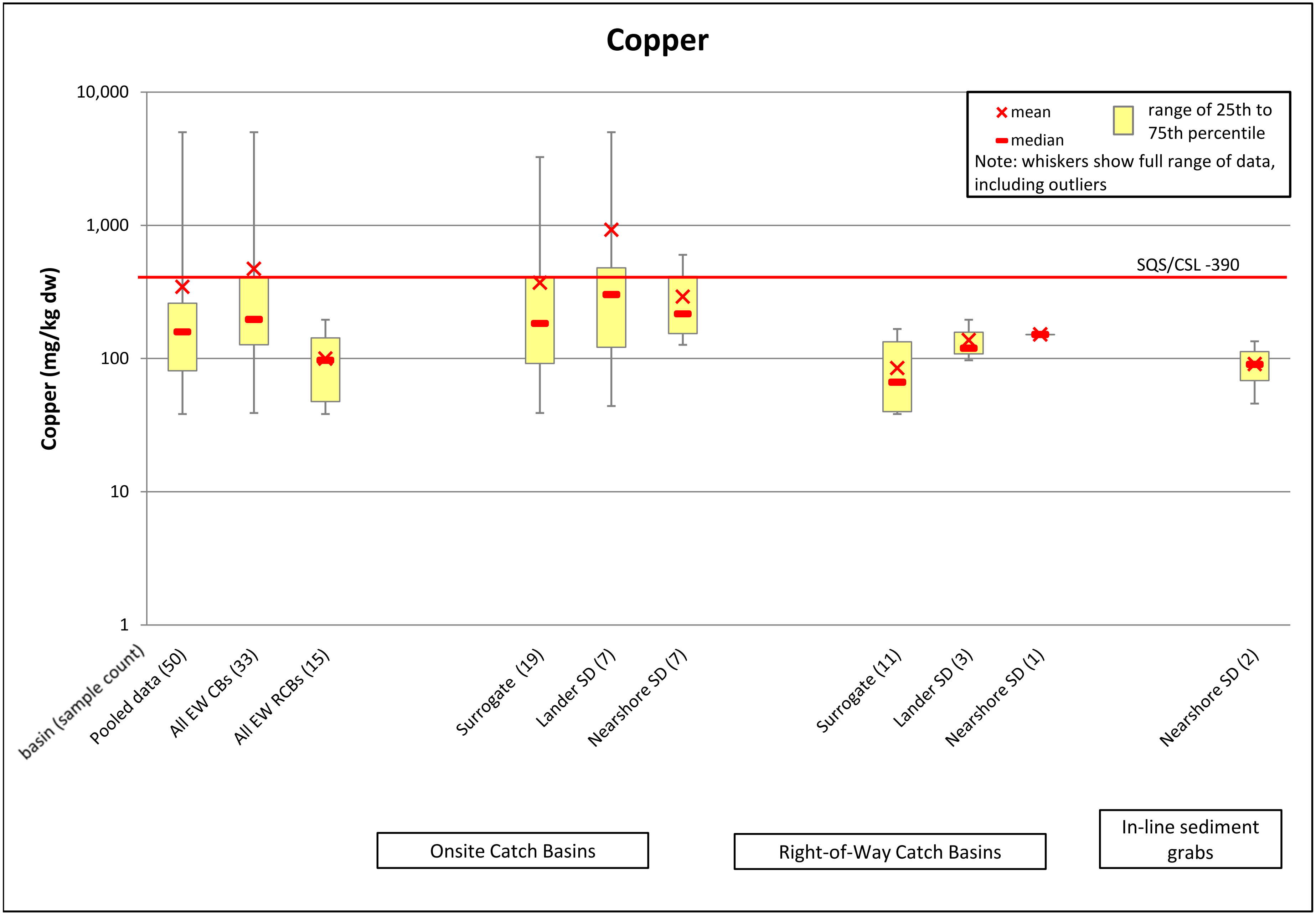


Figure 4-4a
Box Plot - Copper
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

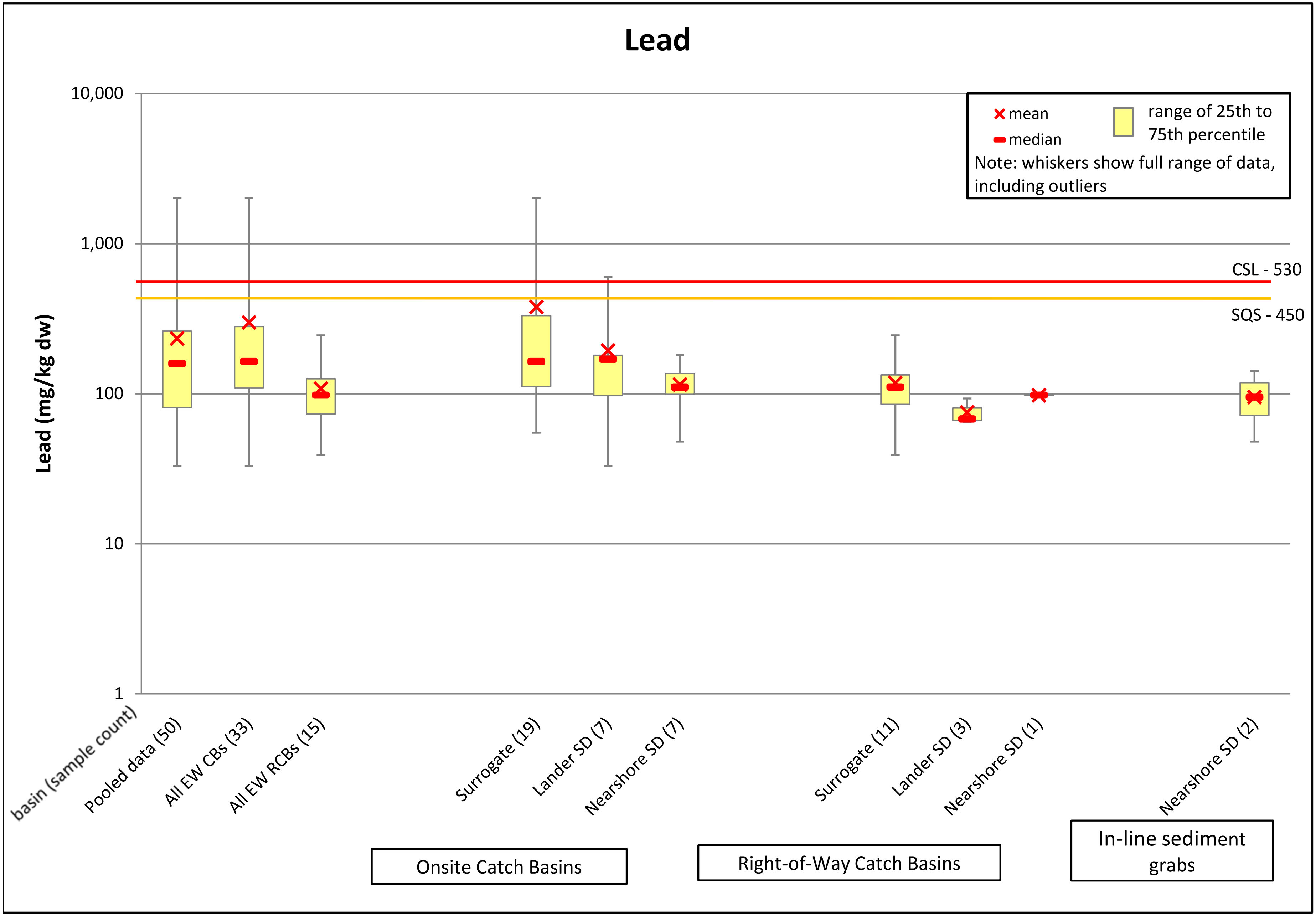


Figure 4-4b
Box Plot - Lead
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

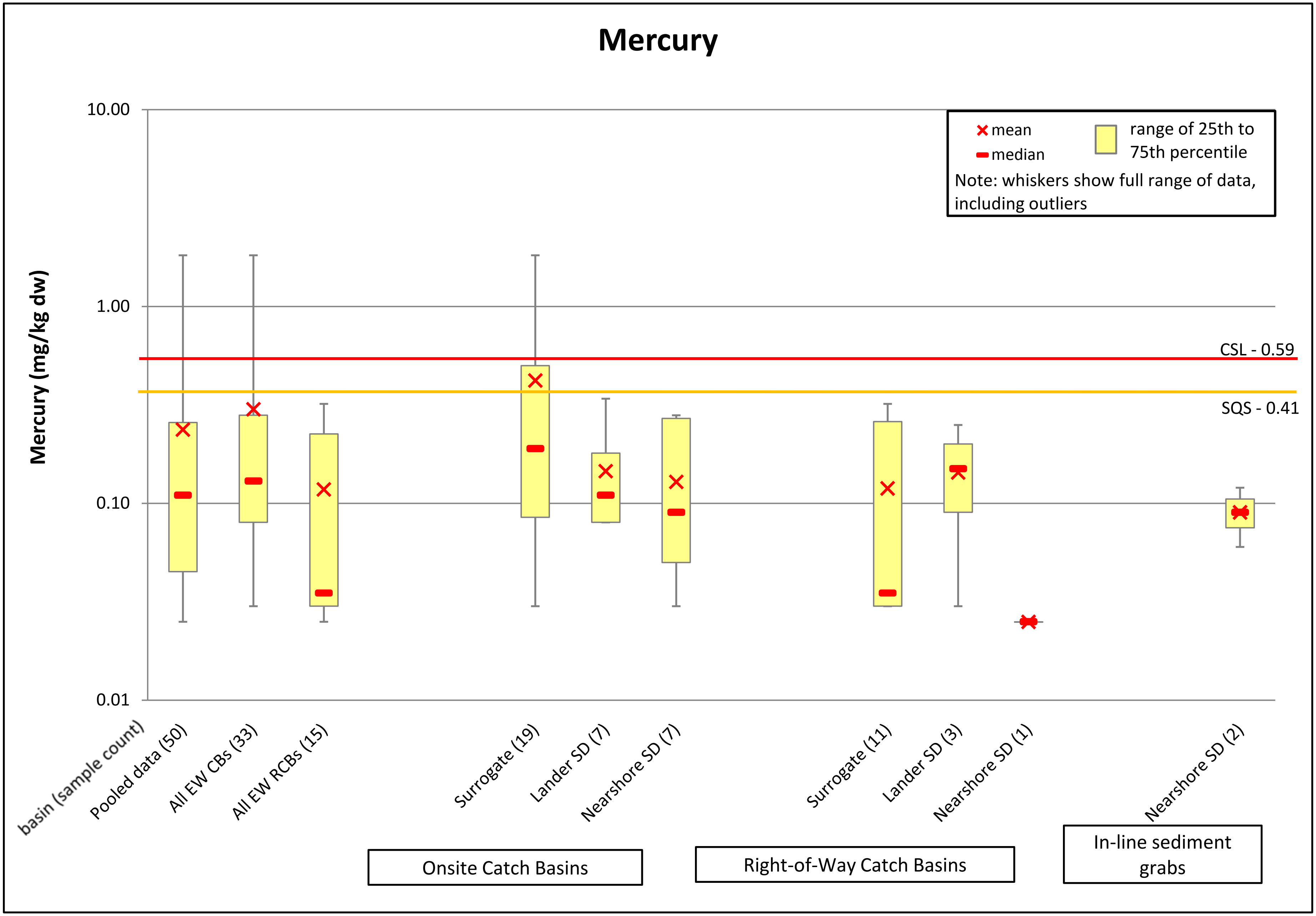


Figure 4-4c
Box Plot - Mercury
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

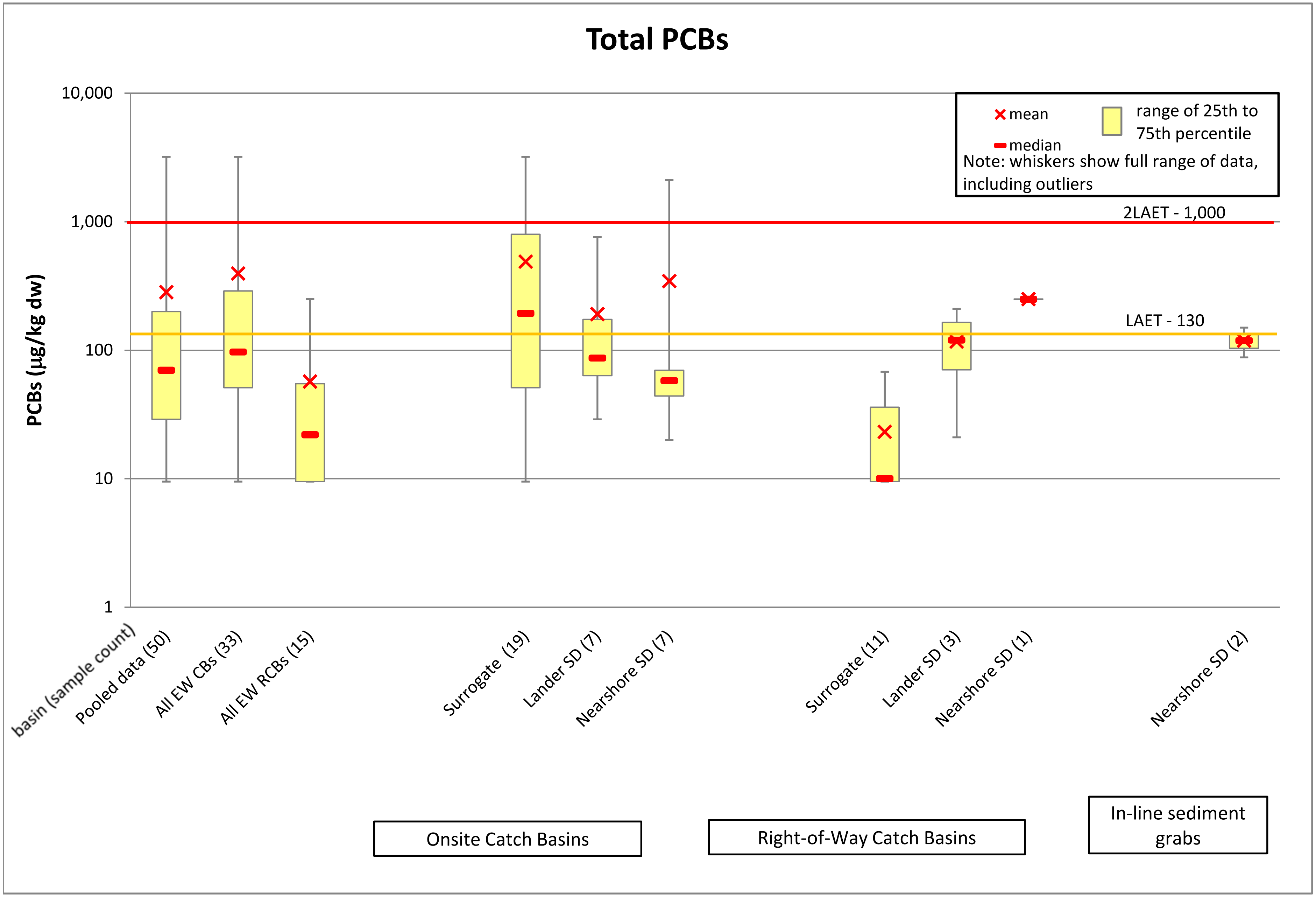


Figure 4-4d
Box Plot - Total PCBs
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

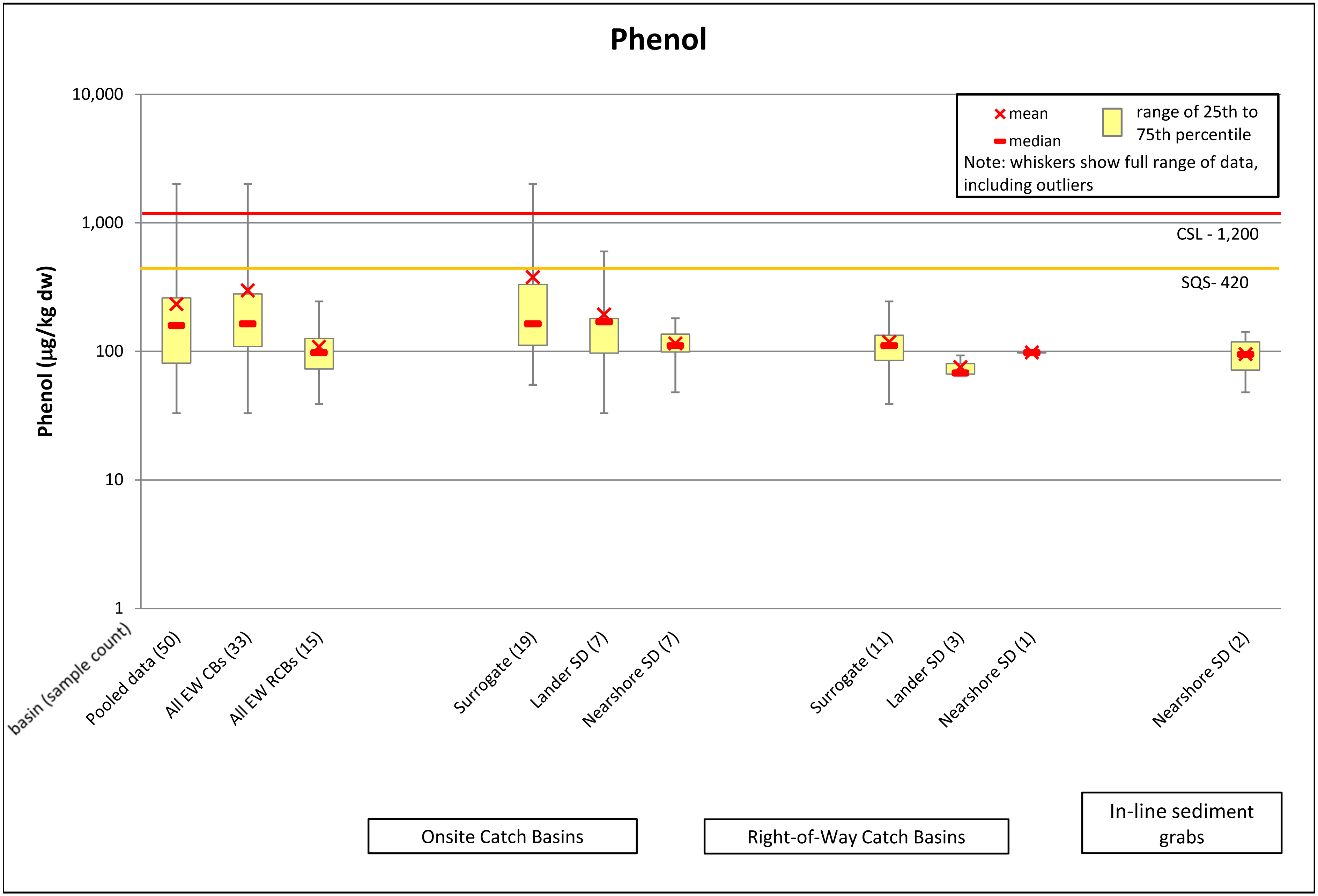


Figure 4-4e
Box Plot - Phenol
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

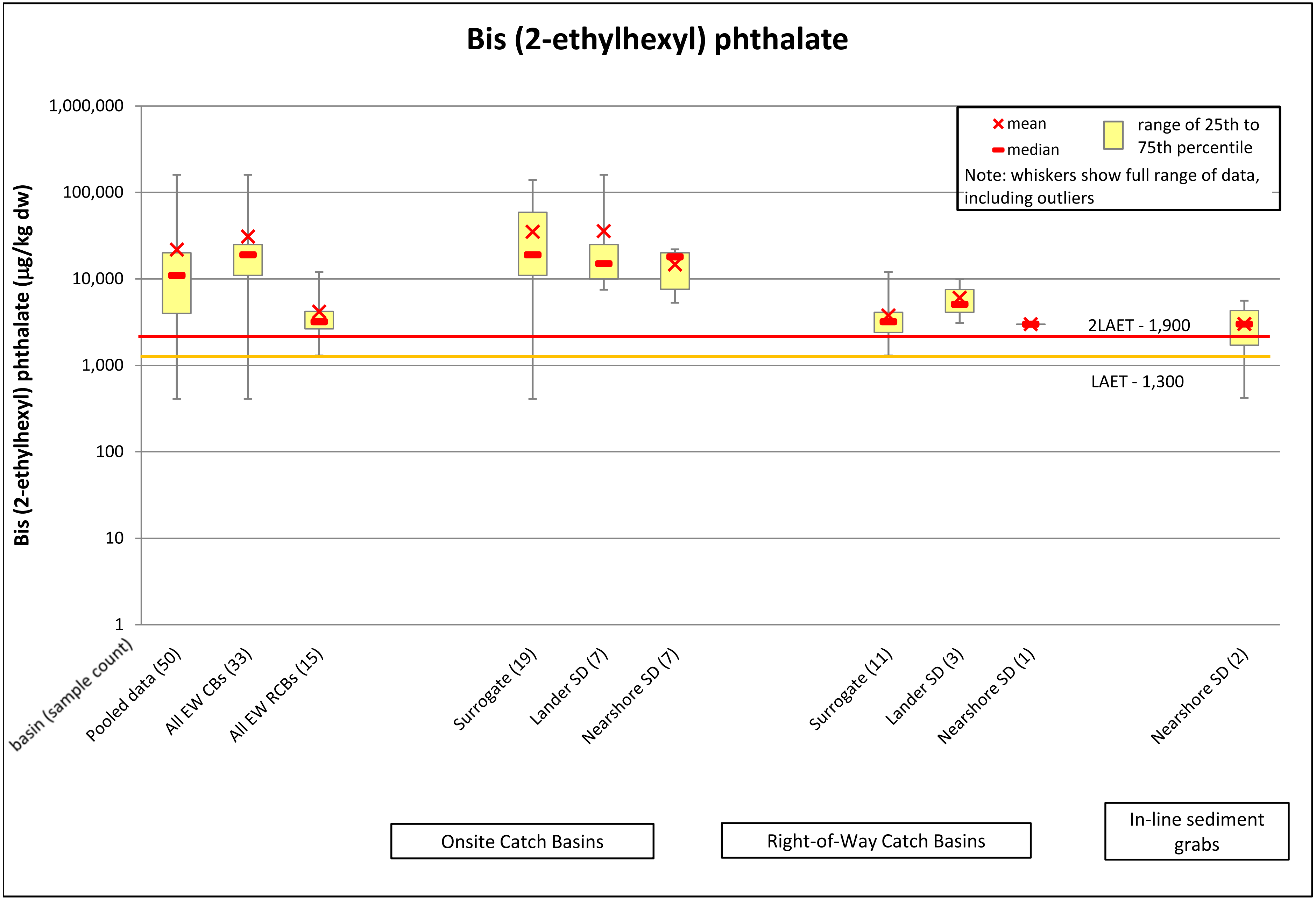


Figure 4-4f
Box Plot - Bis(2-ethyhexyl) phthalate
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

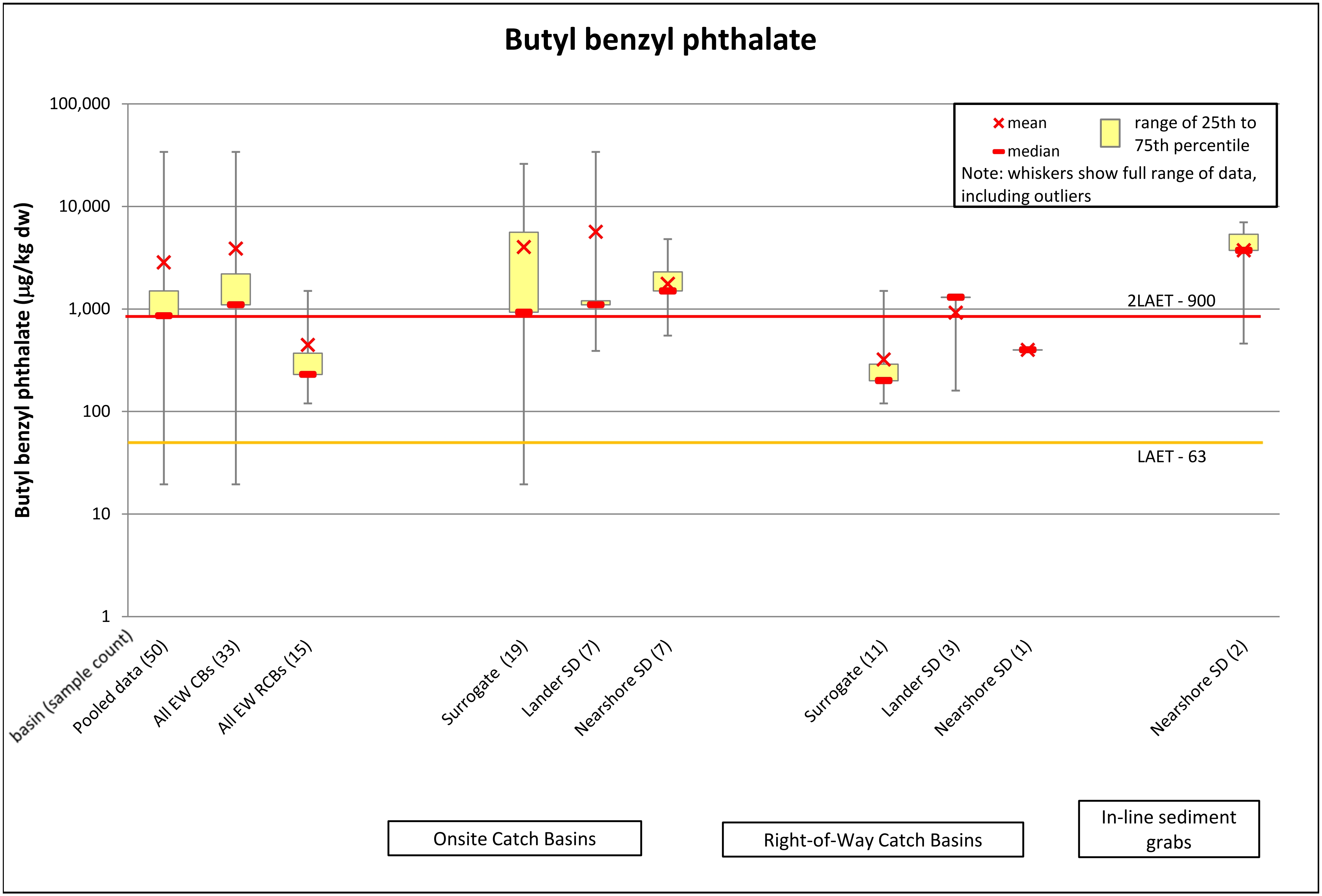


Figure 4-4g
Box Plot - Butyl benzyl phthalate
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

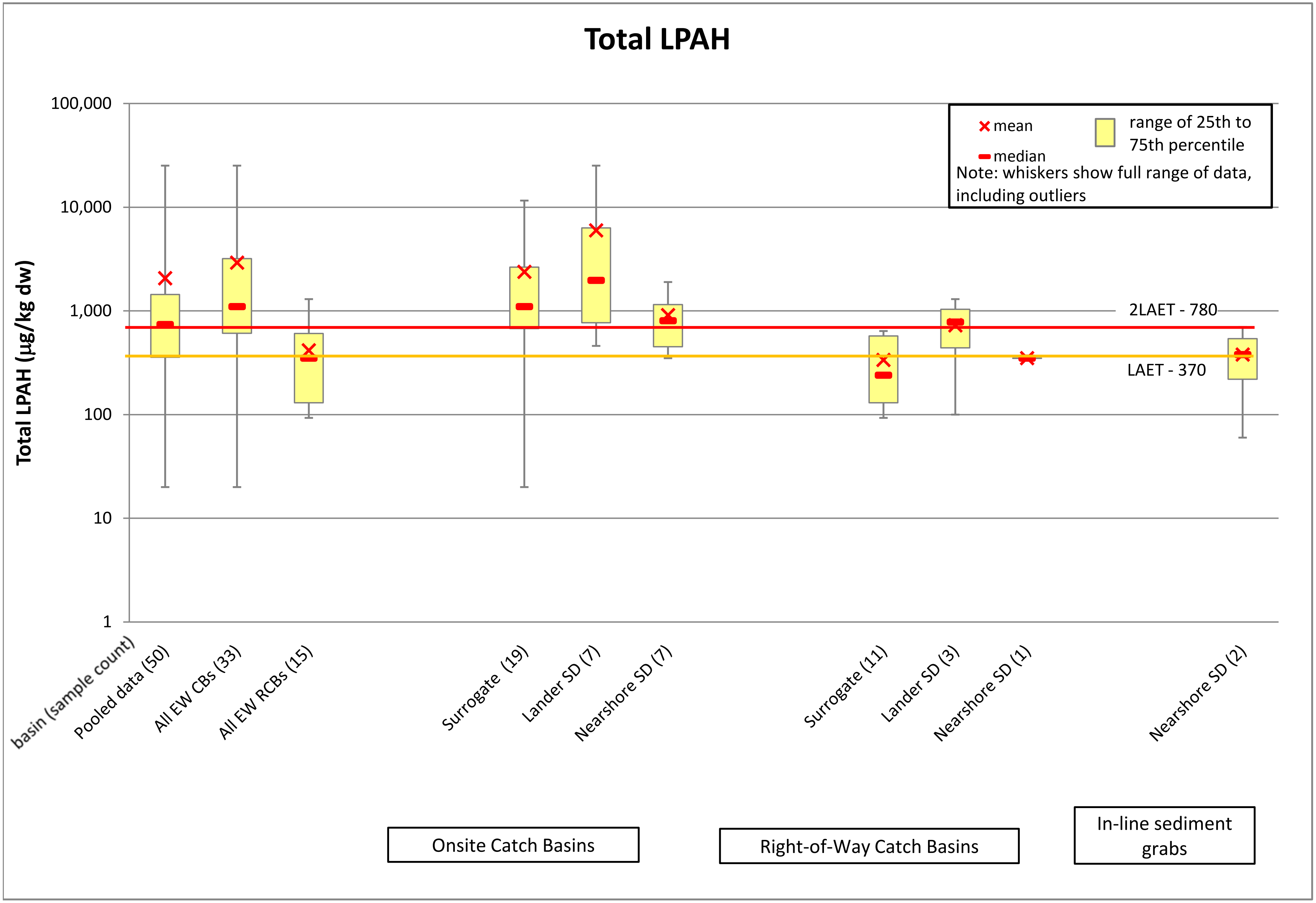


Figure 4-4h
Box Plot - Total LPAH
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

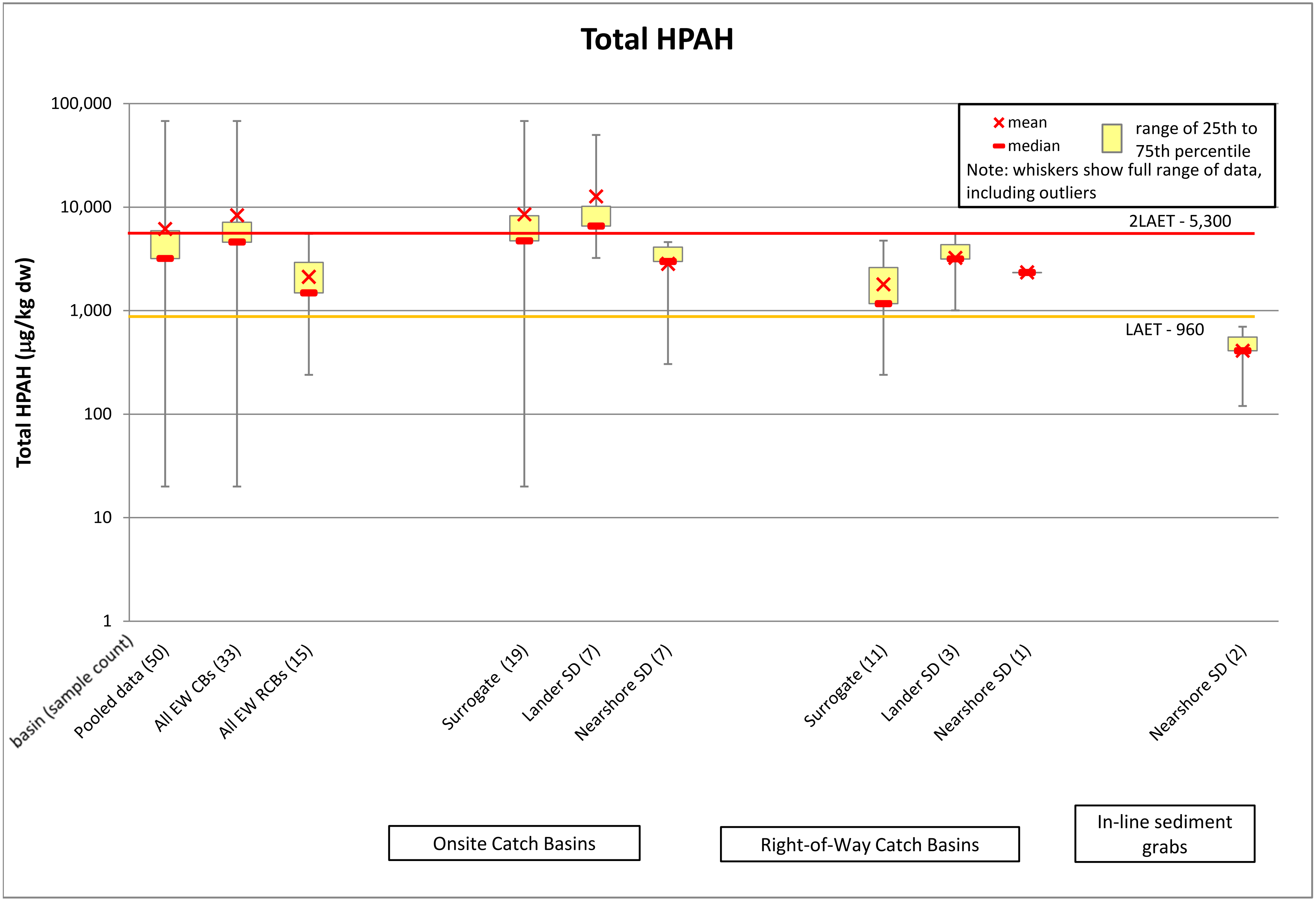


Figure 4-4i
Box Plot - Total HPAH
Initial Source Control Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

4.2.4.3 Lander Stormwater and Base Flow Data

Water quality monitoring data for the Lander SD system were obtained from the County subsequent to the EISR (Anchor and Windward 2008b). That data set included data collected between 1997 and 2002. Whole-water sampling was terminated in 2002.

One of the sampling locations (LAN172S) was located at the regulator where flows from both the separated system and combined system are mixed. The data from LAN172S sampled when no CSO events were occurring are included, since they are representative of water from the separated system. Stormwater data from other sampling locations were not screened out based on possible CSO discharges occurring at the time of sampling because it is difficult to determine the amount of CSO effluent mixed with the stormwater.

All sampling locations are influenced by tidal flows. However, storm conditions were based on rainfall events, rain gauge readings from Chelan Regulator station and field conductivity measurements to ensure that sampling occurs when the system is dominated by stormwater and not tidal water. Base flow samples were conducted during low tide events to decrease the influence of tidal flows. In all cases, the conductivity indicates that the salinity of the stormwater samples was less than 5 parts per thousand (ppt) (i.e., brackish conditions) and in most cases conductivity was indicative of freshwater conditions, suggesting little to no tidal influence present in the storm flow data. Most base flow data have conductivity measurements suggesting brackish to freshwater conditions. Table 4-11 compares the conductivity and calculated salinity data between the Lander storm and base flows. The base flow data has higher conductivity and salinity than the storm flow, indicating that tidal water has a larger influence on the base flow data than the storm flow data.

Table 4-11
Comparison of Lander Storm and Base Flow Conductivity and Salinity
(Sampling 1997-2002)

	Conductivity (umhos/cm)		Salinity (ppt)[a]	
	Base Flow	Storm Flow	Base Flow	Storm Flow
min	218	42.3	<1	<1
max	21,000	6,450	15.9	4.5
mean	3,523	404	2.3	<1
median	896	134	<1	<1
25th	559	88.5	<1	<1
75th	4,179	184	2.8	<1

Notes:
a – Salinity was calculated using the average temperature of base flow data of 14.9°C and storm flow data of 14.1°C.

Tables 4-12 and 4-13 summarize the Lander Street outfall water sampling data collected during storm flow and base flow, respectively. These tables summarize the compound-specific detection frequency, ranges of detected concentrations, and the method detection limit (MDL) ranges. The mean, median, 25th, and 75th percentiles are only applicable and presented when the number of samples for which a particular chemical is detected is greater than five, and the detection frequency is greater than 10 percent of the samples analyzed. These rules were applied in order to avoid the production of unreliable summary statistics.

The range of MDLs is summarized in Tables 4-12 and 4-13. For some contaminants, particularly the heavy metals, the frequency of detection was high, and summary statistics would not be significantly biased by non-detect values and MDLs. However, for most of the organic compounds, the frequency of detection was much lower, and the inclusion of non-detect values in the analysis (e.g., substitution of half-detection limit values for non-detect compounds) would be likely to affect the summary statistics. For PCBs and mercury, all measured values were non-detect.

As discussed in Section 3.2, aqueous stormwater characterization data cannot be compared directly to sediment quality reference values. For comparison to sediment quality reference values, the aqueous concentration data must first be converted to estimates of entrained storm drain sediment quality. This conversion is not performed as part of the current Memorandum, but will be performed as part of the SRI activities when additional data are available from ongoing source characterization work. However, reliable estimates of entrained storm drain sediment quality can only be conducted when paired TSS and chemistry data are available. The stormwater data summarized in Table 4-12 are to be retained for potential further evaluation as part of the SRI.

Table 4-12
Summary of Lander Stormwater Quality Data
(Storm Event Sampling; 1997-2002)

Parameter	Samples (#)	Detects (#)	Detection Frequency	Detected Concentrations						MDL Concentrations	
				Min	Max	Mean	Median	25th percentile	75th percentile	Min	Max
Metals (µg/L)											
Arsenic, Total, ICP-MS	28	26	93%	1	5.62	2.7	2.5	1.95	3.18	0.5	10
Copper, Total, ICP-MS	28	28	100%	2.76	90.6	41.6	35.8	27.0	58.2	0.4	0.5
Lead, Total, ICP-MS	28	28	100%	0.88	64.2	23.6	22.8	14.2	28.9	0.2	0.5
Mercury, Total, CVAA	28	0	0%	na	na	na	na	na	na	0.2	0.2
Zinc, Total, ICP-MS	28	28	100%	28.2	375	158	141	104.5	212	0.5	5
PAHs (µg/L)											
LPAHs											
Acenaphthene	28	1	4%	1.61	1.61	na	na	na	na	0.19	0.2
Acenaphthylene	28	1	4%	0.481	0.481	na	na	na	na	0.28	0.3
Anthracene	28	1	4%	1.16	1.16	na	na	na	na	0.28	0.3
Fluorene	28	2	7%	0.788	3.81	na	na	na	na	0.28	0.3
Pyrene	28	14	50%	0.28	1.2	0.442	0.34	0.3	0.393	0.28	0.3
HPAHs											
Benzo(a)anthracene	28	1	4%	0.31	0.31	na	na	na	na	0.28	0.3
Benzo(a)pyrene	28	0	0%	na	na	na	na	na	na	0.47	0.5
Benzo(b)fluoranthene	28	0	0%	na	na	na	na	na	na	0.75	0.8
Benzo(g,h,i)perylene	28	0	0%	na	na	na	na	na	na	0.47	0.5
Benzo(k)fluoranthene	28	0	0%	na	na	na	na	na	na	0.75	0.8
Chrysene	28	2	7%	0.32	0.801	na	na	na	na	0.28	0.3
Dibenzo(a,h)anthracene	28	0	0%	na	na	na	na	na	na	0.75	0.8
Fluoranthene	28	10	36%	0.29	1.34	0.473	0.345	0.325	0.4275	0.28	0.3
Indeno(1,2,3-Cd)pyrene	28	0	0%	na	na	na	na	na	na	0.47	0.5
Phenanthrene	28	6	21%	0.29	8.18	1.923	0.745	0.3275	1.23	0.28	0.3
Phthalates (µg/L)											
Butylbenzylphthalate	28	19	68%	0.3	3.2	0.796	0.46	0.37	0.65	0.28	0.3
Bis(2-ethylhexyl)phthalate	28	28	100%	1.31	112	10.7	5.55	4.19	8.9	0.28	0.3
Total PCBs (µg/L)	28	0	0%	na	na	na	na	na	na	0.12	0.24
Other SVOCs (µg/L)											
1,4-Dichlorobenzene	28	1	4%	0.708	0.708	na	na	na	na	0.28	0.3
Phenol	28	3	11%	2.93	4.26	3.65	3.75	3.34	4.01	1.9	2

Notes:

a – Only total metals results for samples analyzed by inductively coupled plasma mass spectrometer (ICP-MS) are reported.
na - not applicable
nd - not detected in any of the samples analyzed. Range of MDLs is shown at right for the sample set.
MDL – method detection limit. A non-detected concentration is reported at this value.

Table 4-13
Summary of Lander Base Flow Water Quality Data
(Sampling 1997-2002)

Parameter	Samples (#)	Detects (#)	Detection Frequency	Detected Concentrations: Min	Max	Mean	Median	25th percentile	75th percentile	MDL Concentrations: Min	Max
Metals (µg/L)											
Arsenic	56	47	84%	1.4	41.8	6.12	2.4	2.0	6.16	0.5	13
Copper	56	54	96%	1.4	45.8	8.21	5.13	3.2	10.5	0.4	8
Lead	56	48	86%	0.21	42.9	4.23	2.49	0.783	4.95	0.2	5
Mercury	56	0	0%	na	na	na	na	na	na	0.2	0.2
Zinc	56	56	100%	7.05	1,830	61.1	22	14.3	42.3	0.5	10
PAHs (µg/L)											
LPAHs											
Acenaphthene	56	1	2%	0.458	0.458	na	na	na	na	0.19	0.19
Acenaphthylene	56	0	0%	na	na	na	na	na	na	0.28	0.28
Anthracene	56	1	2%	0.46	0.46	na	na	na	na	0.28	0.28
Fluorene	56	1	2%	0.944	0.944	na	na	na	na	0.28	0.28
Pyrene	56	2	4%	0.33	0.482	na	na	na	na	0.28	0.28
HPAHs											
Benzo(a)anthracene	56	1	2%	0.32	0.32	na	na	na	na	0.28	0.28
Benzo(a)pyrene	56	0	0%	na	na	na	na	na	na	0.47	0.47
Benzo(b)fluoranthene	56	0	0%	na	na	na	na	na	na	0.75	0.75
Benzo(g,h,i)perylene	56	0	0%	na	na	na	na	na	na	0.47	0.47
Benzo(k)fluoranthene	56	0	0%	na	na	na	na	na	na	0.75	0.75
Chrysene	56	1	2%	0.32	0.32	na	na	na	na	0.28	0.28
Dibenzo(a,h)anthracene	56	0	0%	na	na	na	na	na	na	0.75	0.75
Fluoranthene	56	1	2%	0.49	0.49	na	na	na	na	0.28	0.28
Indeno(1,2,3-Cd)pyrene	56	0	0%	na	na	na	na	na	na	0.47	0.47
Phenanthrene	56	1	2%	1.33	1.33	na	na	na	na	0.28	0.28
Phthalates (µg/L)											
Butylbenzylphthalate	56	13	23%	0.3	3.5	1.37	0.761	0.32	2.79	0.28	0.28
Bis(2-ethylhexyl)phthalate	56	56	100%	0.29	59.4	4.45	2.6	1.25	4.60	0.28	0.28
Total PCBs (µg/L)	56	0	0%	na	na	na	na	na	na	0.24	0.24
Other SVOCs (µg/L)											
1,4-Dichlorobenzene	56	1	2%	0.34	0.34	na	na	na	na	0.28	0.28
Phenol	56	4	7%	2.0	8.47	na	na	na	na	1.9	1.9

Notes:
a – Only total metals results for samples analyzed by inductively coupled plasma mass spectrometer (ICP-MS) are reported.
na - not applicable
nd - not detected in any of the samples analyzed. Range of MDLs is shown at right for the sample set.
MDL – method detection limit. A non-detected concentration is reported at this value.

4.3 Potential Data Gaps and Ongoing Data Collection

This section describes the conclusions of the data gaps analysis for stormwater sources. The data needs are presented in Table 4-14, along with a summary of ongoing data collection efforts that are expected to generate information useful for the EW SRI/FS. Remaining data gaps are identified in the right column of Table 4-14.

4.3.1 Mapping of Storm Drainage Basins and Outfalls

The status of storm drainage basin and outfall mapping is described in Section 4.2.1. Storm drainage basin and outfall mapping has been completed; however, the Port and City are conducting ongoing activities to improve the delineation of the storm drainage basins for nearshore properties. Ongoing activities that will be completed in the near future include the following:

- **Basin B-11 Verification:** The Port and City are conducting additional verification work to assess the discharge location for runoff from a small portion (less than 6 acres) of Basin B-11 located on Harbor Island. It is expected that this portion of this basin discharges to outfalls along the WW, rather than to the EW. The basin maps and summary tables will be updated after completion of field verifications.
- **Connecticut Storm Basin:** The Connecticut Street outfall is located just outside of the EW boundary, and it serves as the discharge point for both the Connecticut separated storm drain basin, and for the Kingdome CSO. The boundaries of the Connecticut Street separated storm drain basin are currently being reviewed by the City. Basin maps and summary tables will be updated after completion of this review.
- **S Hinds Street Storm Basin:** The City is reviewing basin delineation data for the S Hinds Street storm drain basin and combined sewer service areas. Basin maps and summary tables will be updated after completion of this review.

As discussed in Sections 6 and 8 of this Memorandum, an updated database review will be conducted to identify cleanup sites and recent spill events within the EW storm drain basins. This information will be presented as part of the SRI report.

Table 4-14
Summary of Existing Data, Data Gaps, and Ongoing Data Collection Activities Relevant to the SRI/FS – Stormwater

Information Needed to Support SRI/FS	EISR Datasets and Use in Initial Evaluation	Useful Data Identified Subsequent to the EISR	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for the SRI/FS	Remaining SRI/FS Data Gaps
Mapping of Storm Drainage Basins and Outfalls	• **Preliminary Basin Maps**: Preliminary basin and outfall maps provided as EISR Figure 5-4), but have been updated by EWG for initial evaluation.	• **Updated Basin Maps:** Refined basin mapping completed by EWG covering all storm basins with outfalls discharging within the EW, and mapping of EW terminal apron areas.	• **Basin B-11 Verification:** Storm basin B-11 is approximated, but requires further verification. • **Connecticut Storm Drain Basin:** The Connecticut separated storm drain basin is not fully defined.	• **Basin B-11 Verification:** Verification of Basin B-11 being performed by the Port and City. • **Connecticut Storm Drain Basin:** The Connecticut separated storm drain basin is under review by the City and will be updated after completion of this review. • **S Hinds Street Storm Drain Basin:** The City is reviewing the S Hinds Street storm drain basin and the Hinds combined sewer service areas. The information for the Hinds basins will be updated upon completion of this review.	• **Review of Cleanup Sites and Spills within Storm Drain Basins:** As part of the SRI report, a mapping of cleanup sites and recent spills within the storm drain basins will be developed.
Estimates of Stormwater Volumes	None identified	• **Volume estimates:** Preliminary estimates of stormwater runoff values were developed by Gould and Hartley (2008).	• **Updated Volume Estimates:** The volume estimates are based on preliminary basin delineations and require updating as basin dimensions are finalized. • **Connecticut SD Flow Estimates:** The influence of the low-flow diversion system on the Connecticut SD runoff estimates has not been defined.	• **Updated Runoff Modeling:** The City intends to update the Gould and Hartley (2008) runoff analysis after the storm drainage basins have been updated. • **Connecticut SD Flow Estimates:** The City is verifying the drainage basin boundaries for the Connecticut separated storm drain system. The low-flow diversion can be handled by running low and high estimates as part of runoff modeling. The runoff model will be updated when this information becomes available.	None identified
Estimates of Typical TSS Concentrations in Stormwater	• **Surrogate TSS Data**: Surrogate TSS data available from SPU analysis of stormwater TSS concentrations performed in support of the LDW.	• **Site-Specific TSS Data:** Site-specific TSS data available from Lander Street separated storm drain monitoring for comparison to surrogate data.	None identified[1]	None identified	None identified
Estimates of Typical Stormwater TSS Size Fractions	• **Surrogate TSS Fractions**: Surrogate TSS fractions data available from SPU analysis of stormwater performed in support of the LDW.	None identified[1]	None identified	None identified	None identified
Chemical Data for Stormwater	None identified	• **Site-Specific Stormwater Chemistry Data:** Site-specific chemistry data are available from Lander Street separated storm drainage basin. Existing data may be used during the SRI as an additional line of evidence to estimate chemical concentrations conveyed in stormwater.	None identified[4]	None identified	None identified
Chemical Data for Storm Drain Sediment	• **Catch Basin and In-Line Solids Data: Catch Basin and In-Line Solids Data:** Chemistry data available from 20 site-specific storm drain sediment and in-line samples from the nearshore and Lander storm drain basins and 30 surrogate storm drain sediment samples[2] from the Lander/Hanford CSO basins.[2]	None identified	• **Additional Storm Drain Sediment Sampling:** Additional solid-phase sampling is warranted to improve data coverage within the nearshore drainage basin and within the Lander drainage basin.	• **In-Line Sediment Trap Sampling:** SPU installed five sediment traps within the Lander drain system and two traps on Harbor Island (SW Florida SD and Hanford PS 73 EOF/SD) in 2008, SPU will operate/maintain the trap in the SW Florida SD and the Port will operate/maintain the trap in the Hanford system. Samples are to be analyzed for chemical and physical parameters.[3] • **Port Catch Basin and In-Line Solids Sampling:** The Port is conducting reconnaissance of all storm water conveyance systems at T-18, T-34, T-30, T-25 and T-104 areas of the nearshore drainage basin.[3] Follow-on sampling activities will be completed based on reconnaissance survey results, where significant sediment deposits are identified or where in-line sampling is determined to be appropriate. • **SPU Catch Basin and In-Line Sediment Sampling:** In 2009, SPU conducted source tracing in the S Hinds CSO/SD drainage basin, collecting sediment samples from maintenance holes and catch basins in the system. SPU plans to collect additional samples as part of ongoing source tracing/characterization efforts.	• **Connecticut Basin Storm Drain Sediment Sampling:** No data are currently available for the Connecticut separated drain system, which discharges just north of the EW.

Notes:

This table describes only source characterization data gaps specifically related to the storm drain sources. The SRI/FS includes collection of EW sediment samples (surface and subsurface) from areas proximate to storm drain outfalls that may be useful (along with the source characterization data and sediment transport evaluation work) as part of the SRI/FS evaluation of recontamination potential.

1. Existing LDW TSS and size fraction data will be used for analysis of stormwater lateral loads during the EW SRI/FS and the sediment transport evaluations. No additional site-specific TSS data are required.
2. Refer to Table 4-8 for a summary of sample types.

3. Sample analysis to include total solids, total organic carbon, PCBs (Aroclors), SVOCs, and heavy metals. Particle size analysis may also be performed if sample quantities are sufficient.
4. Additional chemical testing useful for the SCE will focus on the analysis of storm drain sediment samples rather than aqueous stormwater samples.

Metals: Heavy metals analysis to include arsenic, cadmium, copper, chromium, lead, mercury, nickel, silver, and zinc.

EISR – Existing Information Summary Report (Anchor and Windward 2008b)
EWG – East Waterway Group
LDW – Lower Duwamish Waterway
PCBs – polychlorinated biphenyls
SPU – Seattle Public Utilities
SVOCs – semivolatile organic compounds
TSS – total suspended solids

4.3.2 Estimates of Stormwater Discharge Volumes

The analysis of stormwater discharge volumes presented in Table 4-3 is based on the preliminary work of Gould and Hartley (2008), using preliminary delineations of separated storm drain basins discharging to the EW and immediate vicinity. This analysis is to be updated for use in the STE and in the SRI after completion of the following:

- **Basin B-11, Connecticut Storm Drain Basin, and S Hinds Street Basin Updates:** The Port and City are working to finalize the boundaries of the B-11, Hinds, and Connecticut storm drain basins. This work is expected to slightly reduce (by less than 6 acres) the size of basin B-11, and increase the size of the Connecticut and S Hinds Street basins compared to the basin estimates listed in Table 4-1.
- **Connecticut Stormwater Flow Diversion Estimates:** Because the Connecticut system includes a low-flow diverter, only a portion of the stormwater generated from the basin discharges to the vicinity of the EW. The stormwater flows diverted from the Connecticut Street separated SD to the combined sewer are monitored by County instrumentation. County monitoring information will be reviewed by the SRI/FS team to assess whether the performance of the flow diverter can be estimated and incorporated into the updated stormwater volume estimates.

4.3.3 Stormwater Solids Data

Existing information are available to define the typical TSS concentrations in stormwater discharges and the typical PSD of stormwater solids that may be discharged to the EW. These data, along with discharge volume estimates, can be used to estimate solids inputs to the EW from storm drain systems.

- **TSS Concentrations and Particle Size Distribution:** The LDW assumptions for stormwater TSS concentrations (Table 4-5) are to be carried forward for the EW SRI/FS. Site-specific TSS concentration data (Table 4-4) demonstrated that the LDW assumptions regarding TSS concentrations in stormwater are appropriate for use. Surrogate TSS particle size data (Table 4-6) are to be used for the SRI/FS. There are no additional data gaps associated with TSS concentrations or PSD. Some additional data regarding particle size will be generated during storm drain sediment chemistry data collection by the City, including potential particle size measurements from SD catch basins, in-line samples, or in-line sediment trap samples. As part of its characterization work in support of the LDW, the City is also considering testing contaminant concentrations in different storm drain sediment size fractions.

- **TSS Quantity Estimates:** The preliminary estimates of stormwater solids discharges contained in Table 4-7 will be updated after completion of the storm drain basin updates and updates of stormwater runoff volume estimates as described in Section 4.3.1 and 4.3.2, respectively. The updated estimates will be incorporated into the STE and used for the SRI/FS.

4.3.4 Stormwater Solids Chemical Data

Data for multiple lines of evidence are currently available to document the quality of solids entrained in stormwater discharging to the EW. These data include direct measurements of storm drain sediment chemistry from within the Lander and Nearshore drainage basins, measurements of storm drain sediment chemistry from other drainage systems nearby, as well as existing chemistry data from aqueous stormwater sampling conducted in the Lander SD system. These data provide information which can be used to support the SRI/FS process.

Additional data collection efforts are ongoing, and these efforts will provide more data for use in the SRI/FS process. Significant ongoing data collection efforts to characterize stormwater solids chemistry include the following:

- **In-Line Sediment Trap Sampling:** Sediment traps have been installed and are being sampled by the City and the Port at seven locations within the EW drainage basins (Figure 4-2). The sediment traps consist of a stainless steel bracket mounted inside the storm drain conveyance system that holds a wide-mouth Teflon bottle. Traps are designed to passively collect suspended particulates present in stormwater that passes by the sampling site. Like inline sediment grabs, traps represent contributions from a relatively large contributing area.
  - Lander SD Sediment Traps: The City is currently investigating the Lander storm drain basin, as well as other minor City-owned drainage systems that discharge to the EW. The City program includes installation and sampling of

sediment traps in five locations within the Lander storm system, with possible follow-up investigation and sampling of tributary lines if samples collected indicate concern. The sediment traps were placed during early 2008 and are expected to be sampled twice prior to the SRI/FS, providing up to 10 samples.

- Harbor Island Sediment Traps: Two additional sediment traps have been installed at or near T-18 on Harbor Island. Sediment traps are located in Basin B-21 and Basin B-11, the largest of the storm drainage basins on Harbor Island. Samples were collected from the traps in March 2009. Traps were redeployed and will be resampled in fall 2009.
- Sediment Trap Sample Analysis: The samples collected from the Lander and Harbor Island sediment traps are being analyzed for metals, PCBs (Aroclors), SVOCs, and petroleum hydrocarbons. Samples will also be analyzed for particle size, if there is sufficient material for analysis.

- **SPU Storm Drain Sediment Sampling:** The City and County inspected about 384 businesses in areas that discharge to the EW in 2004 to 2005. City inspectors work with local businesses to improve their pollution prevention practices and to ensure compliance with City code. Inspections cover stormwater, hazardous waste, and industrial waste-related issues. Based on the information obtained during these inspections, the City identified approximately 30 high-priority businesses that discharge to City-owned storm drains. These businesses were targeted for re-inspection beginning in 2008. As of August 2008, the City has inspected 21 of the high-priority sites. The City plans to conduct an additional 40 to 50 inspections in 2009 and will continue inspecting businesses after 2009 as part of its source control efforts in the EW. Inspection numbers beyond 2009 have not yet been determined. Storm drain sediment sampling from on-site areas and from ROWs is being conducted by the City as part of the 2008 and 2009 inspections. These data will provide additional information on storm drain sediment quality within the Lander and Nearshore storm drain basins.
  - On-site SD Sampling: As part of its inspection program within the EW storm drain basins, SPU is collecting sediment samples from onsite catch basins when sites are inspected. Numbers of samples collected will depend on what is observed during the inspection activities and adequacy of sediment

accumulation in onsite catch basins for chemical analysis. These samples will be analyzed for heavy metals, PCBs (Aroclors), SVOCs, petroleum hydrocarbons, TOC, and grain size. Results from some of these investigations will be available in 2009 for use in the SRI/FS.

- Right-of-Way SD Sampling: SPU intends to collect sediment samples from catch basins located in the public ROW to assist in source tracing/ characterization activities. Locations will be selected based on the results from the sediment trap samples and to fill in gaps in spatial coverage.

- **Port Terminal Inspections and Storm Drain Sediment Sampling:** The Port will continue to perform inspections and source-tracing sampling on its terminal properties adjacent to the EW. Port and tenant properties will be inspected as part of the Port's Environmental Compliance Assessment Program. The Port is also conducting storm drain sediment sampling from catch basins and SD lines (as grabs from manholes) from the Port-owned terminals on both the east and west sides of the waterway that drain to the EW. This work includes grab sampling of SD solids from catch basins or from in-line solids accumulations via manholes. A comprehensive reconnaissance has been performed on all drainages located on T-18 on Harbor Island, and at T-30, Terminal 28 (T-28), T-25, and Terminal 104 (T-104) on the eastern shore of the EW to identify the presence or absence of SD solids.
  - Catch basin solids sampling has been performed in drainage networks on T-18, T-25, T-28, and T-30 that were determined by the reconnaissance survey to represent typical terminal operations, as well as drainage networks located in the vicinity of nearshore cleanup sites. The sampling was conducted to determine the physical and chemical characteristics of surface drainage from areas of typical terminal operations, as well as evaluate the potential for sources to the catch basins associated with nearshore cleanup sites. The samples have been analyzed for heavy metals, PCBs (Aroclors), SVOCs, TOC, and grain size. Results from these investigations will be available for use in the SRI/FS. Follow-up source tracing is being conducted as needed, based on the results of the catch basin sampling.
  - In-line storm drain solids sampling will be conducted in available Port drainage networks with outfalls to the EW. Where sufficient volume is

present, samples will be collected from available locations near to the outfalls to further characterize terminal drainage and evaluate potential groundwater or subsurface soil infiltration issues (i.e., potential influence of soil or groundwater quality on stormwater inputs to the EW). Currently, no sampling is planned for the small drainage basin on T-102. The T-102 drainage has been considered insignificant since it only services a small business park consisting of commercial office buildings, parking lots, and landscape areas. This drainage basin is also one of the smallest (less than 1 acre) within the project area.

- **Connecticut Storm Drain Basin Sediments:** At this time, no additional data collection is planned for the Connecticut storm drain basin sediments. However, estimates of stormwater drain basin sediment quality can be developed by applying the findings of work conducted within the Lander and nearshore drainage basins or from surrogate storm drain basin areas.

4.3.5 Integrated Review of SRI/FS and Storm Drain Information

Sediment sampling data (surface and subsurface) are being developed for the SRI, and these data will be reviewed along with the storm drain source characterization information and the results of the STE as part of the SRI/FS SCE activities.

5 COMBINED SEWER OVERFLOWS

Combined systems carry both stormwater and residential/commercial/industrial wastewater in a single pipe. Under normal conditions, stormwater and wastewater are conveyed to King County's West Point Wastewater Treatment Plant for treatment prior to discharge to Puget Sound. However, during large storm events, the volume of stormwater runoff can exceed the pipe capacity. Therefore, combined sewer systems are equipped with an overflow structure to prevent stormwater and wastewater from backing up into homes, businesses, or streets by allowing flow from these large storm events to be discharged directly to the waterway. For example, when the system capacity in the Elliott Bay Interceptor (EBI) is exceeded, some of the combined sewer systems that connect to the EBI back up and may overflow at the connection points, called regulators, to convey dilute but untreated residential/commercial/industrial wastewater and stormwater to nearby receiving water bodies. These events are called CSOs. During a combined sewer overflow event, a mixture of untreated stormwater and residential/commercial/industrial wastewater are discharged directly to the receiving water body.

Both the City and County operate combined sewer systems with CSOs that discharge to the EW using permitted outfalls. In some cases these are CSO/SD outfalls, which service both CSOs and separated storm drains. In other cases the CSOs use dedicated CSO outfalls.

The City and County's NPDES permits (Permit Nos. WA-003168-2 and WA-002918-1, respectively) set discharge limits, guidelines for operation and maintenance, and minimum controls for the combined sewer systems. The permits also require monitoring and reporting of CSO operation and discharge events, development of CSO reduction plans, and evaluation of receiving waterway sediment data from near outfall locations.

Both the City and County operate CSO control programs intended to minimize the frequency and volume of CSOs. CSO control measures were described previously in the EISR (Anchor and Windward 2008b), and the City and County routinely publish data on the number of CSO discharge events and the total volume of CSO discharges each year, as well as other information, as required by their permits. The City completed an evaluation of existing sediment data near selected CSO outfalls in 2006 (Herrera 2007), and concluded that there was no clear cause and effect relationship between surface sediment quality and the CSO outfall locations studied. The NPDES permits are not specific to the EW. The work being conducted to identify, characterize, and control sources in the EW is more extensive and specific than that required under the existing permits. However, the requirements of the NPDES permits do not conflict with the goals of the EW SRI/FS. The permits are periodically renewed and/or amended.

5.1 Existing Data Analysis

As described in Section 3, CSO-related information needs for the SRI/FS SCE include the following:

- Locations of outfalls where CSOs discharge
- Locations and characteristics of combined sewer service areas
- Average annual CSO discharge volumes
- CSO TSS concentrations
- PSDs for the CSO solids
- Chemical characteristics of CSO solids

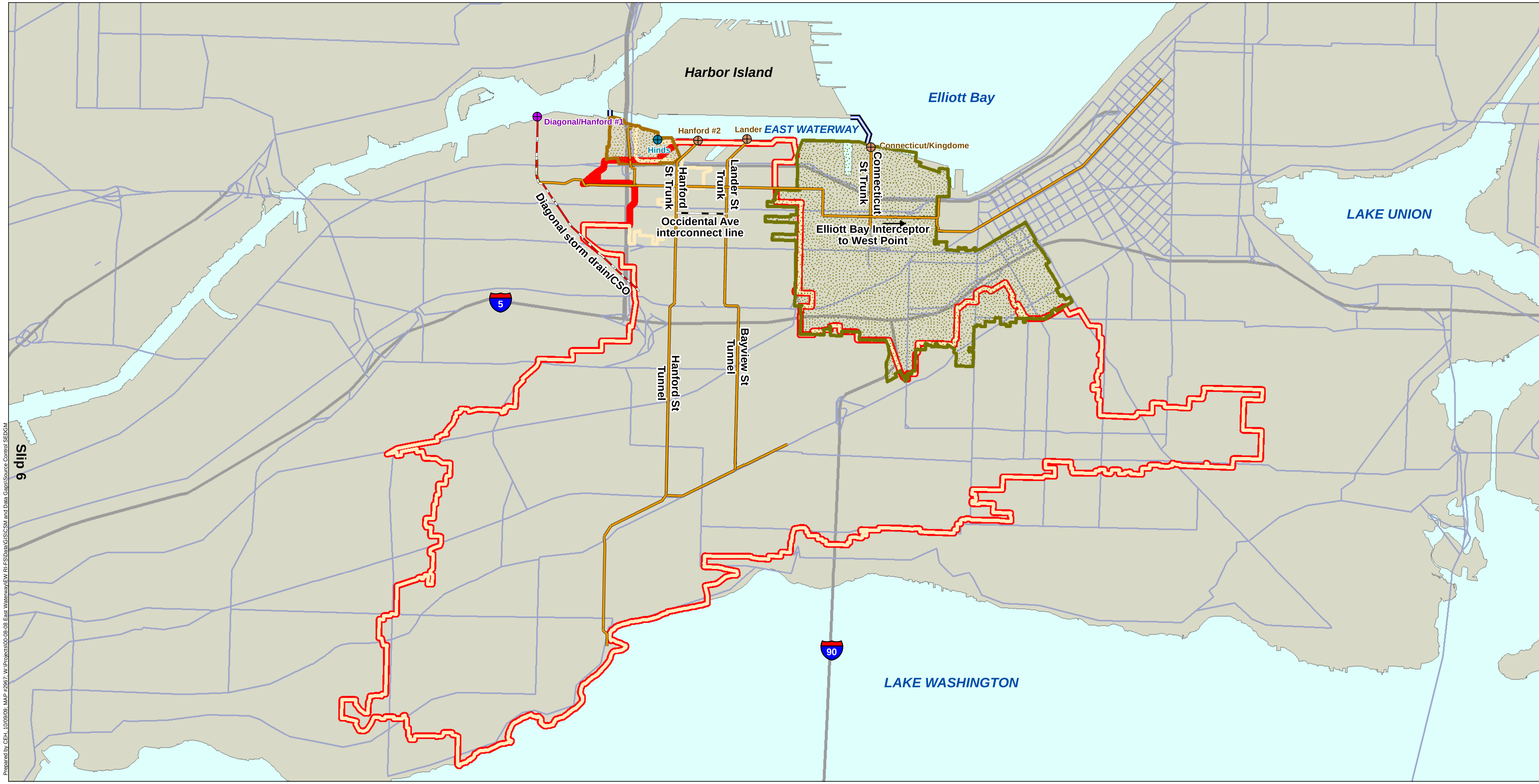
The existing data addressing these information needs are described in Sections 5.1.1 through 5.1.4, below. These data include both site-specific and surrogate CSO-related information.

5.1.1 Combined Sewer Service Areas and CSO Discharge Locations

Two County CSOs and one City CSO discharge from outfalls located along the eastern shoreline of the EW beneath terminal aprons. The two County CSOs discharge via the City's Lander CSO/SD outfall and the County's Hanford #2 CSO outfall, located on either side of Slip 27. The City CSO, known as the S Hinds Street CSO, discharges to the EW from a submerged CSO/SD outfall structure located near the south end of T-25, where the EW widens north of the Spokane Street corridor (Figure 5-1). The specific characteristics of each of these three outfalls and the associated CSOs were identified in the EISR (Anchor and Windward 2008b).

A third County CSO (the Kingdome CSO) discharges via the City's Connecticut Street CSO/SD outfall, which is located north of the northern proposed EW OU study boundary. The County's Kingdome CSO is included in this summary due to the outfall's proximity to the study boundary. In 1998, the Connecticut Street CSO

Separation Project took place, which resulted in a separated storm drainage system. In addition, the overflow control point for this location was moved from the Connecticut Street regulator station to the newly constructed Kingdome regulator station. Since completion of the Kingdome regulator station, the CSO that discharges via the Connecticut Street CSO/SD is known as the Kingdome CSO.



CSO discharge points

- City of Seattle CSO discharge point
- King County CSO discharge point
- City of Seattle and King County CSO discharge point
- Combined sewer trunk line
- Diagonal storm drain
- Hinds combined sewer service area[1]
- Kingdome combined sewer service area[2]
- Lander combined sewer service area[2]
- Hanford #2 combined sewer service area[2]
- Proposed East Waterway Operable Unit Boundary

[1] Source: City of Seattle. The City's Hinds CSO discharges to the Hinds CSO/SD outfall owned by the City of Seattle.
[2] Source: King County. The Lander and Hanford #2 combined sewer service areas are largely coincident. The Lander CSO discharges to a CSO/SD outfall owned by the City of Seattle. The Hanford #2 CSO discharges to a CSO outfall owned by King County. The Kingdome CSO discharges to the Connecticut CSO/SD outfall owned by the City of Seattle.
Note: Service area boundaries have not been completely validated.

Figure 5-1
Combined Sewer Service Areas, Interceptors, and Trunks in the Vicinity of the East Waterway
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

The approximate combined sewer service areas associated with the Lander Street, Hanford #2, Kingdome, and S Hinds Street CSOs were identified in the EISR (Anchor and Windward 2008b). This information is shown in Figure 5-1 and Table 5-1. Land use within the service areas is shown on Figure 5-2. The service area associated with the S Hinds Street CSO is the smallest (see Table 5-1). The Hanford #2 and Lander Street combined sewer service areas are approximately the same size (and cover much of the same area). Table 5-1 also includes service area information for three other County CSOs because data from these CSOs are used a surrogate sources of data.

Table 5-1
Site-Specific and Surrogate CSOs and Associated Service Areas

Discharge Location	CSO	Discharge Serial No. and EW Outfall Type	Combined Sewer Service Area (acres)	Operating Agency
CSO Discharges in or Adjacent to the EW				
East Waterway	Hanford #2	032 (CSO)	4,980	King County
	S. Hinds Street	107 (CSO/SD)	56	City of Seattle
	Lander Street	030 (CSO/SD)	4,890	King County
Elliott Bay	Kingdome[1]	029 (CSO/SD)	915	King County
Other CSOs Used as Surrogates[2]				
West Waterway	Chelan Avenue	036	2471	King County
Lower Duwamish Waterway	Brandon Street	041	380	King County
	Norfolk	044	4,900	King County

Notes:

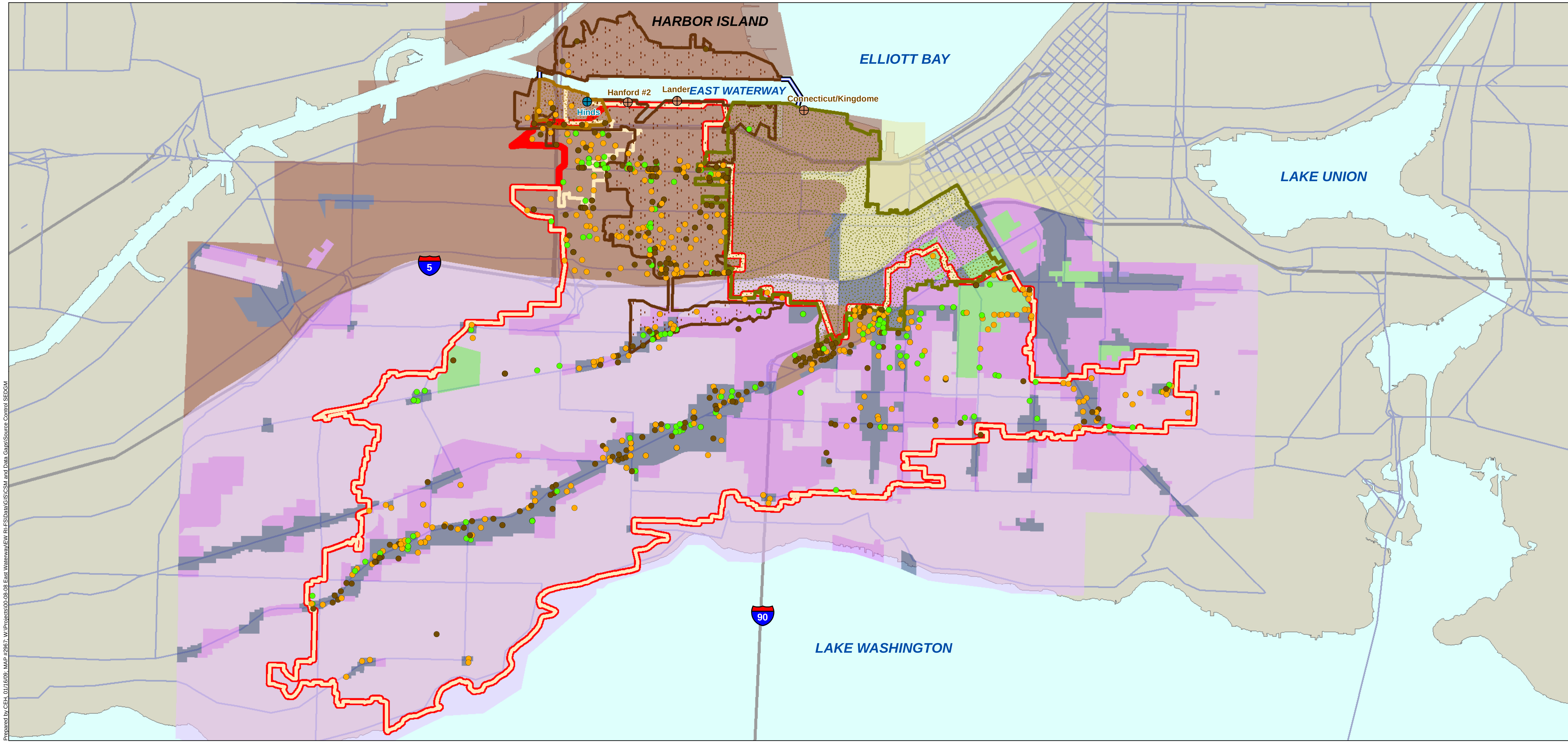
1 – The Kingdome CSO discharges to Elliott Bay north of the EW study area boundary via the Connecticut Street CSO/SD outfall.

2 – These outfalls do not discharge to the EW. They are located along the Duwamish River and West Waterway and service areas with similar land uses. Impacts from outfalls physically located in the LDW will not be individually evaluated in the EW SRI/FS, but rather will be considered as part of the upstream influences (including combined, LDW, Green River, and LDW lateral solids loads) in the STE and SRI/FS evaluations.

As part of the CSO information review, TSS and chemistry data have been compiled for three King County CSOs located along the Duwamish River, including the WW. These CSOs were selected because data were available and they generally serve areas of similar land use in the vicinity of the EW. These are the Chelan Avenue CSO, the

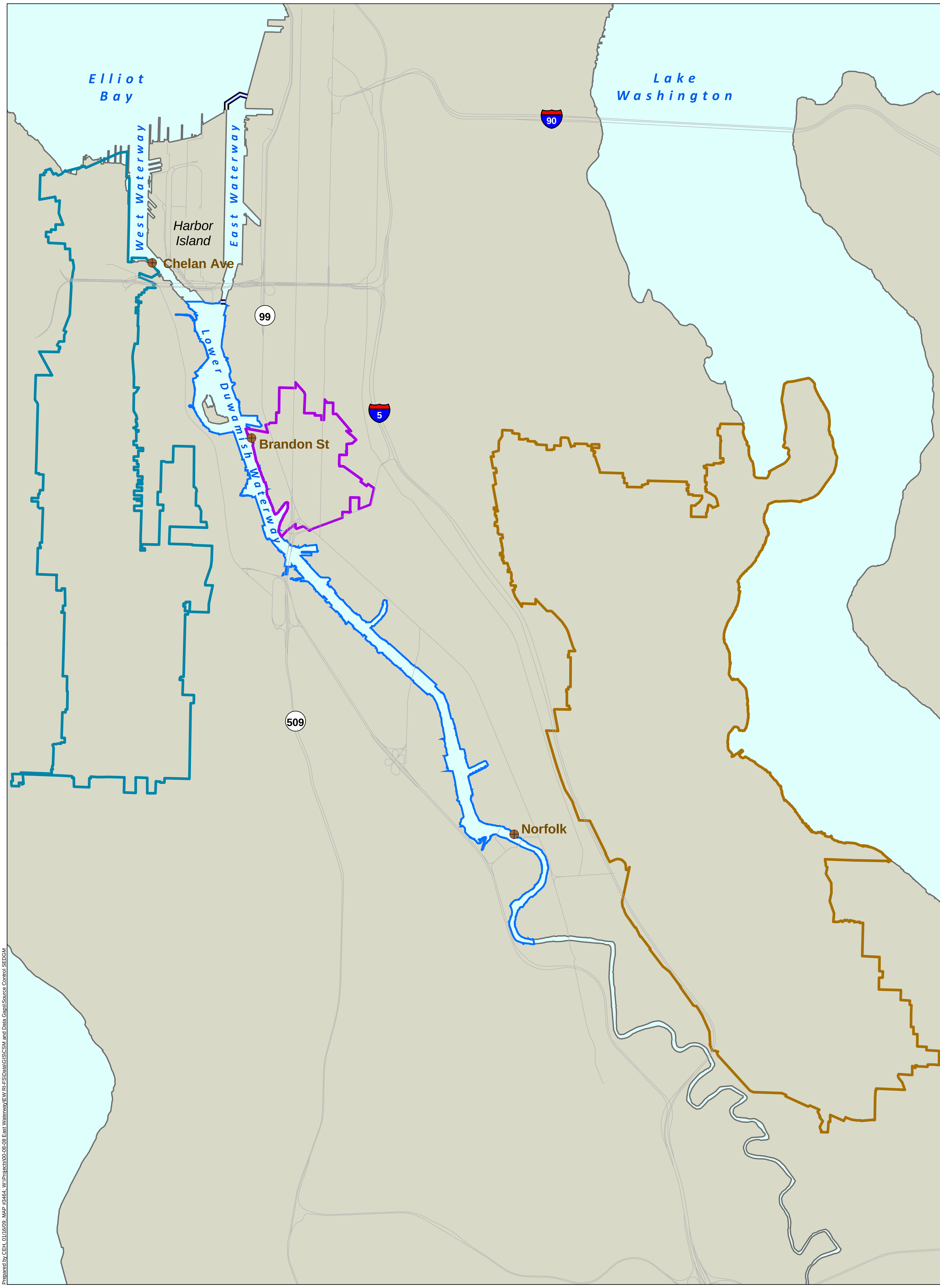
Brandon Street CSO, and the Norfolk CSO. The Chelan Avenue CSO discharges to an outfall located on the western shore of the WW. The Brandon Street CSO discharges to an outfall located on the eastern shore of the LDW at about River Mile (RM) 1.1[1]. The Norfolk CSO discharges to an outfall located on the eastern shore of the LDW at about RM 4.9. The approximate service areas associated with the Chelan Avenue, Brandon Street, and Norfolk CSOs are shown on Figure 5-3 and are summarized in Table 5-1.

[1] River Mile (RM) 0.0 is at the south end of Harbor Island.



[1] Source: King County. The Lander and Hanford #2 combined sewer service areas are largely coincident.
[2] King County's Lander CSO discharges to the Lander CSO/SD outfall owned by the City of Seattle.
[3] King County's Hanford #2 CSO discharges to the Hanford #2 CSO outfall owned by the County.
[4] King County's Kingdome CSO discharges to the Connecticut CSO/SD outfall owned by the City of Seattle.
[5] Source: City of Seattle. The City's Hinds CSO discharges to the Hinds CSO/SD outfall owned by the City of Seattle.
Note: Service area boundaries have not been completely validated.

Figure 5-2
East Waterway Zoning Designations and Business Inspections
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit



Prepared by CEH, 01/16/09; MAP #3464; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\CSM and Data Gaps\Source Control SEDGM

King County CSO discharge point[1]

Combined Sewer Service Area[1]

- Brandon St
- Chelan Ave
- Norfolk
- Road
- Proposed East Waterway Operable Unit Boundary
- Lower Duwamish Waterway study area

[1] Source: King County

0 1,500

Scale in feet

Figure 5-3
Locations of Chelan Ave, Brandon St, and Norfolk Combined Sewer Service Areas
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

5.1.2 CSO Volumes and Frequencies

CSO discharge volumes are monitored for each of the CSOs discharging to outfalls within or adjacent to the EW. A preliminary summary of these data was provided as part of the EISR (Anchor and Windward 2008b). Additional data, including monthly discharge volumes and additional time periods, have been obtained from the County and the City.

The compiled data regarding CSO discharge frequencies and volumes are summarized in Table 5-2, and are presented in more detail in Appendix C. These data will be further analyzed as part of the STE.

Table 5-2
CSO Discharge Frequencies and Volumes

CSO	Annual Average CSO Discharge Frequency (June 1999-May 2006) (events/year)	Annual Average CSO Discharge Volume (June 1999-May 2006) (million gallons/year)
County-Owned CSOs		
Hanford #2	13.4	74.1
Kingdome	7[a]	28.5[a]
Lander Street	11	88.5
City-Owned CSOs		
S Hinds Street	3.1	5.0[b]

Notes:
na – not applicable
a Value is based on 7 months of data (November 2004-May 2005). Prior to the 1998 separation project, the combined system overflowed at the Connecticut regulator (but discharged to same outfall location). CSO discharge monitoring data from the 1998-2003 monitoring periods are not available
b Due to anomalously high flow data in January 2004, this average may not be representative of the S Hinds Street CSO. See Appendix C for more detailed data.

CSO frequencies and volumes vary from year to year. Some of the CSOs, such as Hanford #2, are relatively constant from year to year. In contrast, CSO data from the S Hinds Street CSO have been extremely variable, ranging from no overflow events in the

2000-2001, 2002-2003, and 2005-2006 years (June-May), to approximately 33 million gallons in the 2004-2005 year (see Appendix C for more detailed data).

5.1.3 CSO Solids Data

In the EISR (Anchor and Windward 2008b), CSO effluent sampling data for the Hanford #2 and Connecticut Street CSOs were presented. Additional CSO TSS concentration data were compiled from three other King County CSOs to serve as surrogate data.

5.1.3.1 CSO TSS Concentrations

The typical TSS concentrations in EW CSOs can be estimated using site-specific or surrogate TSS data. Both types of data are shown in Table 5-3. That table summarizes the TSS concentration data available from Connecticut Street and Hanford #2 CSO monitoring, as well as the concentrations from an aggregate dataset, which includes sampling data from Connecticut Street and Hanford #2 CSOs, as well as data from Chelan Avenue, Norfolk, and Brandon Street CSOs. The Connecticut Street CSO[2] effluent TSS data were collected prior to the Connecticut Street CSO Separation Project in 1998, but are included because they represent CSO effluent from a similar service area.

The ranges of the site-specific and surrogate TSS data overlap with the best-estimate value developed by the County for use in the LDW lateral loads analysis (Nairn 2007). That value was developed by the County after evaluation of available CSO effluent TSS data from multiple County outfalls. The LDW average TSS value of 124 mg/L is within the range observed during the site-specific and surrogate monitoring.

[2] When data are available from prior to the Connecticut separation project, they are referred to as Connecticut CSO data, but when data are post-separation, they are referred to as Kingdome CSO data.

Table 5-3
Comparison of Site-Specific and Surrogate CSO TSS Concentrations

Source	Parameter	No. of Samples	TSS Concentrations (mg/L)					
			Min	Max	Mean[a]	Median	25th Percentile	75th Percentile
Hanford #2	Total Suspended Solids	11	65.6	184.5	113.4	99.5	95.6	128.8
	Total Suspended Solids, 0.45µm	19	80.0	142.5	107.0	109.0	96.7	113.0
Connecticut	Total Suspended Solids	3	61.0	156.0	105.3	98.8	na	na
	Total Suspended Solids, 0.45µm	8	48.5	182.0	117.4	128.5	80.9	142.5
Combined[b]	Total Suspended Solids	34	50.8	279.7	118.2	98.5	67.5	155.5
	Total Suspended Solids, 0.45µm	55	48.0	344.3	112.4	100.0	81.2	124.5
LDW RI Transport Model Estimate[c]	Total Suspended Solids, 0.45µm	99	29	703	124	nr	74	137

Notes:

Total suspended solids (TSS) samples were collected using a 1-micrometer (µm) filter, and TSS 0.45µm samples were collected using a 0.45-µm filter.

na – not applicable

nr – not reported

a Arithmetic mean

b Includes Hanford #2, Connecticut, Chelan Avenue, Brandon Street, and Norfolk CSOs.

c Nairn 2007; includes Hanford #2, Connecticut, Chelan Avenue, Brandon Street, and Kingdome CSOs.

5.1.3.2 Particle Size Distribution Data

CSO effluent PSD data were recently developed by the County for use during the LDW lateral loads analysis (Nairn 2007). The size fraction data were developed through settling analysis at four CSOs: Denny, Henderson, M.L. King, and Norfolk (Nairn 2007). The equivalent particle size was calculated for each range of settling velocities, and the measured data were grouped to match the size classes used in the LDW sediment transport model. The TSS fraction data developed for the LDW are summarized in Table 5-4. These fractionation assumptions are appropriate for use in the EW STEs.

Table 5-4
Typical CSO TSS Particulate Size Fractions Measured by King County[1]

Particle Size Fraction	Percent of Total Suspended Solids (Arithmetic Mean)
Clay/Fine Silt (<10 µm)	42%
Medium/Coarse Silt (10 – 62 µm)	41%
Fine/Medium/Coarse Sand (>62 µm)	17%

Notes:
Fine/Medium/Coarse Sand fraction includes the STM size classes 2 (62 – 250 µm) and 3 (>250 µm).
1 – Data Source: Nairn 2007

5.1.3.3 Estimates of CSO Solids Quantity

The quantity of solids contained in CSO discharges may be estimated using the existing CSO discharge volume data and the CSO effluent TSS concentration data. The range in the resulting estimates is a function of the ranges in the TSS concentration data and the ranges in the measured CSO discharge volumes. The calculations of solids loadings from each outfall will be made in the STE based on typical TSS concentrations in CSO effluent and individual CSO discharge volume data.

5.1.4 CSO Chemical Data

Extensive existing chemical data are available to characterize the chemical concentrations typically observed in CSO effluent. In cases where elevated contributions to the combined sewer are identified, the City or County may conduct additional source characterization, tracing, and/or control activities appropriate to their systems, programs, and authorities, examples of which are included in Section 5.2.5.

5.1.4.1 Combined Sewer Sampling Methods

Solid material in the combined sewer system can be transported in the water column as suspended solids or can move along the bottom of the pipe as bedload material. Because of these different transport mechanisms, no one sampling technique is capable of collecting a representative sample of CSO discharge. SPU and King County use a variety of different samples to characterize CSO discharge. Each type of sample represents either different fractions of the sediment in the system or a different geographic scale. Currently, SPU and King County have collected samples using the following methods:

- **Automated effluent sampling[3]:** Autosamplers are used to collect time-paced effluent samples during CSO events. The samples are collected by pump through a tube positioned in the conveyance structure at the regulator station or at the weir structure where CSO effluent is discharged. Auto samplers were automatically triggered by water depth in each sampled pipe for in-pipe samples or by CSO event depending on the location sampled. The samples are collected over a specified time interval and combined at that sample location to create a composite sample. The autosampler may have a tendency to collect a greater fraction of suspended solids than bedload material depending on the pumping speed and position of the pump intake within the water column.
- **In-line aqueous grab sampling:** In-line aqueous grab samples are collected by manually filling sample containers directly from the combined sewer system lines from manhole access points or the regulator station. The grab samples are designed to collect samples that are representative of the combined storm/wastewater at the chosen location within the combined sewer system. In-line aqueous grab samples are typically used for source tracing purposes. The fraction of bedload and suspended solids in the

[3] During the Water Quality Assessment conducted by King County, CSO effluent samples were collected as grab samples at Norfolk CSO during the pilot study and at Brandon CSO for low-level mercury analysis. All other samples were collected using autosamplers.

samples is dependant on the location in the flow stream the sample is collected.

- **In-line sediment grab sampling:** In-line sediment samples are collected from pipes within the combined sewer system where enough sediment has accumulated for sampling. These samples represent contributions from the entire service area upstream of the sampling site during wet-weather and baseflow conditions. In-line sediment samples are typically used for source tracing purposes. Depending on the nature of the structure causing accumulation, the amount of bedload and suspended solids in in-line grab samples is variable.
- **Sediment trap sampling:** Sediment traps are designed to collect sediment entrained in the combined storm/wastewater as it flows through the combined sewer system. The sediment traps consist of a stainless steel bracket mounted inside the pipes of the conveyance system that holds a wide-mouth Teflon bottle. Traps are designed to passively collect suspended particulates during wet-weather flow. Like in-line sediment grab samples, these samples represent contributions from the entire service area upstream of the sampling site. In-line sediment traps can collect more finer-grained sediment than in-line grab samples, since they are mounted on the conveyance wall.

5.1.4.2 CSO Effluent Monitoring

CSO effluent monitoring data were presented in the EISR (Anchor and Windward 2008b) for Hanford Street #2 and Connecticut Street CSOs. These samples were collected in 1996, 1997, and 2004. One sample from the Lander Street CSO, collected in 1988, was also included in the EISR (Anchor and Windward 2008b). However, this sample is not considered representative of current conditions due to changes in the service area over the past 20 years, the completion of the Lander Street separation project, and changes in analytical methods between 1988 and the present. New data are being collected for the Lander Street CSO as described below in Section 5.2.

To supplement site-specific data from the Hanford #2 and Connecticut Street CSOs, surrogate CSO data are also available from Chelan Avenue, Brandon Street, and Norfolk CSOs. These data are used to provide additional information regarding typical chemical concentrations for similar CSOs.

CSO effluent samples from the Hanford Street #2, Connecticut Street, Chelan Avenue, Norfolk[4], and Brandon Street CSOs were collected as part of the King County Water Quality Assessment (King County 1999), in accordance with the project sampling and analysis procedures. Samples were collected during discharge events either by autosampler or, for some parameters, grab samples were taken. Field measurements taken during collection of CSO effluent samples included temperature, conductivity, and pH. Two samples were also collected from the Hanford #2 CSO in 2004. Most samples from the Norfolk CSO were collected as part of the Henderson/M.L. King CSO Control Project (Herrera 1998).

Samples were analyzed by the KC Environmental Laboratory for one or more of the following analytes: conventional parameters, metals, SVOCs, PCBs as Aroclors, and chlorinated pesticides. Laboratory data review of all project data was performed by the Laboratory Quality Assurance/Quality Control (QA/QC) Officer. QA data for all analytical data used in this analysis were reviewed by King County personnel or outside consultant. QA review included review of laboratory deliverables and application of appropriate data qualifiers.

The number of samples available from each CSO for each analyte group are presented in Table 5-5. Tables 5-6 and 5-7 present the data for Connecticut Street and Hanford #2 CSOs, respectively. The aggregate dataset presented in Table 5-8 includes data from Hanford #2, Connecticut Street, Chelan Avenue, Brandon Street, and Norfolk CSOs. Samples collected from the same location during the same CSO event, including duplicates and sequential samples, were averaged and included as single samples. If available, composite sample data were used instead of using the average of sequential sample data. The data shown in Tables 5-6 through 5-8 include

[4] Norfolk was only sampled during the pilot study for the King County Water Quality Assessment.

those chemicals that were frequently detected, and all of the chemicals that were identified as preliminary focus compounds for the SCE in Section 3.

Table 5-5
Sample Distribution of the Aggregate CSO Effluent Dataset

Parameter	No. of EW CSO Samples		No. of Surrogate CSO Samples			Total No. of Samples
	Hanford #2	Connecticut Street	Brandon Street	Norfolk	Chelan Avenue	
Metals[a]	17	8	20	3	8	56
Low-Level Mercury[b]	0	0	2	0	0	2
SVOCs[c]	16	7	19	5	8	55
PCBs (as Aroclors)	6	4	8	4	2	24
TSS	11	3	10	5	5	34
TSS, 0.45µm	19	8	20	0	8	55

Notes:

a Metals include mercury measured using CVAA

b Low-level mercury was measured using CVAF.

c Except 1,2,4 Trichlorobenzene, which was measured in 15 Hanford #2 effluent samples, giving 54 samples total.

Table 5-6
Summary of Connecticut CSO[c] Effluent Data

Parameter	Samples (#)	Detected Concentrations								Reporting Limits[a] of Non-Detects		
		Detects (#)	Detection Frequency	Min	Max	Mean[b]	Median	25th Percentile	75th Percentile	Non-Detects (#)	Min	Max
Metals (µg/L)												
Arsenic, Dissolved	8	8	100%	0.8	1.4	1.0	1.0	0.84	1.1	0	na	na
Arsenic, Total	8	8	100%	1.5	3.5	2.4	2.4	1.6	3.1	0	na	na
Copper, Dissolved	8	8	100%	3.5	21.4	7.5	5.3	4.5	7.5	0	na	na
Copper, Total	8	8	100%	21.7	72.8	41.7	34.4	28.8	53.8	0	na	na
Lead, Dissolved	8	4	50%	0.5	1.3	na	na	na	na	4	0.5	0.5
Lead, Total	8	8	100%	17	101	47	40	21	62	0	na	na
Mercury, Dissolved, CVAA	8	0	0%	na	na	na	na	na	na	8	0.2	0.2
Mercury, Total, CVAA	8	1	13%	0.28	0.28	na	na	na	na	7	0.2	0.2
Zinc, Dissolved	8	8	100%	23	91	42	31	27	44	0	na	na
Zinc, Total	8	8	100%	79	331	181	142	105	267	0	na	na
HPAHs (µg/L)												
Benzo(a)anthracene	7	4	57%	0.17	0.44	na	na	na	na	3	0.14	0.438
Benzo(a)pyrene	7	4	57%	0.26	0.57	na	na	na	na	3	0.24	0.68
Benzo(g,h,i)perylene	7	2	29%	0.42	0.51	na	na	na	na	5	0.24	0.68
Chrysene	7	5	71%	0.2	1.0	0.5	0.4	0.3	0.8	2	0.41	0.843
Dibenzo(a,h)anthracene	7	0	0%	na	na	na	na	na	na	7	0.38	1.1
Fluoranthene	7	7	100%	0.37	1.96	0.93	0.70	0.54	1.21	0	na	na
Indeno(1,2,3-Cd)pyrene	7	2	29%	0.4	0.5	na	na	na	na	5	0.24	0.68
Total Benzofluoranthenes	7	4	57%	0.42	1.44	0.88	0.84	0.57	1.15	3	0.38	1.1
Total HPAHs	7	7	100%	0.89	7.05	3.24	3.45	1.90	4.99	0	na	na
LPAHs (µg/L)												
Acenaphthene	7	2	29%	0.098	0.281	na	na	na	na	5	0.094	0.27
Fluorene	7	5	71%	0.15	1.06	0.34	0.16	0.16	0.17	2	0.14	0.41
Phenanthrene	7	6	86%	0.36	2.38	0.87	0.53	0.38	0.96	1	0.41	0.41
Total LPAHs	7	6	86%	0.36	7.51	2.12	1.19	0.58	1.87	1	0.27	1.1
Phthalates (µg/L)												
Benzylbutylphthalate	7	2	29%	0.58	0.65	na	na	na	na	5	0.14	0.658
Bis(2-ethylhexyl)phthalate	7	6	86%	4.63	8.08	6.71	7.19	5.77	7.71	1	3.67	3.67
Other SVOCs (µg/L)												
1,2,4-Trichlorobenzene	7	0	0%	na	na	na	na	na	na	7	0.14	0.41
1,4-Dichlorobenzene	7	3	43%	0.31	0.60	na	na	na	na	4	0.14	0.41
Dibenzofuran	7	1	14%	0.623	0.623	na	na	na	na	6	0.24	0.68
Phenol	7	3	43%	2.92	4.35	na	na	na	na	4	0.94	2.7
PCBs (µg/L)												
Total PCBs (as Aroclors)	4	0	0%	na	na	na	na	na	na	4	0.24	0.34
TSS (mg/L)												
Total Suspended Solids	3	3	100%	61.0	156.0	na	na	na	na	0	na	na
Total Suspended Solids, 0.45µm	8	8	100%	48.5	182.0	117.4	128.5	80.9	142.5	0	na	na

Notes:

a Reporting Limits are MDLs as reported by King County Environmental Laboratory

b Arithmetic mean

c When CSO data are available from prior to the Connecticut separation project, they are referred to as Connecticut CSO data. When data are available from post-separation, they are referred to as Kingdome CSO data.

na – not applicable

Table 5-7
Summary of Hanford #2 CSO Effluent Data

Parameter	Samples (#)	Detected Concentrations								Reporting Limits[a] of Non-Detects		
		Detects (#)	Detection Frequency	Min	Max	Mean[b]	Median	25th Percentile	75th Percentile	Non-Detects (#)	Min	Max
Metals (µg/L)												
Arsenic, Dissolved	17	17	100%	1.0	2.6	1.4	1.3	1.2	1.5	0	na	na
Arsenic, Total	17	17	100%	1.6	3.6	2.3	2.2	1.9	2.5	0	na	na
Copper, Dissolved	17	17	100%	2.7	6.3	4.8	4.7	3.8	5.8	0	na	na
Copper, Total	17	17	100%	19.7	39.0	27.4	26.8	23.2	30.5	0	na	na
Lead, Dissolved	17	17	100%	0.5	2.4	1.2	1.2	0.9	1.4	0	na	na
Lead, Total	17	17	100%	13.0	38.4	20.9	18.9	15.8	23.8	0	na	na
Mercury, Dissolved, CVAA	17	1	6%	0.006	0.006	na	na	na	na	16	0.05	0.2
Mercury, Total, CVAA	17	2	12%	0.056	0.071	na	na	na	na	15	0.2	0.2
Zinc, Dissolved	17	17	100%	20	87	34	29	25	41	0	na	na
Zinc, Total	17	17	100%	21	155	105	103	93	125	0	na	na
HPAHs (µg/L)												
Benzo(a)anthracene	16	1	6%	0.14	0.14	na	na	na	na	15	0.14	0.57
Benzo(a)pyrene	16	0	0%	na	na	na	na	na	na	16	0.097	0.94
Benzo(g,h,i)perylene	16	0	0%	na	na	na	na	na	na	16	0.24	0.97
Chrysene	16	1	6%	0.18	0.18	na	na	na	na	15	0.14	0.57
Dibenzo(a,h)anthracene	16	0	0%	na	na	na	na	na	na	16	0.38	1.5
Fluoranthene	16	10	63%	0.1	0.4	0.2	0.2	0.2	0.3	6	0.14	0.57
Indeno(1,2,3-Cd)pyrene	16	0	0%	na	na	na	na	na	na	16	0.24	0.97
Total Benzofluoranthenes	16	0	0%	na	na	na	na	na	na	16	0.097	1.5
Total HPAHs	16	10	63%	0.23	0.80	0.46	0.46	0.36	0.51	6	0.38	1.5
LPAHs (µg/L)												
Acenaphthene	16	7	44%	0.10	0.13	0.11	0.12	0.10	0.12	9	0.094	0.38
Fluorene	16	7	44%	0.15	0.27	0.18	0.16	0.15	0.19	9	0.14	0.57
Phenanthrene	16	15	94%	0.18	0.74	0.33	0.30	0.24	0.42	1	0.57	0.57
Total LPAHs	16	15	94%	0.22	2.95	1.03	1.05	0.53	1.20	1	0.38	1.5
Phthalates (µg/L)												
Benzylbutylphthalate	16	5	31%	0.417	0.978	0.667	0.729	0.467	0.745	11	0.14	0.915
Bis(2-Ethylhexyl)phthalate	16	11	69%	2.7	11.6	5.8	4.7	3.7	7.5	5	1.805	4.51
Other SVOCs (µg/L)												
1,2,4-Trichlorobenzene	15	0	0%	na	na	na	na	na	na	15	0.14	0.57
1,4-Dichlorobenzene	16	16	100%	0.25	75.25	6.21	0.34	0.29	0.64	0	na	na
Dibenzofuran	16	0	0%	na	na	na	na	na	na	16	0.097	0.94
Phenol	16	15	94%	1	9	3	2	2	4	1	4.85	4.85
PCBs (µg/L)												
Total PCBs (as Aroclors)	6	0	0%	na	na	na	na	na	na	6	0.026	0.24
TSS (mg/L)												
Total Suspended Solids	11	11	100%	65.6	184.5	113.4	99.5	95.6	128.8	0	na	na
Total Suspended Solids, 0.45µm	19	19	100%	80.0	142.5	107.0	109.0	96.7	113.0	0	na	na

Notes:
a Reporting Limits are MDLs as reported by King County Environmental Laboratory
b Arithmetic mean
na – not applicable

Table 5-8
Summary of Aggregate CSO Effluent Data*

Parameter	Samples (#)	Detected Concentrations								Reporting Limits[a] of Non-Detects		
		Detects (#)	Detection Frequency	Min	Max	Mean[b]	Median	25th Percentile	75th Percentile	Non-Detects (#)	Min	Max
Metals (µg/L)												
Arsenic, Dissolved	56	56	100%	0.5	2.6	1.3	1.2	1.0	1.5	0	na	na
Arsenic, Total	56	56	100%	1.5	5.6	2.9	2.7	2.0	3.5	0	na	na
Copper, Dissolved	56	56	100%	2.0	222	9.2	4.7	3.8	6.1	0	na	na
Copper, Total	56	56	100%	12.9	360	38.6	30.3	23.7	38.0	0	na	na
Lead, Dissolved	56	46	82%	0.51	61.40	2.47	1.00	0.68	1.39	10	0.5	0.5
Lead, Total	56	56	100%	4	260	37	26	20	44	0	na	na
Mercury, Dissolved, CVAA	56	1	2%	0.006	0.006	na	na	na	na	55	0.05	0.2
Mercury, Total, CVAA	56	7	13%	0.06	0.28	0.19	0.23	0.14	0.25	49	0.2	0.2
Mercury, Dissolved, CVAF	2	2	100%	0.0010	0.0014	na	na	na	na	0	na	na
Mercury, Total, CVAF	2	2	100%	0.0270	0.0540	na	na	na	na	0	na	na
Zinc, Dissolved	56	56	100%	4.3	395.0	38.3	30.9	22.4	42.1	0	na	na
Zinc, Total	56	56	100%	38	445	147	130	101	160	0	na	na
HPAHs (µg/L)												
Benzo(a)anthracene	55	11	20%	0.14	0.44	0.22	0.17	0.15	0.26	44	0.14	0.57
Benzo(a)pyrene	55	4	7%	0.26	0.57	na	na	na	na	51	0.097	0.94
Benzo(g,h,i)perylene	55	2	4%	0.42	0.51	na	na	na	na	53	0.24	0.97
Chrysene	55	24	44%	0.15	0.96	0.29	0.23	0.18	0.30	31	0.14	0.843
Dibenzo(a,h)anthracene	55	0	0%	na	na	na	na	na	na	55	0.38	1.5
Fluoranthene	55	44	80%	0.1	2.0	0.4	0.3	0.2	0.5	11	0.14	0.57
Indeno(1,2,3-Cd)pyrene	55	2	4%	0.4	0.5	na	na	na	na	53	0.24	0.97
Total Benzofluoranthenes	55	4	7%	0.42	1.44	na	na	na	na	51	0.097	1.5
Total HPAHs	55	46	84%	0.16	7.05	1.10	0.83	0.41	1.00	9	0.14	1.5
LPAHs (µg/L)												
Acenaphthene	55	14	25%	0.10	0.41	0.18	0.12	0.11	0.25	41	0.094	0.38
Fluorene	55	19	35%	0.14	1.06	0.25	0.16	0.15	0.26	36	0.14	0.57
Phenanthrene	55	47	85%	0.16	2.38	0.41	0.31	0.24	0.44	8	0.14	0.57
Total LPAHs	55	47	85%	0.16	7.51	0.86	0.51	0.26	1.12	8	0.094	1.5
Phthalates (µg/L)												
Benzylbutylphthalate	55	20	36%	0.23	23.80	1.99	0.72	0.45	1.04	35	0.14	2.3
Bis(2-ethylhexyl)phthalate	55	43	78%	1.38	11.60	5.26	4.97	3.78	6.65	12	0.28	5.09
Other SVOCs (µg/L)												
1,2,4-Trichlorobenzene	54	0	0%	na	na	na	na	na	na	54	0.14	0.57
1,4-Dichlorobenzene	55	50	91%	0.15	75.25	2.65	0.37	0.29	0.55	6	0.14	0.41
Dibenzofuran	55	3	5%	0.265	0.623	na	na	na	na	52	0.097	0.94
Phenol	55	23	42%	1	16	4	3	2	4	32	0.94	4.85
PCBs (µg/L)												
Total PCBs (as Aroclors)	24	0	0%	na	na	na	na	na	na	24	0.024	0.34

Notes:

* Includes Hanford #2, Connecticut, Chelan Avenue, Brandon Street, and Norfolk CSOs.

a Reporting Limits are MDLs of non-detected values as reported by King County Environmental Laboratory.

b Arithmetic mean

na – not applicable

The summary tables present detection frequency, ranges of detected concentrations, and reporting limit ranges. The mean, median, 25th, and 75th percentiles are presented when the detect sample count is greater than or equal to 5 and the detection frequency is greater than or equal to 10 percent of the samples analyzed.

As discussed in Section 3.2, aqueous CSO characterization data cannot be compared directly to sediment quality reference values. For comparison to sediment quality reference values, the aqueous concentration data must first be converted to estimates of chemical concentrations on entrained solids. This conversion is not performed as part of the current Memorandum, but may be performed as part of the SRI activities when additional data are available from ongoing source characterization work. The aqueous CSO data summarized in Tables 5-6, 5-7, and 5-8 are to be retained for potential further evaluation as part of the SRI.

Comparison of the site-specific and surrogate data indicates that most analytical parameters are similar between the datasets. However, for the Hanford #2 CSO, the concentrations of 1,4-DCB were elevated in the most recent data relative to the data from other CSOs and relative to older data from the Hanford #2 CSO. As described below (see Section 5.2.4), the County has initiated sampling activities to determine the origin of the elevated 1,4-DCB concentrations in the more recent CSO effluent samples collected from this location.

Analytical results for HPAHs, PCBs (as Aroclors), and mercury were generally non-detect. As described in Section 5.2, the County is conducting additional CSO effluent testing with lower detection limits, and is also collecting samples of combined sewer solids to better assess the chemical content of CSO discharges for PAHs, PCBs and mercury.

5.1.4.3 Chemical Testing of CSO Solids

At the time that the EISR (Anchor and Windward 2008b) was produced, no solid-phase chemistry data were identified for the four CSOs discharging into or adjacent to the EW. CSO solids data can be difficult to obtain because of the lack of solids accumulation in the combined sewer system. King County sampling efforts include

CSO effluent samples in part for this reason. For evaluation of sediment recontamination potential, testing data for solids samples can be preferable, but not always feasible to obtain. For CSOs, multiple lines of evidence are often used to characterize solids within CSO discharges. Additional data collection efforts have been initiated by both the County and the City in order to provide additional data, including collection of combined sewer solids samples that may be used within the SRI/FS. These ongoing data collection activities are described in Section 5.2.

The EISR (Anchor and Windward 2008b) included presentation of storm drain sediment samples collected from catch basins on private properties or within public ROWs within the combined sewer service areas associated with the Hanford #2, Lander Street, and S Hinds Street CSOs. The samples from Lander Street and Hanford #2 combined sewer service areas were collected between 2003 and 2006, and the S Hinds Street samples were collected in 2005. These data are summarized in Section 4 of this Memorandum. Since catch basins collect solids only from surface water runoff, and do not collect any industrial/municipal wastewater that may be present during CSOs, the catch basin solids data are not considered representative of CSO discharges. While catch basin solids data for the CSO systems may be used for characterization of the stormwater quality within a combined sewer service area, they are not used in this report to characterize CSO discharges to the EW.

5.2 Potential Data Gaps and Ongoing Data Collection

This section describes remaining CSO data gaps and the associated ongoing data collection that would be useful for the SRI/FS SCE. A summary of these potential SCE data gaps and associated work is included in Table 5-9, along with any remaining SRI/FS data gaps.

5.2.1 Combined Sewer Service Area and Outfall Mapping

Existing combined sewer service area and outfall information is sufficient for purposes of the SRI/FS.

An updated listing of industrial dischargers to the combined sewers associated with EW CSOs will be developed and included in the SRI report. This information will expand on the data presented in Table 5-5 of the EISR (Anchor and Windward 2008b).

As discussed in Sections 6 and 8 of this Memorandum, an updated database review will be conducted to identify cleanup sites and recent spill events within the combined sewer service areas. This information will be presented as part of the SRI report.

5.2.2 CSO Discharge Volumes

CSO discharge frequencies and volumes are continuously monitored by the County and City as required by their NPDES permits. No additional data, beyond those available from the City and County, are required to support the SRI/FS SCE or STE. However, ongoing discharge volume monitoring is conducted by the City and County as part of their NPDES permit requirements, and updated volume monitoring data can be incorporated as additional information for use in the SRI if desired.

Table 5-9
Summary of Existing Data, Ongoing Data Collection Efforts, and Remaining SRI/FS Data Gaps – CSO Discharges

Information Needed to Support SRI/FS	EISR Datasets and Use in Initial Evaluation	Useful Data Identified Subsequent to the EISR	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for SRI/FS	Remaining SRI/FS Data Gaps
Combined Sewer Service Areas and CSO/SD Outfall Locations	• **Service Area and Outfall Maps:** Service area and outfall maps were provided as EISR Figures 5-2 and 5-3. • **Permitted Industrial Dischargers:** Permitted discharges to the combined sewer system were documented in EISR Table 5-5.	None identified	None identified	• **Additional Delineation:** The storm drain basin boundaries within the S Hinds Street CSO/SD system is being reviewed by SPU and will be revised by SPU as needed. • **Updated List of Industrial Dischargers:** An updated list of permitted industrial dischargers and a map of facility locations will be developed by the County for use as part of the SRI report.	• **Review of Cleanup Sites and Spills within Storm Drain Basins:** As part of the SRI report, a mapping of cleanup sites and recent spills within the combined sewer service areas will be developed.
Estimates of CSO Discharge Volumes	• **2000-2005 Discharges:** Site-specific flow monitoring data for 2000-2005 compiled as part of the EISR.	• **2006 Discharge Data**: Additional CSO discharge data compiled for 2006.	None identified	• **Ongoing Monitoring:** CSO discharges are monitored by the County and SPU as required under their NPDES permits.	None identified
Estimates of Typical TSS Concentrations in CSO Effluent	• **TSS Data:** Site-specific TSS measurements available from 1996, 1997, and 2004 from whole-water sampling at Hanford #2 and Connecticut CSOs. • **Surrogate TSS Data:** Typical CSO TSS concentrations are available from King County analysis of CSO TSS loadings performed in support of the LDW.	• **Updated TSS Data Compilation:** Site-specific and surrogate (from Chelan, Brandon, and Norfolk CSOs) TSS concentration data compiled.	None identified[1]	• **Ongoing TSS Data Collection:** Additional site-specific data are being collected from Hanford #2, Lander, and Kingdome CSOs.	None identified
Estimates of Typical CSO Effluent TSS Size Fractions	• **Surrogate TSS Fraction Data:** TSS fractions data are available from King County analyses performed in support of the LDW lateral loads analysis.	None identified[1]	None identified	None identified	None identified
Chemistry Data for CSO Effluent (Aqueous Sampling)	• **Hanford #2 and Connecticut Effluent Data:** Existing site-specific data from Hanford #2 and Connecticut Street CSOs.	• **Surrogate Effluent Chemistry Data:** Surrogate CSO effluent chemistry data available for other area CSOs including Chelan, Brandon, and Norfolk CSOs.	• **Low-Level Chemical Analyses:** Low-level whole-water PCB, PAH, and mercury analyses useful to evaluate CSO PCB, PAH, and mercury concentrations, which have been below method detection limits in previous whole-water testing. • **Other Chemical Analyses:** Additional SVOCs and metals for Hanford #2 and Lander.	• **Chemical Analyses:** King County is collecting CSO samples for metals, select SVOCs, and low-level PCB analysis at Hanford #2 and Lander. Samples may also be collected from the Kingdome CSO. Additional surrogate data available from other area CSOs to be sampled by the County.	None identified
Chemistry Data for CSO and Combined Sewer Solids	None identified[2]	None identified	• **In-Line Solids Sampling:** Analysis of solid-phase chemical concentrations would assist with 1) measuring concentrations of chemicals not previously detected in effluent sampling (e.g. PCBs), and 2) evaluating chemical partitioning to CSO solids to supplement estimates that can be made using CSO effluent data.	• **Hanford Trunk Line Sediment Trap Sampling:** King County has deployed sediment traps within the Hanford #2 trunk line in order to evaluate select chemicals in CSO solids near the point of discharge to the EW. • **Hanford and Lander In-Line Solids Sampling:** King County collected solids samples from the Lander and Hanford #2 CSO systems. Chemical analysis includes PCBs, TOC, total solids, SVOCs (including phthalates), and metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn). • **S Hinds CSO Solids Sampling:** If sufficient sediment has accumulated in the system, SPU will collect samples for chemical analysis at key locations in the system.	None identified
Potentially Useful Data from Other Source Control Program Activities	• **Catch Basin Sampling:** Existing storm drain sediment data are available for the combined sewer service areas associated with the Lander and Hanford CSOs, including on-site catch basins and ROW catch basins. These samples provide concentration data for chemicals in solids entering the combined sewer systems from surface stormwater drainage, but are not representative of CSO solids.	None identified	• **1,4-DCB Sampling:** Recent CSO monitoring data for Hanford #2 showed elevated concentrations of 1,4-DCB compared to historical Hanford and surrogate CSO measurements. Additional data useful to determine the origin of the elevated 1,4-DCB concentrations and whether they are likely to remain elevated in sewer effluent. • **PCB Follow-Up Testing:** Follow-up testing is warranted to evaluate the progress of PCB source control efforts at the Rainier Commons (former Rainier Brewery).	• **1,4-DCB Sampling:** King County has initiated sampling of selected manholes to locate the origin of elevated 1,4-DCB concentrations in the recent Hanford #2 CSO effluent. • **PCB Sampling – Rainier Commons:** King County has conducted follow-up sampling at the Rainier Commons to evaluate potential PCB contributions to the combined sewer that flows into the Hanford trunk line. • **Ongoing Inspections:** King County and City continue to conduct inspections associated with their ongoing respective source control programs. These inspections may include additional sampling and analysis where appropriate.	None identified

Notes:

This table describes only source characterization data gaps specifically related to CSOs. The SRI/FS includes collection of EW sediment samples (surface and subsurface) from areas proximate to CSO discharge locations that may be useful (along with the source characterization data and sediment transport evaluation work) as part of the SRI/FS evaluation of recontamination potential.

1. Existing LDW TSS and size fraction data are sufficient for analysis of sediment lateral loads during sediment transport evaluations.
2. Storm drain sediment sampling data for catch basin samples collected within the combined sewer service areas associated with the Lander and Hanford CSOs. However, these data are not used in this Initial Evaluation to characterize CSO solids, because they characterize only the potential stormwater-associated solids within the drainages.

1,4-DCB – 1,4-dichlorobenzene
CSO – combined sewer overflow
EISR – Existing Information Summary Report (Anchor and Windward 2008b)
LDW – Lower Duwamish Waterway
PAHs – polycyclic aromatic hydrocarbons
PCBs – polychlorinated biphenyls
ROW – right-of-way
SPU – Seattle Public Utilities
SVOCs – semivolatile organic compounds
TOC – total organic carbon
TSS – total suspended solids

5.2.3 CSO Solids Data

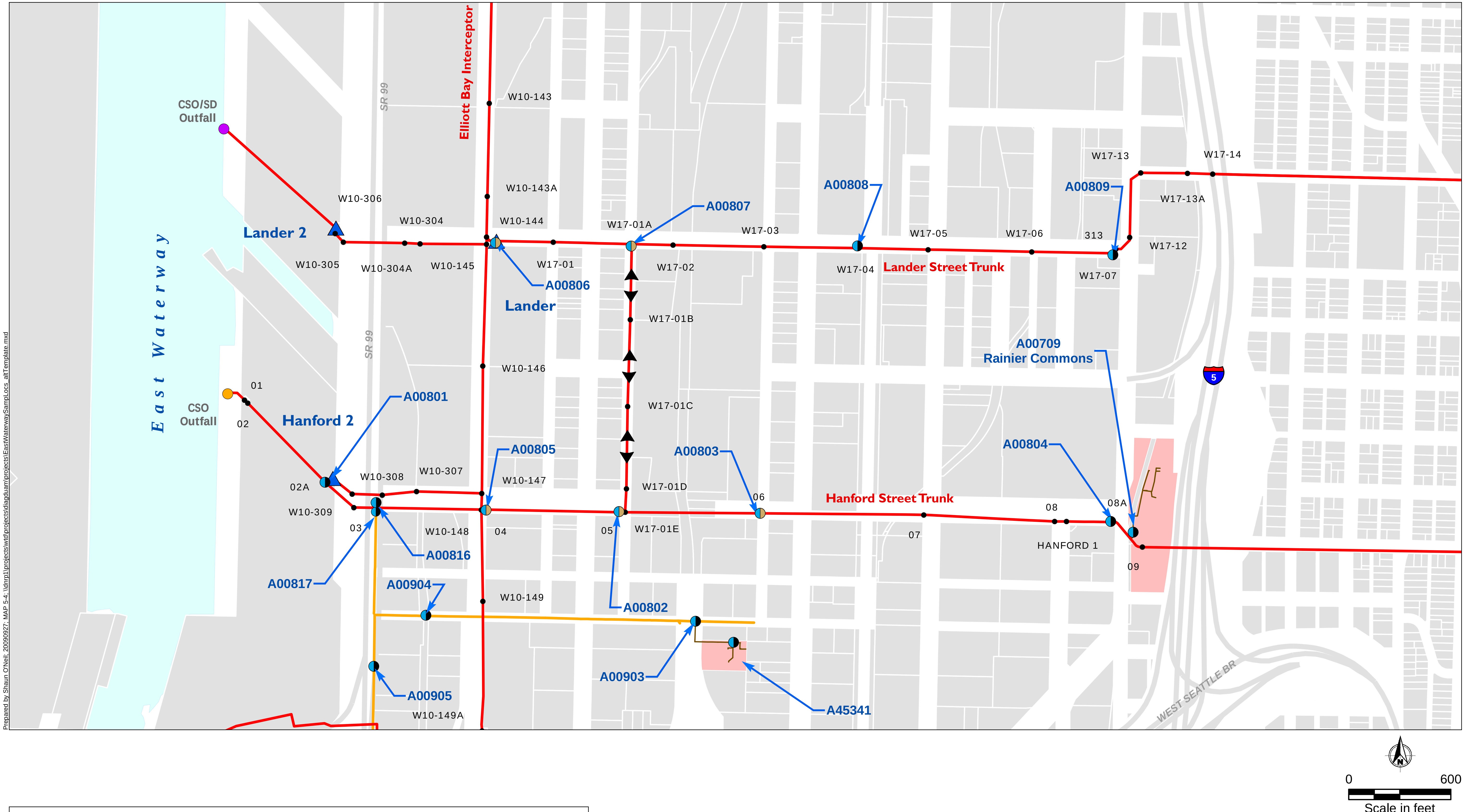
While no additional data are required to evaluate TSS concentrations or PSD for CSOs, additional TSS data are being collected with chemistry data at Hanford #2, Lander, and Kingdome CSOs. These new data can be used if needed; however, existing data are sufficient for completion of the STE and the SRI/FS.

5.2.4 CSO Chemical Testing

Additional data collection efforts are in progress by the City and the County to supplement available chemistry data. The proposed sampling includes testing of CSO effluent, as well as testing of solids samples collected from the combined sewer systems.

- **Additional Sampling of CSO Effluent:** Additional sampling is being conducted for Hanford #2, Lander, and Kingdome CSOs to supplement the existing CSO effluent dataset. For some compounds, such as PCBs, the additional sampling is to address a data gap. Existing data for PCBs using Aroclor methods have resulted in no PCB detections. Because of this, the County has initiated additional CSO effluent sampling to assess potential concentrations of PCBs using a high-resolution PCB congener analytical method with low detection-limits. Other compounds, such as HPAHs, were also largely non-detects. Analytical methods with lower detection limits for these compounds have also been initiated. The CSO effluent sampling will be conducted during CSO events or near-full conditions in the combined sewer lines near or at the regulator stations. The samples will be analyzed, in order of priority, for: PCBs, TSS, TOC, DOC, SVOCs, and metals (including mercury).
- **Sediment Trap Sampling in the Hanford #2 Trunk Line:** During 2008, the County installed SPU-style sediment traps in the Hanford #2 CSO trunk line. The traps were installed approximately 900 feet upstream of the Hanford #2 regulator station. The traps were placed vertically along the wall of the conveyance pipe to capture wet weather low flow, wet weather high flow, and CSO-level discharges or near-full conditions in the trunk line. The County will collect sediment trap samples at periodic intervals and submit them for analysis. The samples will be analyzed, in order of priority, for: PCBs, TOC, SVOCs, and metals. The sampling location is identified on Figure 5-4 as "Station A00805."

- **In-Line Sediment Sampling (Hanford #2 and Lander Street Combined Sewers):** As part of source tracing efforts, the County is conducting an evaluation of solids from within the combined sewer service system associated with the Hanford #2 and Lander CSOs. The County has collected in-line sediment samples during low-flow conditions at various locations in the Hanford and Lander trunk lines. The samples are being analyzed, in order of priority, for: PCBs, total solids, TOC, SVOCs, and selected heavy metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn). In-line solids samples were collected at one location in June 2008 and at five locations in August 2008 (see Figure 5-4), with additional locations to be sampled if results indicate that additional source tracing is needed.
- **In-Line Sampling at the S Hinds Street CSO:** SPU collected an in-line sediment sample from the combined sewer in the S Hinds Street CSO/SD system in July 2009. Results from this sample may be used as a line of evidence to characterize the S Hinds Street CSO. The sample was analyzed for PCBs (as Aroclors), TOC, metals, SVOCs, and grain size. If necessary, additional samples will be collected from key locations in the system (e.g., major trunk lines and laterals) to assist in tracing sources.



Sampling Locations
- In-Line Sediment & In-Line Water
- In-Line Water

Outfalls
- CSO Outfall
- CSO/SD Outfall

- Manholes
- Regulator Station
- KC-WTD Conveyance
- Seattle Combined Conveyance
- Seattle Sewer Conveyance

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 5-4
King County Source Tracing Sampling Locations
Shown by Locator ID for King County East Waterway
Combined Sewer Overflow Basins
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

5.2.5 Other Ongoing Sampling Activities

The County and City work together on source control programs and activities within the combined sewer service areas, including completion of business inspections and sampling of sources that may introduce contaminants into the combined sewer system. Catch basin sampling data generated by SPU for the combined sewer service areas associated with the Hanford #2 and Lander Street CSOs were presented in the EISR (Anchor and Windward 2008b) and in Section 4 of this Memorandum. Those catch basin data provide source tracing information for stormwater entering the combined sewer systems. Inspections by the City and County are ongoing as part of their authorized programs.

As part of their ongoing programs, the City and County have initiated the following additional sampling activities in parallel with the SRI/FS. Though these activities are intended to identify and evaluate specific sources, they may produce data which are helpful in interpreting the CSO characterization data described elsewhere in this section.

- **Sampling of Selected Manholes for 1,4-DCB:** The County has collected aqueous grab samples from various locations in the Hanford and Lander trunk lines during dry weather and precipitation events for volatile organic compound (VOC) analysis. Samples were collected in March and June 2008 at eight locations, in July 2008 at 11 locations, and in April 2009 at five locations (see Figure 5-4). This work was conducted in response to recent Hanford #2 CSO monitoring, which has shown elevated concentrations of 1,4-DCB. Additional effluent sampling may be done in the combined sewer service area based on initial sampling and analysis results for 1,4-DCB in order to assess the origin of the elevated concentrations in the CSO effluent. These data may be helpful in evaluating whether the 1,4-DCB concentrations are likely to remain elevated in the CSO effluent.
- **PCB Follow-Up Sampling at Rainier Commons:** The former Rainier Brewery property is an approximately 4.57-acre parcel located at 3100 Airport Way South in Seattle. Rainier Commons, LLC owns the site, which is currently being redeveloped into community mixed use. PCBs had previously been detected in catch basins at the north end of this property draining to the Diagonal CSO/SD

system during an October 2005 inspection by the City. The County has collected samples of wastewater that included stormwater runoff to assess potential PCB concentrations in water that enters the combined sewer at the Hanford trunk line from the southern portion of the old Rainier Brewery site. The additional sampling is warranted to assess the current concentrations of PCBs entering the combined system from this property.

- **Ongoing Inspections and Potential Sampling:** Both the City and the County are continuing the inspections of properties within the combined sewer service areas, consistent with their regulatory authorities. The County's Industrial Pretreatment Program has issued control documents to 24 significant industrial users in the Hanford #2 and Lander combined sewer service areas. Six of these sites are inspected annually. The remaining 18 are inspected once every 5 years. Additional site inspections are being conducted in 2008-2009 by Ecology as part of the Urban Waters Initiative. Additional sampling activities may be performed by the City or County as appropriate to follow-up on source control issues observed during the inspections. Some of these data could be useful in interpreting source characterization data related to CSOs.
- **Integrated Review of CSO Data with SRI/FS Data:** Sediment sampling data (surface and subsurface) are being developed for the SRI, and these data will be reviewed along with the CSO source characterization information and the results of the STE as part of the SRI/FS SCE activities.

6 CLEANUP SITES AND CREOSOTE-TREATED STRUCTURES

This section summarizes the SRI/FS SCE activities for upland cleanup sites. This evaluation considers potential pollutant inputs from both nearshore cleanup sites (those located adjacent to the EW) and those located in areas distant from the EW, but within the EW storm drain basins or combined sewer service areas. The nearshore cleanup sites can potentially contribute pollutants through the groundwater transport and bank erosion pathways. Both nearshore and distant cleanup sites can, in some instances, contribute pollutants to stormwater or to CSO discharges.

This section also provides a summary of existing creosote-treated structures that are located within or adjacent to the EW.

6.1 Regulatory Background on EW Nearshore Cleanup Sites

A review of cleanup sites located in nearshore areas adjacent to the EW was conducted as part of the EISR (Anchor and Windward 2008b). The analysis of nearshore sites was prioritized during the EISR phase of the project because a more exhaustive data review was required in order to assess potential pollutant inputs through the three pathways of concern (groundwater to sediments, bank erosion, and potential inputs to stormwater or CSO discharges). Additional reviews are planned as part of the SRI to identify distant cleanup sites located within the EW storm drain basins and combined sewer service areas.

The characterization and remediation of all the nearshore cleanup sites identified along the EW is being conducted under federal (CERCLA), and state (Model Toxics Control Act [MTCA]) authorities.

CERCLA is the basis for the federal program to clean up hazardous waste sites identified by EPA on the National Priorities List (NPL). The Harbor Island Superfund Site was initially listed on the NPL in 1983 (ID WAD980722839), and has subsequently been separated into multiple OUs. The Harbor Island Soil and Groundwater OU encompasses the majority of upland nearshore areas west of the EW project area, as shown in Figure 6-1.

A number of additional cleanup sites located along the EW are being cleaned up under the authority of Ecology. These include the nearshore areas located on Harbor Island south of

Spokane Street (which are not included within the Harbor Island Superfund Site), as well as additional sites located on the eastern shore of the EW. These non-CERCLA cleanups are being performed under Ecology's Voluntary Cleanup Program (VCP), as independent actions, or under the direction of Ecology via an Agreed Order or Consent Decree. In addition, a limited number of upland sites have also been registered in Ecology's underground storage tank (UST) program and have been identified as leaking UST (LUST) sites. These Ecology cleanup sites are subject to MTCA regulations.

6.2 Source Description

6.2.1 Nearshore Cleanup Sites

A review of cleanup sites located along the EW was conducted as part of the EISR (Anchor and Windward 2008b). For each site, the EISR described the background and regulatory context for the cleanup, the contaminants identified, and the status of the investigation and related cleanup activities. Table 6-1 provides a synopsis of the nearshore cleanup sites identified, and presents a summary of information relevant to the EW. This table was initially presented as Table 5-15 of the EISR, but has been updated to include new data that have become available.

A review of cleanup sites located away from the EW shoreline (i.e., within the Hanford/Lander drainage basins) was not conducted as part of the EISR development, but will be conducted in development of the SRI report. Cleanup sites located further from the EW shoreline have the potential to affect the EW primarily if contaminated groundwater or stormwater runoff from these sites is transported toward the EW through storm drains or combined sewer systems. The ongoing SCE and source-tracing studies being performed by the Port, City, and County are addressing potential pollutant sources in these systems. These studies will provide information on the recontamination potential associated with storm drain and CSO inputs, including potential releases from cleanup sites located within the drainage basins or combined sewer service areas. Information on cleanup sites located within the storm drain basins and combined sewer service areas will assist in potential source tracing and source control activities being conducted under the Port, City, and County source control programs, or under source control activities conducted by Ecology or other regulatory agencies.

The nearshore cleanup sites listed in Table 6-1 are shown on Figures 6-1, 6-2, and 6-3. These figures show the nearshore cleanup site locations, identify the key groundwater monitoring locations at each site that are useful for evaluating the groundwater-to-sediment pathway, and show the site-specific groundwater gradients measured at each site using available data. The nearshore cleanup site names, cleanup status, and summary of recent groundwater monitoring activities are summarized in Table 6-1. Taken together, the studies completed for evaluation and cleanup of the sites listed in Table 6-1 provide groundwater characterization data along much of the EW shoreline. Sampling locations were developed based on historical uses and previous site investigations.

Table 6-1
Updated Summary of Recent Groundwater Monitoring at Nearshore Cleanup Sites

Site and Release Type	Cleanup Status	Site-Specific Groundwater Monitoring Performed	Recent Groundwater Monitoring Reports
Harbor Island Soil and Groundwater OU: Multi-parcel cleanup addressed under EPA oversight by Harbor Island Soil and Groundwater OU Group. Site contaminants of concern determined through RI/FS and risk assessment process.	Cleanup activities completed consistent with Soil and Groundwater OU ROD, including soil removals and upland capping. Site is undergoing long-term groundwater monitoring.	Monitoring is performed consistent with an EPA-approved groundwater monitoring plan. Groundwater monitoring network includes seven nearshore wells along the EW shoreline, and additional monitoring wells located in inland areas and in areas adjacent to the West Waterway.	First groundwater monitoring report updates results from two quarterly monitoring events in late 2005 and two monitoring events in early 2006 (RETEC 2006a). Additional report from 2007 summarizes monitoring in late 2006 and early 2007 (ENSR 2007).
Terminal 102 LUST Site: MTCA soil and groundwater cleanup related to diesel release from former UST.	Tanks and excavated soil were removed from the site, with capping of remaining impacted soils. Cleanup at this site is complete. Work was performed as an independent action. No request has been made for an Ecology opinion letter following completion of the cleanup.	Groundwater monitoring was performed at time of tank and soil removal, including sampling of six temporary soil borings.	Groundwater monitoring data for six temporary soil borings are described in UST decommissioning report (RETEC 1997).
Coast Guard (Pier 35): MTCA soil and groundwater cleanup related to petroleum USTs formerly used for truck refueling. Contaminants of concern include petroleum (gasoline and diesel) and arsenic.	Former USTs and associated soil contamination have been removed under an independent remedial action. No additional cleanup actions are planned. No request has been made for an Ecology opinion letter following completion of the cleanup.	Groundwater monitoring was last performed in 2003-2004 as part of a site investigation report. Groundwater monitoring at that time included 7 sampling locations (2 wells and 5 temporary borings), all of which were located in upland site areas over 300 feet from the EW.	Environmental sampling report summarizes results of 2003-2004 groundwater monitoring event (Hart Crowser 2004).
Former-GATX (Pier 34): MTCA soil and groundwater cleanup related to former bulk fuel handling facility. Site contaminants of concern determined through RI/FS process and include petroleum and associated constituents (petroleum, BTEX, and PAHs) and selected heavy metals (arsenic, copper, and lead).	Cleanup action was performed as independent remedial action with Ecology oversight after completion of an RI/FS and Compliance Monitoring Plan. Cleanup included plant demolition, removal of contaminated soils, capping, groundwater treatment (by air sparging and vapor extraction), and groundwater monitoring. Cleanup at this site is complete. No request has been made for an Ecology opinion letter following completion of the cleanup.	Groundwater monitoring performed as part of site cleanup included periodic monitoring of five nearshore wells and multiple groundwater seep locations. Compliance wells and seep monitoring locations were located along five transects arranged perpendicular to the shoreline. Groundwater monitoring was also performed at additional upland groundwater well locations used to monitor remediation system performance.	Remedial action included 5 years of groundwater monitoring, as summarized in 5-year review report (RETEC 2004). Most recent event from April and August 2003 included monitoring of all nearshore wells and one groundwater seep. Relevant historical data (also summarized in RETEC 2004) include most recent seep monitoring data from the monitoring transects.
Former Chevron (Terminal 30): MTCA soil and groundwater cleanup related to petroleum releases (primarily diesel) at the former Chevron bulk fuel handling facility. Site contaminants of concern determined through RI/FS process and include petroleum, BTEX compounds, and PAH compounds.	Initial cleanup action performed during the late 1980s included plant demolition, product recovery, nearshore sediment dredging and capping of the shoreline with clean structural fill and armoring (Figure 6-5), and upland capping. An RI/FS was completed in 1998 under an Agreed Order to determine any other required remedial actions. Groundwater monitoring and other site cleanup actions are being implemented by the Port consistent with a draft Compliance Monitoring Plan.	Monitoring is performed quarterly, consistent with the draft Compliance Monitoring Plan. The groundwater compliance monitoring program includes five nearshore wells. Groundwater monitoring is also performed at seven additional upland locations, and product recovery and gauging is performed at 13 additional upland well locations.	The site is undergoing quarterly groundwater monitoring consistent with the draft Compliance Monitoring Plan. The results of the February 2007 groundwater monitoring event were summarized in a quarterly monitoring report (RETEC 2007).
Terminal 25: MTCA petroleum cleanup associated with former underground diesel storage tanks at former Rainier Cold Storage site.	Former USTs and associated soil contamination have been removed under an independent remedial action. Cleanup at this site is complete. No request has been made for an Ecology opinion letter following completion of the cleanup.	Groundwater monitoring was last performed in 1989 and 1990 as part of upland site investigations. Monitoring included seven upland sampling locations.	Results of 1989 and 1990 groundwater sampling summarized in 1990 reports (Landau 1990; Sweet-Edward 1990).
Terminal 104 and Vicinity: Localized groundwater contamination areas were identified during recent environmental assessment activities. Groundwater contamination with TCE and arsenic was identified in a localized area in the southeastern portion of the property and localized areas of petroleum contamination were identified in the northeastern portion of the property.	Site cleanup is currently being conducted by the Port under the voluntary cleanup program. Cleanup includes in situ groundwater treatment (within the localized TCE-impacted area) (Bahnick 2007), soil removal (in the petroleum-impacted area), and groundwater monitoring. Additional monitoring is being conducted as part of ongoing site cleanup.	Extensive groundwater testing was performed as part of recent environmental assessment activities. Sampling included monitoring of groundwater at 13 upland wells and 49 additional temporary borings. Sampling delineated all contaminated groundwater areas. No contamination extending to the EW shoreline was identified. Sampling at 11 of these groundwater locations provides water quality information downgradient of site cleanup areas.	Groundwater monitoring data for the period 2005 to 2007 are summarized in an environmental assessment report (Environmental Partners 2007).

Notes:

This table was initially presented as Table 5-15 in the EISR (Anchor and Windward 2008b). It has been updated to incorporate additional groundwater data reviewed since production of the EISR. An additional survey of cleanup sites located within the EW storm drain basins and combined sewer service areas is to be conducted in development of the SRI report.

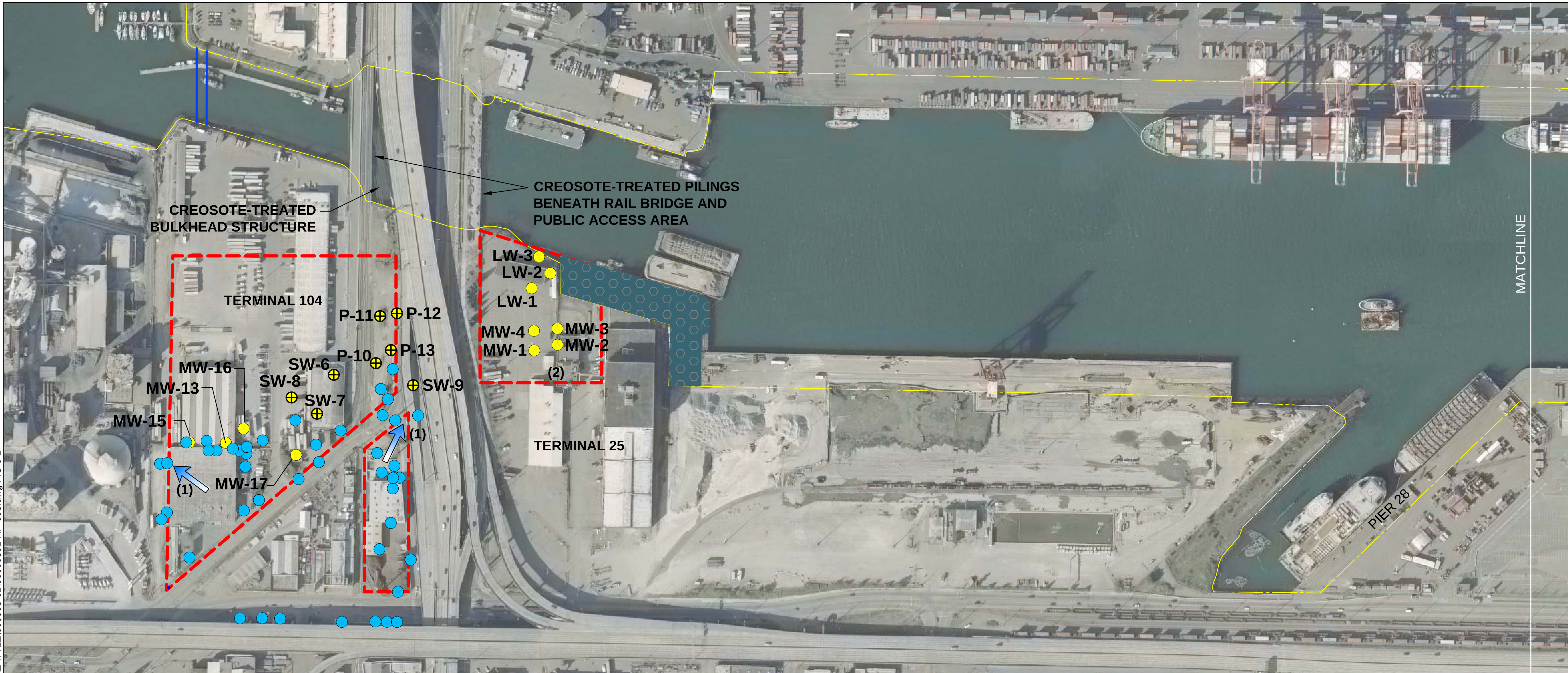
1. Site-specific groundwater cleanup levels are those used to evaluate groundwater data in the referenced report(s).
2. Groundwater data referenced in this table are summarized in tabular form in Appendix E.

AWQC – Washington State surface water marine ambient water quality criteria
BTEX – benzene, toluene, ethylbenzene, and xylene
EPA – U.S. Environmental Protection Agency
EW – East Waterway
LUST – leaking underground storage tank
MTCA – Model Toxics Control Act
OU – Operable Unit
PAHs – polycyclic aromatic hydrocarbons
PCBs – polychlorinated biphenyls
RI/FS – Remedial Investigation/Feasibility Study
ROD – Record of Decision
UST – underground storage tank
TCE – trichloroethene
VOCs – volatile organic compounds

- Harbor Island groundwater operable unit (OU) compliance monitoring well[1]
- Harbor Island groundwater operable unit (OU) inland monitoring well[2]
- Geoprobe boring (approximate location)
- Approximate location of USTs removed from T-18[3]
- Former Terminal 18 hot spot[3]
- Approximate location of T-102 removed USTs[3]
- Cleaned up LUST at property (exact LUST location not known)
- Approximate location of Terminal 18 dock pipeline spill[3]
- Portion of Terminal 18 where capping or other environmental work was completed during terminal expansion
- Harbor Island soil and groundwater OU boundary
- East Waterway OU Boundary

[1] "Compliance" is defined for the purposes of this report as wells closest to the East Waterway and does not reflect any well designations based on the Harbor Island Soil and Groundwater OU or related reports and agreements.
[2] "Inland" is defined for the purposes of this report as wells farther away from the East Waterway shoreline.
[3] Sources for these investigations were presented in Table 5-6 of the Existing Information Summary Report (Anchor & Windward, 2008).

Figure 6-1
Nearshore Cleanup Sites – Harbor Island
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit



LEGEND

MONITORING WELL GROUNDWATER SAMPLE LOCATION

TEMPORARY BORING GROUNDWATER SAMPLE LOCATION

UPLAND GROUNDWATER SAMPLE LOCATION (WELL OR BORING)

APPROXIMATE UPLAND SITE AREAS

DEMOLISHED TIMBER DECK - REMAINING PILINGS TO BE REMOVED

EAST WATERWAYOPERABLE UNIT BOUNDARY

MHHW LINE

REPORTED GROUNDWATER FLOW DIRECTION

(1) ENVIRONMENTAL PARTNERS (2007)

(2) SWEET-EDWARDS/EMCON (1990)

0 300
SCALE IN FEET

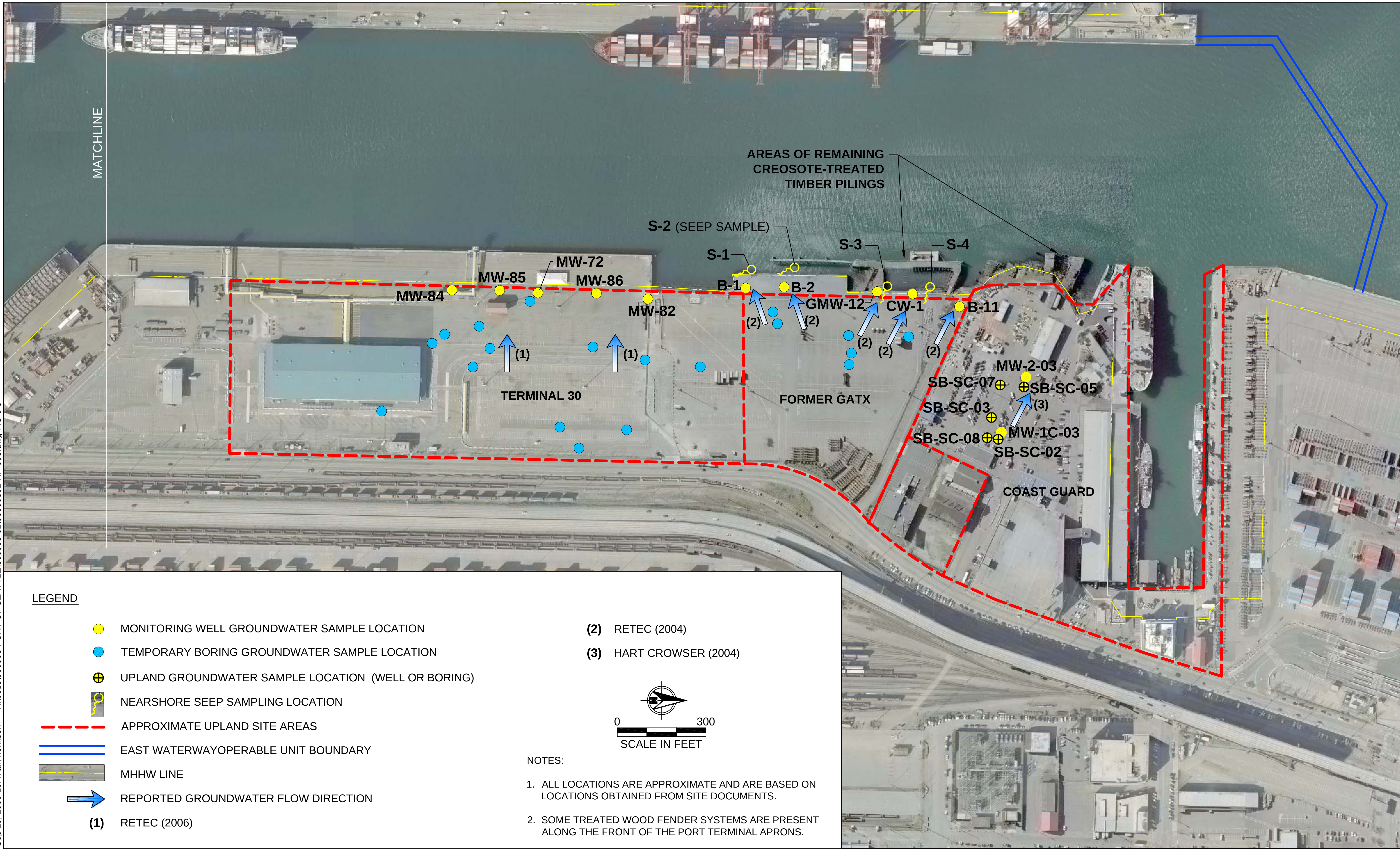
NOTES:

1. ALL LOCATIONS ARE APPROXIMATE AND ARE BASED ON LOCATIONS OBTAINED FROM SITE DOCUMENTS.

2. SOME TREATED WOOD FENDER SYSTEMS ARE PRESENT ALONG THE FRONT OF THE PORT TERMINAL APRONS.

Sep 10, 2009 10:56am heriksen K:\Jobs\060003-PORT OF SEATTLE\060003-01\06000301-RP-003.dwg FIG 6-2

Figure 6-2
Nearshore Cleanup Sites Located Along the Southeast Portion of the East Waterway
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit



K:\Jobs\060003-PORT OF SEATTLE\060003-01\06000301-RP-003.dwg FIG 6-3

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LEGEND

- MONITORING WELL GROUNDWATER SAMPLE LOCATION
- TEMPORARY BORING GROUNDWATER SAMPLE LOCATION
- UPLAND GROUNDWATER SAMPLE LOCATION (WELL OR BORING)
- NEARSHORE SEEP SAMPLING LOCATION
- APPROXIMATE UPLAND SITE AREAS
- EAST WATERWAYOPERABLE UNIT BOUNDARY
- MHHW LINE
- REPORTED GROUNDWATER FLOW DIRECTION
- **(1)** RETEC (2006)
- **(2)** RETEC (2004)
- **(3)** HART CROWSER (2004)

0 300
SCALE IN FEET

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE AND ARE BASED ON LOCATIONS OBTAINED FROM SITE DOCUMENTS.
2. SOME TREATED WOOD FENDER SYSTEMS ARE PRESENT ALONG THE FRONT OF THE PORT TERMINAL APRONS.

Figure 6-3
Nearshore Cleanup Sites Located Along the Northeast Portion of the East Waterway
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

6.2.2 Groundwater Fate and Transport

Detailed groundwater studies have been performed as part of the RI for the Harbor Island Upland OU (Weston 1993), and as part of the RI/FS and supplemental studies performed at the T-30 site (RETEC 2006b), and at the Pier 34/Former GATX site (RETEC 2004). Extensive information on regional geologic and hydrogeologic conditions is also available as part of the LDW RI Report (Windward 2007b). Additional groundwater studies have been performed at each of the cleanup sites documenting localized groundwater gradients and soil properties.

The SRI report will include a more expansive discussion of geologic and hydrogeologic conditions specific to the EW. The following information is provided as background information for the discussion of the nearshore groundwater data and the data gaps analysis conducted as part of the current Memorandum.

Cross sections summarizing identified aquifer characteristics and groundwater behavior are presented in Figure 6-4 for the Harbor Island/T-18 area and in Figure 6-5 for the T-30 area. Site groundwater studies have documented the following general groundwater fate and transport characteristics, as illustrated in Figures 6-4 and 6-5:

- **Groundwater Discharge to Surface Water:** Groundwater gradients for shallow and intermediate water-bearing zones trend generally toward the EW on both the eastern and western shorelines. Localized gradients differ at some sites based on site-specific development features or differences in infiltration. However, the groundwater generally discharges to the adjacent surface water body as illustrated by the flow arrows developed from site-specific data in Figures 6-4 and 6-5. Groundwater can discharge in a diffuse manner through sediments, or can discharge to surface water via visible seeps. Groundwater quality can be measured using nearshore wells or by sampling of visible seeps.
- **Tidally-Induced Groundwater Mixing:** Groundwater elevations in nearshore areas fluctuate with the tide as shown in Figures 6-4 and 6-5. Generally, tidal influence is greatest within 200 feet of the shoreline, although the extent of influence varies with soil properties. In nearshore areas, tidal effects cause mixing of groundwater and surface water and mixing of shallow and deeper groundwater horizons within the aquifer system. This tidally-influenced mixing

is shown conceptually in Figures 6-4 and 6-5. Surface water gradually infiltrates into nearshore areas, creating a "wedge" of brackish or saline groundwater, typically at depth. The groundwater elevations change with each tidal cycle, and this causes periodic reversal of the groundwater flow directions in the nearshore areas. This back-and-forth and up-and-down motion of the groundwater results in mixing of the shallow and deeper groundwater horizons and mixing between the site groundwater and the surface water infiltrating the shoreline. The net effect of these processes is that the water nearest the shoreline often consists primarily of surface water, mixed with a smaller part of upland site groundwater. Even in the absence of other processes, this tidally-influenced mixing can significantly reduce the concentration of site-related chemicals in groundwater as the groundwater migrates toward the point of groundwater discharge in the waterway. For example, at the T-30 site, the influence of tidal mixing was quantified, and a mixing ratio of between 4x and 5x was demonstrated for this shoreline (i.e., shallow groundwater from nearshore well locations was found to mix with approximately 4 parts of deep groundwater and infiltrating surface water prior to discharging to the sediments in the EW) (RETEC 2006b).

- **Biological and Geochemical Factors:** The fate and transport of chemicals in groundwater can be affected by a variety of biological and geochemical processes. Many organic contaminants can biodegrade in the presence of soil and groundwater microbes. The effect of biological degradation processes on petroleum and related compounds has been studied at the T-30 site (RETEC 2006b) and was found to be a significant factor in limiting the migration of petroleum and associated constituents (benzene, toluene, ethylbenzene, and xylene [BTEX] and PAH compounds), in addition to other factors such as tidally-influenced groundwater mixing. Geochemical processes such as metals complexing and changes in metals speciation can also affect the transport of groundwater chemicals. Some of these processes have been extensively studied as part of nearshore remediation projects conducted within Elliott Bay (Boatman and Hotchkiss 1997) and have been found to be significant at limiting the potential migration of inorganic constituents toward the surface water body. The potential for hydrocarbon contamination to enhance mobilization metals has been addressed at the nearshore cleanup sites either through 1) remediation of petroleum in groundwater, or 2) direct measurement of groundwater metals concentrations. The state MTCA regulations (Washington Administrative Code [WAC] 173-340-720(7)(e)(ii)) recognize that biological and geochemical attenuation processes can significantly limit the transport of chemicals in groundwater, and should be taken into account when evaluating groundwater monitoring data in nearshore areas. The combination of hydrogeologic, biological, and geochemical factors frequently results in attenuation of groundwater chemical concentrations between upland groundwater monitoring locations and the point of discharge of the groundwater into the surface water body.

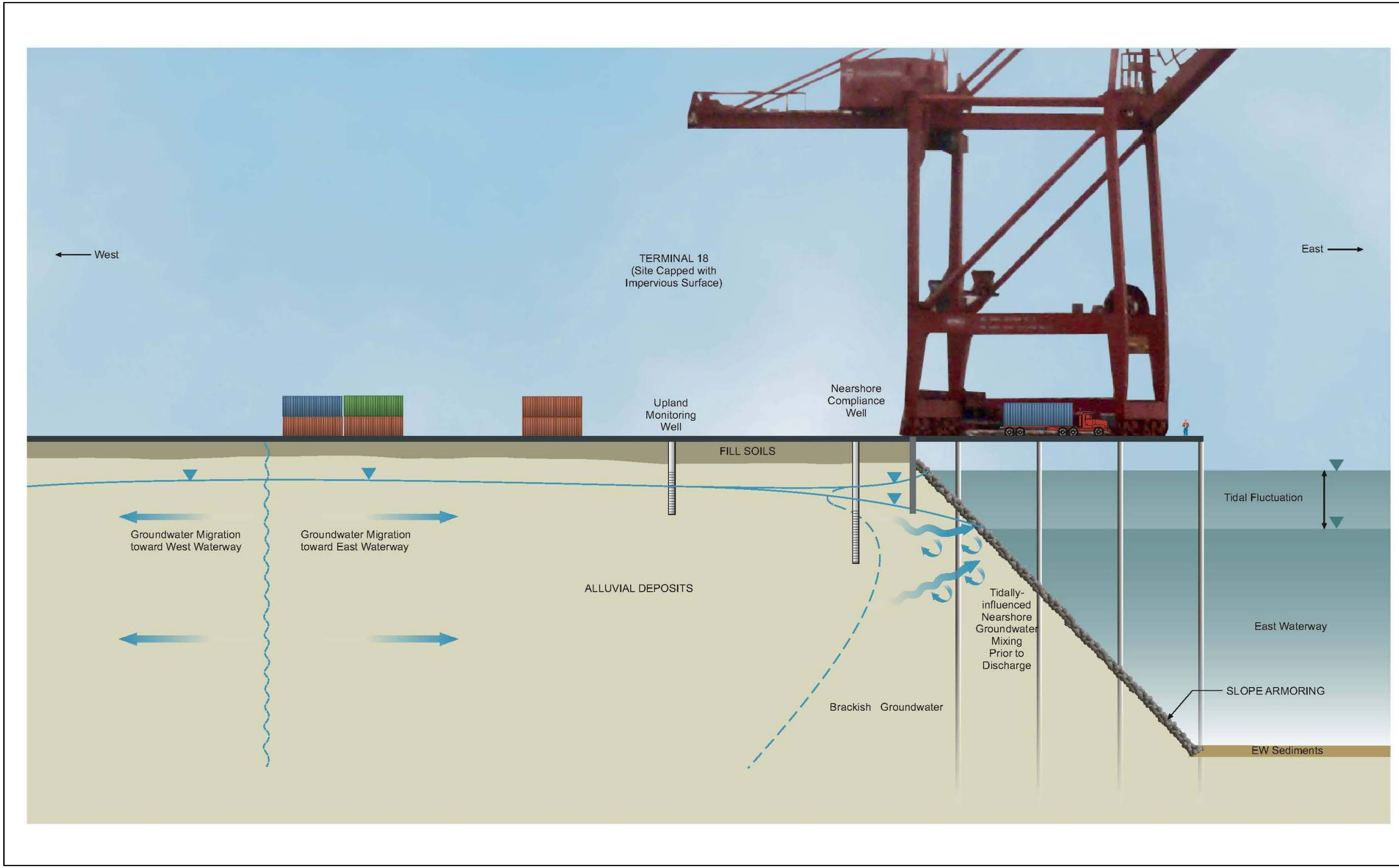


Figure 6-4
Hydrogeologic Characteristics – Harbor Island/Terminal 18 Shoreline
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

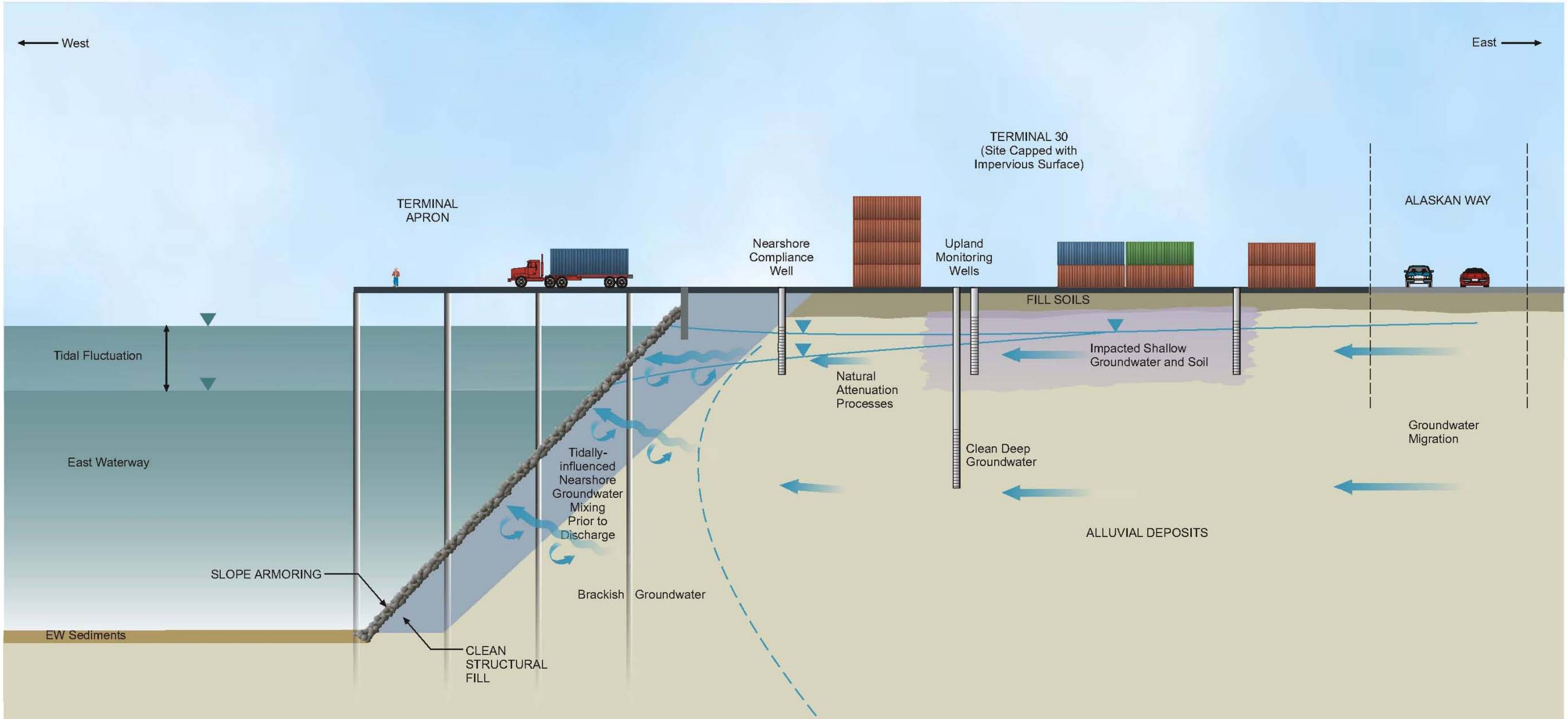


Figure 6-5
Hydrogeologic Characteristics – Terminal 30 Shoreline
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

6.2.3 Data Evaluation Process – Groundwater to Sediment Pathway

The review of nearshore cleanup sites described in this section focuses on the groundwater migration pathway. The data evaluation process included a review of available groundwater monitoring data for each of the nearshore cleanup sites along the EW. This evaluation relies on data reports compiled and attached to the EISR (Anchor and Windward 2008b), and supplemental sampling data available since that time (attached as Appendix F). Data from wells or sampling locations adjacent to the EW, or in downgradient locations between site cleanup/source areas and the EW, were prioritized because these data are most representative of the groundwater-to-sediment pathway.

Groundwater data at cleanup sites may vary over time due to the progress of site cleanup actions. Where data were limited to initial investigations or to less than four sampling events, all data were used. At active cleanup sites where extensive data were available from multiple rounds of sampling, the most recent groundwater data were used.

Relevant groundwater data were then analyzed by two methods. The first of these was a direct comparison to the site-specific groundwater cleanup levels. The second was a conservative groundwater evaluation against reference values developed using equilibrium partitioning theory. Additional reference values are used for evaluation of VOCs, cyanide, and petroleum for which no SMS criteria are available for development of partitioning-based reference values. Each of these methods is described in more detail below.

As noted in Section 3.2, the groundwater data discussed in this section are being retained for potential further review during the SRI/FS. Should the SRI or the risk assessment define other, more-stringent and applicable reference values, the data will be re-evaluated as appropriate.

6.2.3.1 Comparison to Site-Specific Cleanup Levels

Consistent with the SCEAM, initial evaluation of groundwater quality data was first performed by comparing the most recent groundwater monitoring results to the cleanup levels or remedial action objectives established by the oversight regulatory agencies for the individual sites. The cleanup levels established for individual sites are based on applicable MTCA cleanup levels, or on state and federal surface water protection criteria. For example, the cleanup goals for groundwater at Harbor Island were established in the ROD to be the "Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201)" and the human health criteria for consumption of marine organisms in the federal "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance Final Rule" as defined and in effect at the time of the ROD.

The groundwater evaluation for each nearshore cleanup site included a tabulation of the chemical data for the nearshore groundwater datasets, analysis of observed concentration ranges, and the development of summary statistics to document any exceedances of site-specific cleanup levels. Comparison to reference values was performed without incorporation of attenuation or mixing factors. These data are summarized in Appendix E and in Section 6.3. If relevant to the site conditions, other factors that may be relevant to groundwater data interpretation (e.g., chemical speciation or groundwater fate and transport properties) are discussed along with the monitoring results (though the data were not adjusted based on those factors).

6.2.3.2 Evaluation Using Equilibrium Partitioning Approaches

Consistent with the SCEAM the groundwater data for each site were also evaluated against groundwater reference values developed using an equilibrium partitioning approach. The groundwater reference values identify the potential for dissolved chemicals in groundwater to partition or be sorbed (bound) onto sediment particulates.

Equilibrium partitioning coefficients are available from the scientific literature and from EPA and Ecology databases for most chemicals. These values can be used to conservatively estimate concentrations of chemicals in groundwater which should be protective of sediment quality, even if the groundwater were discharged without mixing or other attenuation into the sediments.

The "distribution coefficient" is also commonly known as the "soil-water" partitioning coefficient. It is the ratio of a chemical's sorbed concentration (reported as mg/kg) divided by the dissolved concentration of the same chemical (typically reported as mg/L) at chemical equilibrium. Under conditions of static equilibrium, the distribution coefficient can be used to predict the concentration of a chemical in one phase (e.g., sediment) from the measured concentration of a chemical in the other phase (e.g., nearshore groundwater or sediment porewater).

$$\text{Kd (L/kg)} = \frac{\text{Concentration in sediment (mg/kg)}}{\text{Concentration in groundwater or porewater (mg/L)}}$$

For a given sediment concentration goal (e.g., the SQS), the distribution coefficient can be used to develop preliminary reference values for use in screening groundwater for protection of sediment quality.

$$\text{Groundwater Reference Value } (\mu\text{g/L}) = \frac{\text{SQS (mg/kg)} \times 1{,}000\ \mu\text{g/mg}}{\text{Kd (L/kg)}}$$

These groundwater reference values are conservative in that they do not take into account other attenuation factors such as tidally-induced groundwater mixing, biological or geochemical attenuation of chemicals along the groundwater migration pathway, or the potential failure of groundwater chemicals to achieve static equilibrium in sediments as predicted by the distribution coefficient. Because of their conservative nature, the reference values can be used in a preliminary evaluation of the groundwater data to identify nearshore cleanup sites or sub-areas warranting further evaluation, including consideration of other factors that may affect the transport or attenuation of these chemicals. Values of distribution coefficients were obtained for selected heavy metals from EPA summary documents (EPA 2005) and other sources (Baes 1984). These distribution coefficient references were used by Ecology as part of groundwater source control evaluation work for the Slip 4 area of the LDW (SAIC 2006). These values and the resultant sediment protection reference values are shown in Table 6-2.

Table 6-2
Summary of Partitioning Assumptions and Groundwater Reference Values

Non-Ionizing Organics	CAS No.	Class	SQS (mg/kg OC)	Koc Estimate (L/kg OC) [(d)]	Koc Reference	Reference Value Based on SQS[b] (µg/L)
Acenaphthene	83-32-9	LPAH	16	6.12E+03	d	**2.6**
Acenaphthylene	208-96-8	LPAH	66	6.12E+03	d	**11**
Anthracene	120-12-7	LPAH	220	2.04E+04	d	**11**
Benzo(g,h,i)perylene	191-24-2	HPAH	31	2.68E+06	d	**0.012**
Benzo[a]anthracene	56-55-3	HPAH	110	2.31E+05	d*	**0.48**
Benzo[a]pyrene	50-32-8	HPAH	99	7.87E+05	d	**0.13**
Benzo[b]fluoranthene	205-99-2	HPAH	230	8.03E+05	d	**0.29**
Benzo[k]fluoranthene	207-08-9	HPAH	230	7.87E+05	d	**0.29**
Bis(2-ethylhexyl) phthalate	117-81-7	Phthalates	47	1.65E+05	d	**0.28**
Butyl benzyl phthalate	85-68-7	Phthalates	4.9	9.36E+03	d	**0.52**
Chrysene	218-01-9	HPAH	110	2.36E+05	d	**0.47**
Dibenz[a,h]anthracene	53-70-3	HPAH	12	2.62E+06	d	**0.0046**
Dibenzofuran	132-64-9	Misc.	15	1.13E+04	d	**1.3**
Di-butyl phthalate (di-n-butyl phth.)	84-74-2	Phthalates	220	1.46E+03	d	**151**
Dichlorobenzene, 1,2-	95-50-1	Chlor	2.3	4.43E+02	d	**5.2**
Dichlorobenzene, 1,4-	106-46-7	Chlor	3.1	4.34E+02	d	**7.1**
Diethyl phthalate	84-66-2	Phthalates	61	1.26E+02	d	**484**
Dimethyl phthalate	131-11-3	Phthalates	53	3.71E+02	d	**143**
Di-n-octyl phthalate	117-84-0	Phthalates	58	1.96E+05	d	**0.30**
Fluoranthene	206-44-0	HPAH	160	7.09E+04	d	**2.3**
Fluorene	86-73-7	LPAH	23	1.13E+04	d	**2.0**
Hexachlorobenzene	118-74-1	Chlor	0.38	3.38E+03	d	**0.11**
Hexachlorobutadiene	87-68-3	Misc.	3.9	9.94E+02	d	**3.9**
Indeno[1,2,3-cd]pyrene	193-39-5	HPAH	34	2.68E+06	d	**0.013**
Methylnaphthalene, 2-	91-57-6	LPAH	38	2.98E+03	d*	**13**
Naphthalene	91-20-3	LPAH	99	1.84E+03	d	**54**
Nitrosodiphenylamine, N-	86-30-6	Misc.	11	6.15E+03	d*	**1.8**
PCB mixtures	1336-36-3	PCBs	12	4.48E+04	d	**0.27**
PCB - Aroclor 1016	12674-11-2	PCBs	12	2.71E+04	d	**0.44**
PCB - Aroclor1221	11104-28-2	PCBs	12	2.71E+04	d	**1.17**
PCB - Aroclor 1232	11141-16-5	PCBs	12	2.71E+04	d	**1.17**
PCB - Aroclor 1242	53469-21-9	PCBs	12	2.71E+04	d	**0.27**
PCB - Aroclor 1248	12672-29-6	PCBs	12	4.39E+04	d	**0.27**
PCB - Aroclor 1254	11097-69-1	PCBs	12	7.56E+04	d	**0.16**
PCB - Aroclor 1260	11096-82-5	PCBs	12	2.07E+05	d	**0.058**
PCB - Aroclor 1262	37324-23-5	PCBs	12	'Not available	d	**Not available**
PCB - Aroclor 1268	11100-14-4	PCBs	12	Not available	d	**Not available**
Phenanthrene	85-01-8	LPAH	100	2.08E+04	d	**4.8**
Pyrene	129-00-0	HPAH	1,000	6.94E+04	d	**14**
Trichlorobenzene, 1,2,4-	120-82-1	Chlor	0.81	7.18E+02	d	**1.1**

Ionizing Organics	CAS No.	Class	SQS (µg/kg dry wt.)	Koc Estimate (L/kg OC) [(d)]	Koc Reference	Reference Value Based on SQS[c] (µg/L)
Benzoic acid	65-85-0	Misc.	650	1.45E+01	d	**2,243**
Benzyl alcohol	100-51-6	Misc.	57	1.57E+01	d	**182**
Dimethylphenol, 2,4-	105-67-9	Phenols	29	7.18E+02	d	**2.0**
Methylphenol, 2- (o-cresol)	95-48-7	Phenols	63	4.43E+02	d	**7.1**
Methylphenol, 4- (p-cresol)	106-44-5	Phenols	670	4.34E+02	d	**77**
Pentachlorophenol	87-86-5	Phenols	360	3.38E+03	d	**5.3**
Phenol	108-95-2	Phenols	420	2.68E+02	d	**78**

Heavy Metals	CAS No.	Class	SQS (mg/kg dry wt.)	K_d Estimate (L/kg) [(a, f)]	Kd Reference	Reference Value Based on SQS [e] (µg/L)
Arsenic, total	7440-38-2	Metals	57	2.51E+02	a	**227**
Cadmium	7440-43-9	Metals	5.1	2.00E+03	a	**2.6**
Chromium, total	7440-47-3	Metals	260	8.50E+02	f	**306**
Copper	7440-50-8	Metals	390	3.16E+03	a	**123**
Lead	7439-92-1	Metals	450	3.98E+04	a	**11**
Mercury	7439-97-6	Metals	0.41	7.94E+04	a	**0.0052**
Silver	7440-22-4	Metals	6.1	3.98E+03	a	**1.5**
Zinc	7440-66-6	Metals	410	1.26E+04	a	**33**

Notes:
Chlor: Chlorinated Organics
LPAH: Light Polycyclic Aromatic Hydrocarbon (PAH) Compounds HPAH: Heavy PAH Compounds
Misc.: Miscellaneous Extractable Organics
Sediment protection reference values for groundwater derived based on groundwater to sediment equilibrium partitioning estimate.
(a) EPA 2005. Partition Coefficients for Metals in Surface Water, Soil, and Waste. EPA/600/R-05/074. July 2005. Values obtained from Table 4 of that document.
(b) Derivation of reference value for non-ionizing organics: Reference Value (µg/L) = (SQS (mg/kg OC) / Koc (L/kg OC)) x 1,000 µg/mg
(c) Derivation of reference value for ionizing organics: Reference Value (µg/L) = SQS (µg/kg) / (Koc [L/kg OC] * foc). Calculation assumes a fraction organic carbon (foc) of 0.02 (2% total organic carbon [TOC]), which is within the range of East Waterway sediments.
(d) EPI: EPA Estimation Programs Interface (EPI) Suite, V. 3.20, 2008. (http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm)
(d*) EPI estimated value has been updated by EPA V 3.20 since V 3.12 of EPI database.
(e) Derivation of reference value for heavy metals: Reference Value (µg/L) = (SQS (mg/kg) / Kd (L/kg)) x 1,000 µg/mg
(f) Baes 1984. Baes, C.F. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. (http://homer.ornl.gov/baes/documents/ornl5786.html)

For organic chemicals, the distribution coefficient is not directly predictive of chemical partitioning, because organic chemicals tend to associate predominantly with the organic carbon contained within a soil or sediment. A special partitioning coefficient is used in this case to represent the equilibrium between a chemical bound to soil organic carbon and that chemical in the dissolved phase. This is known as the "soil organic carbon-water partitioning coefficient" (Koc).

$$\text{Koc (L/kg OC)} = \frac{\text{Chemical concentration within the Organic carbon fraction of a soil or Sediment (mg/kg OC)}}{\text{Concentration in groundwater or Porewater (mg/L)}}$$

If the concentration of organic carbon within the soil or sediment (foc; typically reported as a fraction) is known, the Koc for an organic chemical can be converted to the soil/water partitioning coefficient. This is necessary for development of groundwater reference values for ionic organic compounds that have SMS criteria specified in dry weight sediment concentrations (refer to calculations specified in Table 6-2).

$$\text{Kd (L/kg sediment)} = \text{Koc (L/kg OC)} \times \text{foc (kg OC/kg sediment)}$$

Groundwater reference values can then be developed for specific organic chemicals using the same approach as was performed for heavy metals. For organic compounds, values of Koc were obtained from the EPA compilation known as the Estimations Programs Interface Suite (EPI Suite, version 3.20). That compilation is available electronically to the public and is frequently updated by the agency (http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm). Groundwater reference values were compiled using the sediment SQS, and assuming a sediment organic carbon content of 2 percent (foc = 0.02). As described in Table 2-3 of the EISR (Anchor and Windward 2008b), the surface sediments within the EW currently contain a mean TOC concentration of 1.9 percent (median concentration 1.7 percent) and shallow subsurface sediments (0-4 feet) contain an average TOC concentration of 2.6 percent (median concentration 1.9 percent).

Resultant groundwater reference values are listed in Table 6-2. Calculation methods for metals, organic compounds, and ionizing organic compounds are listed in the footnotes to the table.

6.2.3.3 Evaluation for Volatile Organic Compounds

Some of the cleanup sites located along the EW include VOCs (e.g., benzene) that do not have SMS criteria. Therefore, it is not possible to evaluate sediment recontamination potential for these compounds using the same methods as described above in Section 6.2.3.2.

For VOCs that are have been confirmed in nearshore monitoring locations or in other relevant groundwater monitoring locations, sampling data were compared to reference values applicable to the protection of benthic or aquatic organisms. These reference values are identified in Table 6-3.

The reference values in Table 6-3 were developed by Windward as part of the baseline ecological risk assessment for the LDW. For each of these compounds, a literature survey was conducted and available toxicity studies were reviewed to define concentrations that would be protective of benthic organisms and aquatic receptors. Compliance of nearshore groundwater, groundwater seeps, and/or sediment porewater with these concentrations would be expected to protect against toxicity to ecological receptors.

6.2.3.4 Evaluation for Other Hazardous Substances

At the Harbor Island site, cyanide is present in some groundwater locations. As with VOCs, there are no SMS criteria for cyanide in sediment. However, Washington water quality criteria (WAC 173-201a) define marine chronic criteria (2.8 micrograms per liter [µg/L]) for weak acid dissociable cyanide (available cyanide). These criteria can be used to screen against the potential for porewater toxicity to benthic organisms and/or aquatic receptors.

Table 6-3
Groundwater Reference Values for Selected Volatile Organic Compounds

VOC Compounds Detected in Nearshore Sampling Locations [2]	LDW Review of Aquatic Toxicity Literature Data [1] (µg/L)					
	Lowest Reported Literature Value [3]	Test Description	Highest Reported Literature Value [3]	Test Description	Selected NOAEL	Selected LOAEL
1,2-Dichloroethene (cis or trans)	6,785	LC50, 72-hour *Artemia salina* (Brine shrimp) Mortality	140,000	LC50, 24 to 96-hour *Lepomis macrochirus* (Bluegill) Mortality	136[4]	6,785
Trichloroethene	1,700[3]	LC50, 7-day *Platyhelminthes* sp. (Flat worm) Mortality	132,000	LC50, 48-hour *Tubificidae* (Oligochaete) Mortality	2,200[3]	14,000
Benzene	180	NOAEL, 24-day *Cancer magister* (Dungeness crab) Mortality, Growth, and Development	550,000	LC50, 120-hour *Lymnaea stagnalis* (Great pond snail) Mortality	180	1,100
Toluene	737	NOAEL, 7-day *Ceriodaphnia dubia* (Water flea) Reproduction	1,100,000	LC50, 96-hour *Melanoides tuberculata* (Snail) Mortality	737	14,700

Notes:

1. Survey of toxicity literature as published in Attachment 7 of the LDW Baseline Ecological Risk Assessment (ERA) (Windward 2007c).
2. Toxicity data are presented only for specific VOC compounds that were detected in one or more nearshore or downgradient groundwater sampling locations and where there is a reasonable potential for a complete pathway to exist between the testing area and the EW based on groundwater flow paths and existing data.
3. Not all studies discussed in the LDW Baseline ERA report were considered appropriate endpoints for use in developing ecological screening values. Considerations regarding studies not used are discussed in the Baseline ERA report (Windward 2007c).
4. The NOAEL was estimated for the LDW Baseline ERA by dividing the LOAEL by 50.

LC50 Lethal concentration for 50 percent of a test population.
LDW Lower Duwamish Waterway
LOAEL Lowest observed adverse effect level
NOAEL No observed adverse effect level
VOC Volatile organic compound

Some of the cleanup sites located along the EW are primarily impacted by petroleum hydrocarbons and associated hazardous constituents (e.g., PAH compounds). Where monitoring data includes testing for the specific semivolatile organic constituents, the groundwater reference values listed in Table 6-2 can be used directly to evaluate groundwater data using partitioning-based approaches. Similarly, where the monitoring includes testing for VOCs, the toxicity based reference values (Table 6-3) can be used.

For some of the cleanup sites (typically smaller UST removal projects), groundwater monitoring has focused on evaluation of TPH. There is no SQS established for TPH and, therefore, a groundwater reference value based on SQS cannot be established. For these sites, the MTCA Method A groundwater cleanup level for gasoline (1,000 μg/L) and for diesel (500 μg/L) are used as a conservative screening for the TPH groundwater data. Where specific constituent (i.e., BTEX and/or PAH compounds) testing data exist, these specific constituent data are used preferentially in data analysis. However, as described below, toxicity testing has shown the Method A cleanup levels for diesel to be conservative estimates of potential toxicity to benthic or aquatic organisms (i.e., toxic effects are generally not observed at or below the Method A concentrations).

The Method A cleanup level for diesel and oil hydrocarbons is considered a conservative (i.e., stringent) screening tool to evaluate the potential toxicity of petroleum mixtures to aquatic organisms, and to sediment benthic organisms via porewater toxicity. Recent literature surveys (Markarian 1994) of the toxicity of diesel fuel oils to invertebrates, fish, and algae have identified median concentration criteria of 2.35 to 4.3 mg/L. Recent studies have focused on additional exposure scenarios and have yielded lower toxicity threshold in some instances. A number of recent studies (Carls et al. 1999, 2000) have documented lower toxicity thresholds for fish eggs or embryos than for adult fish. These studies have yielded total PAH toxicity values (EC50s) of 18 to 34 μg/L in tests with weathered crude oils. Assuming that the PAH constituents are responsible for the toxic effects (this is subject to debate—see Neff et al. 2000), and based on a 5 percent typical PAH composition in diesel fuels (Millner and Nye 1992) and similar total PAH/TPH ratios observed during previous investigations, these values suggest that TPH concentrations between 0.36 to 0.68 mg/L (very similar to the Method A concentrations) would be protective for these exposure scenarios. Other experimenters (Little et al. 2000) have focused on the toxicity of petroleum-associated PAH in the presence of ultraviolet light and have detected toxicity of diesel-range petroleum at concentrations between 0.51 and 2.84 mg/L. The Method A concentrations remain protective even under these conditions (which would not likely apply to deep intertidal or subtidal groundwater discharge areas such as those in the EW). Finally, other researchers (Croce and Stagg 1997) have detected additive sublethal toxicity of petroleum and other compounds for TPH concentrations of 2 mg/L. These and other research efforts have continued to document the protectiveness of the MTCA Method A cleanup levels for diesel, to aquatic receptors. Where specific constituent data have not been collected, use of the Method A concentrations as a preliminary, conservative reference value remains appropriate.

6.2.3.5 Comparison to Ambient Water Quality Criteria

As part of the groundwater evaluation for nearshore cleanup sites, nearshore groundwater data were compared to Washington State surface water marine ambient water quality criteria (AWQC) (WAC 173-201a-240). The AWQC acute reference values generally represent exposure values of 1-hour average concentrations. AWQC chronic values generally represent longer-term exposures of 4-day average concentrations. For the current data evaluation, all AWQC values were compared to discrete sample data. The AWQC values used as reference values are presented in Table 6-4. Table 6-4 also includes reference values developed under the National Toxics Rule (40 CFR 131) to protect against human health exposures.

Table 6-4
Applicable Washington State Marine Ambient Water Quality Criteria and National Toxics Rule Reference Values

Chemical	Marine AWQC (µg/L)		National Toxics Rule (µg/L)
	Chronic	Acute	Human Health
Metals			
Arsenic (total)	36 [a]	69 [c]	0.14 [1]
Cadmium (total)	9.3 [a]	42 [c]	NA
Chromium (total)	50 [a]	1,100 [c]	NA
Copper (total)	3.1 [a]	4.8 [c]	NA
Lead (total)	8.1 [a]	210 [c]	NA
Mercury (total)	0.025 [a]	1.8 [c]	0.15
Nickel (total)	8.2 [a]	74 [c]	4,600
Selenium (total)	NA	290 [c]	NA
Silver (total)	NA	1.9 [d]	NA
Thallium	NA	NA	6.3
Zinc (total)	81 [a]	90 [c]	NA
PCBs			
Total PCBs	0.03 [b]	10 [b]	0.00017
Other			
1,2- dichlorobenzene	NA	NA	17,000
1,1,2-trichloroethane	NA	NA	42

Chemical	Marine AWQC (µg/L)		National Toxics Rule (µg/L)
	Chronic	Acute	Human Health
Anthracene	NA	NA	110,000
Benzo[a]anthracene	NA	NA	0.031
Benzo[a]pyrene	NA	NA	0.031
Benzo[b]flouranthene	NA	NA	0.031
Benzo[k]flouranthene	NA	NA	0.031
Benzene	NA	NA	71
Carbon Tetrachloride	NA	NA	4.4
Chyrsene	NA	NA	0.031
Cyanide	2.8 [a]	9.1 [c]	220,000
Dibenzo[a,h]anthracene	NA	NA	0.031
Ethylbenzene	NA	NA	29,000
Flouranthene	NA	NA	370
Fluorene	NA	NA	14,000
Indeno[1,2,3-cd]pyrene	NA	NA	0.031
Pyrene	NA	NA	11,000
Toluene	NA	NA	200,000
Tricloenthylene	NA	NA	81

Notes:

a A 4-day average concentration not to be exceeded more than once every 3 years on the average. Criteria are based on Weak Acid Dissociable form of cyanide.

b A 24-hour average not to be exceeded.

c A 1-hour average concentration not to be exceeded more than once every 3 years on the average.

d An instantaneous concentration not to be exceeded at any time.

1. The arsenic reference value has not been adjusted to take into account natural background concentrations of arsenic that may be present in surface water or groundwater.

NA Not applicable. There is no applicable AWQC reference value in WAC 173-201a-240 or human health reference value in 40 CFR 131.

6.3 Existing Data Analysis – Groundwater to Sediment Pathway

Tables 6-5 through 6-11 provide summaries of the EW nearshore cleanup sites groundwater data evaluation. Detailed data summaries supporting this analysis are contained in Appendix E. As described in the EISR, relevant data consist of the recent groundwater or seep data collected from nearshore locations adjacent to the EW, or from locations located downgradient of cleanup areas (i.e., along the pathway between the cleanup areas and the EW).

6.3.1 Harbor Island Soil and Groundwater OU

Table 6-5 summarizes the results of quarterly groundwater monitoring conducted for the Harbor Island Soil and Groundwater OU. Site contaminants of concern and the requirements of the groundwater monitoring program were identified in the ROD (EPA 1993). Groundwater monitoring data are available for a total of eight quarterly monitoring events. The total number of valid testing results for each well varies based on the well monitoring program requirements and data validation issues encountered. The analytical data are tabulated in Appendix E, Tables E-1 through E-8.

Table 6-5
Summary of Harbor Island Nearshore Groundwater Quality

		Reporting Limit of Non-Detects										
Chemical	**Chemical Detected at Nearshore Locations**	**Non-Detects (#)**	**Range (Min to Max)**	**Detected Chemical Concentration Range (µg/L)**	**ROD-Specified Cleanup Goal (µg/L)**	**Nearshore Concentration Exceeds Cleanup Goal**	**Groundwater Reference Value [2,3] (µg/L)**	**Nearshore Concentration Exceeds Reference Value**	**AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)**	**Nearshore Concentration Exceeds AWQC Chronic Reference Value [12]**	**Nearshore Concentration Exceeds AWQC Acute Reference Value [12]**	**Nearshore Concentration Exceeds NTR Human Health Reference Value [13]**
Metals (Total) [1]												
Arsenic	7 of 7	0	NA	0.03 to 3	36	0 of 7	227	0 of 7	36 / 69 / 0.14	0 of 7	0 of 7	6 of 7
Cadmium	7 of 7	0	NA	0.008 to 0.535	8	0 of 7	2.6	0 of 7	9.3 / 42 / NA	0 of 7	0 of 7	NA
Copper	7 of 7	0	NA	0.03 to 4.78	2.9	**1 of 7**	123	0 of 7	3.1 / 4.8 / NA	1 of 7	0 of 7	NA
Lead	7 of 7	0	NA	0.008 to 3.68	5.8	0 of 7	11	0 of 7	8.1 / 210 / NA	0 of 7	0 of 7	NA
Mercury	6 of 7	1	0.00015 to 0.00041	0.00011 to 0.00541	0.025	0 of 7	0.0052	**1 of 7** (HI-12) [4]	0.025 / 1.8 / 0.15	0 of 7	0 of 7	0 of 7
Nickel	7 of 7	0	NA	0.2 to 6.7	7.9	0 of 7	NA	NA	8.2 / 74 / 4,600	0 of 7	0 of 7	0 of 7
Silver	4 of 7	3	0.004 to 0.2	0.002 to 0.183	1.2	0 of 7	1.5	0 of 7	NA / NA / 1.9	0 of 7	0 of 7	0 of 7
Thallium	5 of 7	2	0.02 to 0.2	0.001 to 0.042	6.3	0 of 7	NA	NA	NA / NA / 6.3	NA	NA	0 of 7
Zinc	7 of 7	0	NA	0.13 to 127	76.6	**1 of 7**	33	**1 of 7** (HI-12) [5]	81 / 90 / NA	1 of 7	1 of 7	NA
Cyanide [2]												
Total Cyanide	6 of 7	1	1 to 5 [2]	1 to 44	1	3 of 7 [2]	NA	NA	NA	NA	NA	NA
Available Cyanide	2 of 7	5	2 to 2	0.96-1.3	1	**1 of 7 [2]**	2.8 [2]	0 of 7	2.8 / 9.1 / 220,000	NA	0 of 7	0 of 7
Volatile Organic Compounds												
1,1,1-Trichloroethane	0 of 7	7	1 to 1	--	42	0 of 7	NA	ND	NA	NA	NA	NA
1,1,2-Trichloroethane	0 of 7	7	1 to 1	--	42	0 of 7	NA	ND	NA / NA / 42	NA	NA	0 of 7
Benzene	1 of 7	6	1 to 1	1-1.4	71	0 of 7	180	0 of 7	NA / NA / 71	NA	NA	0 of 6
Carbon Tetrachloride	0 of 7	7	1 to 1	--	4.4	0 of 7	NA	ND	NA / NA / 4.4	NA	NA	0 of 7
Tetrachloroethene	0 of 7	7	1 to 1	--	8.8	0 of 7	NA	ND	NA	NA	NA	NA
Polychlorinated Biphenyls												
Aroclor 1016	0 of 7	7	0.01 to 0.1 [6]	--	0.03	0 of 7	0.44	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1221	0 of 7	7	0.01 to 0.3 [7]	--	0.03	0 of 7	1.17	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1232	0 of 7	7	0.01 to 0.2 [8]	--	0.03	0 of 7	1.17	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1242	0 of 7	7	0.01 to 0.12 [9]	--	0.03	0 of 7	0.27	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1248	0 of 7	7	0.01 to 0.1 [10]	--	0.03	0 of 7	0.27	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1254	0 of 7	7	0.01 to 0.2 [11]	--	0.03	0 of 7	0.16	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1260	0 of 7	7	0.01 to 0.03	--	0.03	0 of 7	0.058	0 of 7	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1262	0 of 7	7	0.01 to 0.02	--	0.03	0 of 7	NA	ND	NA / NA / 0.00017	NA	NA	0 of 7
Aroclor 1268	0 of 7	7	0.01 to 0.01	--	0.03	0 of 7	NA	ND	NA / NA / 0.00017	NA	NA	0 of 7

Notes:

Results presented above are summarized on a location-by-location basis. There are multiple sampling events (dates) for each location. Refer to Appendix Tables E-1 through E-8 for a detailed summary of relevant groundwater monitoring data.

[1] Metals interferences were noted during the September and December 2005 groundwater sampling events in multiple wells. Data with identified interferences that were R-flagged during data validation are not included in the summary statistics.

[2] Initial groundwater sampling was performed using total cyanide test methods, though the toxicity criteria on which the cleanup goal was established are based on free (available) cyanide. Testing for available cyanide was introduced beginning in December 2006. The groundwater reference value for available cyanide (2.8 µg/L) is based on the Washington chronic marine criterion (WAC 173-201A) for weak acid dissociable cyanide.

[3] Refer to Table 6-2 for the derivation of the groundwater reference values based on equilibrium partitioning considerations. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes that likely limit the potential for sediment recontamination to occur. Refer to Table 6-3 for the derivation of toxicity-based reference values for benzene.

[4] Only one exceedance (out of 6 samples analyzed) has been noted for mercury in well HI-12, and that sample exceeded the reference value only slightly (0.0054 compared to a reference value of 0.0052 µg/L).

[5] Concentrations of zinc in well HI-12 have been highly variable, ranging from 4.65 µg/L to 127 µg/L over the past six sampling events. The geometric mean of these six measured values within this one well is 38 µg/L, compared to a reference value of 33 µg/L.

[6] Higher detection limit for Aroclor 1016 occurred on earliest sample at HI-16. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[7] Higher detection limits for Aroclor 1221 occurred on earliest samples at HI-3 and HI-4 wells. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[8] Higher detection limit for Aroclor 1232 occurred once on earliest sample for HI-3 well. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[9] Higher detection limit for Aroclor 1242 occurred on earliest sample at HI-3 well and first two samples on HI-16 well. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[10] Higher detection limit for Aroclor 1248 occurred once on earliest samples at HI-3 and HI-16 wells. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[11] Higher detection limit for Aroclor 1254 occurred once on earliest sample at HI-16 well. Sampling methods were improved and following non-detects were at a detection limit of 0.01 µg/L.

[12] Washington State AWQC reference values are compared to discrete samples.

[13] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples. The reference values for arsenic have not been adjusted to take into account naturally occurring arsenic concentrations that may be present in groundwater or surface water.

NA: Not applicable. Chemical does not have a reference value of the indicated type (AWQC, NTR human health value, SQS, or no partitioning estimate was available from Table 6-2).
ND: Compound was not detected in any samples. No additional groundwater reference value defined.
The presence of nonaqueous phase liquid (NAPL) was not identified at any groundwater monitoring well location.
Type of Site and Release: Harbor Island was listed on the National Priorities List (NPL) due to former lead smelter operations as well as elevated concentrations of organic and inorganic chemicals in soil and groundwater. The Soil and Groundwater Operational Unit (OU), a component of the larger Harbor Island Superfund Site is one of seven that are part of the Harbor Island Superfund Site. The Soil and Groundwater OU borders the western shoreline of the East Waterway.
Groundwater Sampling Network and Rationale: Groundwater sampling results from the 2005-2007 quarterly monitoring events are summarized for those monitoring wells within the Harbor Island Soil and Groundwater OU network located along the nearshore area of the East Waterway (HI-1, HI-2, HI-3, HI-4, HI-5, HI-12 and HI-16). These monitoring well locations are presented on Figure 5-7. Ongoing groundwater monitoring is being performed at the Harbor Island Soil and Groundwater OU consistent with the Site ROD.
Site-specific Groundwater Cleanup Levels: The site-specific cleanup levels for Harbor Island are the cleanup goals specified in the ROD. These were based on the protection of surface water quality as defined by criteria applicable at the time of the ROD.

Two analytical methodology issues have been investigated and discussed in the groundwater monitoring reports. The first issue dealt with analytical method interferences associated with the analysis of metals in saline or partially saline groundwater. This issue was noted in the 2005-2006 monitoring report (RETEC 2006a) and was resolved by using the reductive precipitation test method for analysis of heavy metals in affected wells. Analytical data flagged with an "R" value in the monitoring reports were not used in the data analysis summarized in Table 6-5. A second issue was investigated with the 2006-2007 monitoring report. That issue was associated with the different forms of cyanide that can be present in groundwater and measured using available analytical methods. The ROD cleanup goal was based on the toxicity of free or available cyanide, though initial groundwater testing was performed using analyses for total cyanide. The total cyanide analysis measures both available cyanide and cyanide that is tightly bound to iron or other constituents and does not have the same toxicity characteristics. Testing performed as part of the 2006-2007 monitoring period has utilized both the total cyanide and the available cyanide test methods. The report concludes that the latter data are more appropriate for data interpretation against the ROD cleanup goals (ENSR 2007).

Groundwater monitoring for PCBs was performed during the 2005-2006 monitoring period. No PCBs were detected in any of the seven wells. The method reporting limits were less than the cleanup goals and the groundwater reference values.

VOCs have been tested during each of the monitoring events. Most VOCs were undetected. Benzene was detected only in a single well and at concentrations well below the ROD cleanup goals. No groundwater reference values are established because there is no SQS for VOCs.

Available cyanide has been detected in two wells. One of the detections (HI-4) was below the ROD cleanup goal. The other detection (well HI-5) was slightly above the cleanup goal (1.3 μg/L compared to a ROD cleanup goal of 1.0 μg/L). Groundwater monitoring for available cyanide is continuing during the 2007-2008 monitoring period. No groundwater reference values are established because there is no SQS for cyanide.

Copper concentrations in well HI-12 ranged from 1.65 to 4.78 μg/L, compared to a cleanup goal of 2.9 μg/L. These measured concentrations are all below the groundwater reference values. Therefore, the copper concentrations in well HI-12 are not a potential concern for sediment recontamination.

Zinc concentrations in well HI-12 varied significantly between monitoring events, ranging from a concentration of 4.65 to 127 μg/L, compared to a cleanup goal of 76.6 μg/L. The mean (66 μg/L) and median (67 μg/L) of the concentrations are below the cleanup goal, as is the geometric mean (37 μg/L). Further monitoring is planned and will provide information on the long-term trends in the zinc concentrations. The groundwater reference value for zinc is 33 μg/L. The range in concentrations observed at well HI-12 indicates that further evaluation may be warranted for zinc in this area, depending on the findings of ongoing groundwater monitoring. Evaluation steps are discussed in Section 6.4. As described in Section 3 of this Memorandum and in the EISR (Anchor and Windward 2008b), zinc concentrations measured in EW sediments during previous sediment sampling efforts did not indicate elevated zinc concentrations in surface or subsurface sediments in the area offshore of well HI-12, nor have elevated zinc concentrations been noted during sediment recontamination monitoring within the EW (Windward 2006, Windward 2007a, Windward 2008).

Mercury concentrations in HI-12 have varied between non-detect values and a high of 0.00541 μg/L. All concentrations measured in this well have been below the ROD-specified cleanup goals. One of the measured concentrations (0.00541 μg/L; December 2006 monitoring event) was slightly greater than the groundwater reference value (0.0052 μg/L). Given the low range of groundwater mercury concentrations detected at this location, groundwater concentrations of mercury at well HI-12 are not considered significant. The mean, median, and geometric mean values were 0.0017, 0.0009, and 0.0012, respectively (assuming half-detection limit values for non-detect results), well below the reference values. The one-time exceedance was only 4 percent greater than the groundwater reference value. Further groundwater monitoring is planned for this location, and will provide verification of the long-term concentration trends for this well.

6.3.2 Southern Harbor Island UST Removals (Terminal 102)

A summary of the land use history at T-102 was recently completed as part of Ecology's source control activities for the LDW (E&E 2008). As described in that report, the majority of Harbor Island was filled for development circa 1905. As of 1936, the area that has become T-102 had not been filled. The T-102 area was filled by 1976, and the Anchor Marina had been constructed along the shoreline. By 1981, Associated Transportation Center used the property for container storage. Redevelopment of T-102 was completed in the mid-1980s, including construction of the Harbor Marina Corporate Center.

Three USTs were associated with the marina. These USTs were removed in October 1996 (E&E 2008). Soil and groundwater testing at T-102 has been focused on the areas associated with these UST removals. No reported contamination problems have been noted in other areas of the site.

The UST removal area within T-102 has undergone previous cleanup actions. Recent groundwater monitoring data are summarized in Table 6-6. None of the measured concentrations for T-102 groundwater exceeded the site-specific cleanup level, which was based on the MTCA cleanup levels applicable at the time of the cleanup action (1,000 µg/L).

Because the recent groundwater monitoring data at T-102 are limited to total petroleum hydrocarbons (diesel-range hydrocarbons) the current MTCA Method A groundwater cleanup level (500 µg/L) was used to evaluate the data rather than the groundwater reference values from Table 6-2. Groundwater TPH was not detected in any of the samples collected from T-102. The method reporting limits were well below the current MTCA Method A groundwater cleanup level for diesel (500 µg/L).

During previous sediment sampling in the portion of the EW located south of the Spokane Street Bridge and adjacent to the BNSF railroad and emergency access bridges, concentrations of PAH compounds were identified above the SQS. Additional testing is being performed in this area as part of the SRI/FS investigations.

No additional cleanup or monitoring activities are ongoing for the T-102 site.

Table 6-6
Summary of Terminal 102 Groundwater Quality

Chemical	Chemical Detected	Reporting Limit of Non-Detects		Detected Chemical Concentration Range (µg/L)	Site-Specific Cleanup Levels (µg/L)	Downgradient Chemical Concentration Exceeds Cleanup Level	Groundwater Reference Value [1] (µg/L)	Nearshore Concentration Exceeds Reference Value	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)
		Non-Detects (#)	Range (Min to Max)						
Petroleum Hydrocarbons									
Diesel range hydrocarbons	0 of 6	6	100 to 100	--	1,000	0 of 6	500	0 of 6	NA

Notes:

The T-102 groundwater sampling locations included temporary borings GP-2, GP-5, GP-6, GP-7, GP-8, and GP-9. Refer to Appendix Table E-9 for a detailed summary of relevant groundwater monitoring data.

[1] The MTCA Method A cleanup levels are used conservatively as a surrogate for evaluation of total petroleum hydrocarbon data, because testing for specific petroleum-associated constituents was not performed. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes that likely limit the potential for sediment recontamination to occur.

NA: No chronic or acute reference values are specified in the Washington State AWQC and no human health reference values are specified in the NTR.

Type of Site and Release: T-102 is located at the southern tip of Harbor Island. Currently, the Harbor Island Marina and several office and warehouse buildings are located at this property. Three USTs were removed from the marina property in 1996. These tanks were used for marina operations and included a 10,000-gallon diesel tank, a 10,000-gallon leaded gasoline tank, and a 2,000-gallon waste oil tank. Soil and groundwater monitoring was conducted as part of the UST decommissioning. Testing performed after decommissioning activities indicated that petroleum-related contamination from the USTs was limited to the UST area and groundwater sampling confirmed the absence of potential petroleum impacted groundwater migration to the EW.

Document Presenting Groundwater Results: RETEC 1997. (Underground Storage Tank Decommissioning.)

Groundwater Sampling Network and Rationale: Groundwater sampling results from the RETEC October 1996 groundwater sampling event are summarized above. All groundwater sampling locations were used in the evaluation below. Previous groundwater sampling performed by GeoEngineers was collected prior to tank decommissioning activities and was not used in the evaluation. The GeoEngineers groundwater sampling indicated that benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were not present.

Site-specific Cleanup Levels: The reference value for T-102 is based on the MTCA Method A groundwater cleanup levels applicable at the time and referenced in the report (RETEC 1997).

6.3.1 Pier 35 and Vicinity (Coast Guard)

The U.S. Coast Guard property at Pier 35 has undergone multiple rounds of investigation and cleanup. Recent groundwater monitoring data are summarized in Table 6-7.

Heavy metals were monitored in site groundwater using both permanent monitoring wells and geoprobe borings. Other than arsenic, none of the measured parameters exceeded their respective site-specific cleanup levels.

Arsenic concentrations were slightly elevated in site groundwater, ranging from 7 μg/L to a high of 180 μg/L. These values exceeded the site-specific cleanup level based on MTCA Method A cleanup levels (5 μg/L). That cleanup level is in turn based on natural background concentrations of arsenic in Washington groundwater. None of the measured arsenic concentrations exceeded the groundwater reference value for arsenic in groundwater from Table 6-2. Results indicate that the measured arsenic concentrations are not a potential concern for sediment recontamination based on the SQS.

Testing for organic compounds included analysis of SVOCs at two of the monitoring well locations. None of the SVOCs were detected.

VOCs were tested at all of the sampling locations, including multiple rounds of testing at the permanent monitoring wells. None of the VOCs exceeded the site-specific cleanup levels, with the exception of 1,1,2-trichloroethane. That compound was detected in one sample from a single monitoring well (MW-1C), but was not detected in subsequent resampling of that well.

Testing for petroleum hydrocarbons was performed at each of the Pier 35 groundwater sampling locations, including multiple rounds of sampling at the permanent monitoring wells. No exceedances of the site-specific cleanup levels were noted (Table 6-7).

No ongoing investigation or monitoring activities are occurring at the Pier 35/U.S. Coast Guard site.

Table 6-7
Summary of USCG (Pier 35) Groundwater Quality

Chemical	Chemical Detected	Reporting Limit of Non-Detects		Detected Chemical Concentration Range (µg/L)	Site-Specific Cleanup Levels (µg/L)	Downgradient Chemical Concentration Exceeds Cleanup Level	Groundwater Reference Value [3] (µg/L)	Downgradient Chemical Concentration Exceeds Reference Value	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)	Nearshore Concentration Exceeds AWQC Chronic Reference Value [8]	Nearshore Concentration Exceeds AWQC Acute Reference Value [8]	Nearshore Concentration Exceeds NTR Human Health Reference Value [9]
		Non-Detects (#)	Range (Min to Max)									
Metals (Dissolved)												
Arsenic	5 of 5	0	NA	7 to 180	5	5 of 5	227	0 of 5	36 / 69 / 0.14	1 of 5	1 of 5	5 of 5
Cadmium	0 of 5	5	5 to 5	--	5	--	2.6	0 of 5	9.3 / 42 / NA	0 of 5	0 of 5	NA
Copper	0 of 5	5	10 to 10	--	592b	0 of 5	123	0 of 5	3.1 / 4.8/ NA	0 of 5	0 of 5	NA
Chromium	0 of 5	5	10 to 10	--	50	0 of 5	306	0 of 5	50 / 1,100 / NA	0 of 5	0 of 5	NA
Lead	4 of 5	1	2 to 2	2 to 5	15	0 of 5	11	0 of 5	8.1 / 210 / NA	0 of 5	0 of 5	NA
Mercury	0 of 5	5	0.5 to 0.5	--	2	--	0.0052	0 of 5	0.025 / 1.8 / 0.015	0 of 5	0 of 5	0 of 5
Nickel	2 of 5 [2]	3	10 to 10	20 to 30	--	0 of 5	NA	NA	8.2 / 74 / 4,600	2 of 5	0 of 5	0 of 5
Zinc	3 of 5 [2]	2	1 to 1	2	4,800b	0 of 5	33	0 of 5	81 / 90 / NA	0 of 5	0 of 5	NA
Petroleum Hydrocarbons												
Gasoline range hydrocarbons	2 of 7	5	100 to 100	210 to 350	1,000	0 of 5	1,000 [4]	0 of 7	NA	NA	NA	NA
Diesel range hydrocarbons	0 of 7	7	20,000 to 20,000 [5]	--	500	0 of 7	500 [4]	0 of 7	NA	NA	NA	NA
Heavy oil	0 of 7	7	500 to 50,000 [5]	--	500	0 of 7	500 [4]	0 of 7	NA	NA	NA	NA
Volatile Organic Compounds												
1,1,2-Trichloroethane	0 of 7 [1]	6	1 to 1	-- [1]	0.768b	0 of 7 [1]	ND	ND	NA / NA / 42	NA	NA	0 of 5
Xylenes	2 of 7	5	1 to 1	1.1 to 5.3	1,000	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
Isopropylbenzene	1 of 7	6	1 to 1	1.5 to 2.1	800b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
n-Propylbenzene	1 of 7	6	1 to 1	7.2 to 8.9	320b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
4-Chlorotoluene	1 of 7	6	1 to 1	2.0	160b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
1,3,5-Trimethylbenzene	2 of 7	5	1 to 1	1.5 to 18	400b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
tert-Butylbenzene	1 of 7	6	1 to 1	11	320b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
1,2,4-Trimethylbenzene	2 of 7	5	1 to 1	2.0 to 11	400b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
sec-Butylbenzene	1 of 7	6	1 to 1	3.7 to 4.6	320b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
Isopropyltoluene	1 of 7	6	1 to 1	3.1	400b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
n-Butylbenzene	2 of 7	5	1 to 1	1.3 to 12	320b	0 of 7	NA [7]	NA [7]	NA	NA	NA	NA
Naphthalene	2 of 7	5	1 to 1	2.3 to 3.9	160	0 of 7	54	0 of 7	NA	NA	NA	NA
Other EPA 8260 VOCs [6]	0 of 7	7	1 to 1	--	--	0 of 7	ND	ND	NA	NA	NA	ND
Semivolatile Organic Compounds [6]	0 of 2	2	NR	--	--	0 of 2	Table 6-2	0 of 2	NA	NA	NA	ND

Notes:

The USCG groundwater sampling locations included in the evaluation are: MW-1C-03, MW-2-03, SB-SC-02, SB-SC-03, SB-SC-05, SB-SC-07, and SB-SC-08. Results presented above were evaluated on a location-by-location basis and there may be multiple sampling events (dates) per location. Refer to Appendix Table E-10 for a detailed summary of the groundwater monitoring data.

[1] 1,1,2-Trichloroethane was detected (6.6 µg/L) in sample location MW-1C in October 2003. More recent groundwater sampling at location MW-1C in November 2004 showed a non-detect concentration at less than 1.0 µg/L suggesting that the 2003 detection was a false positive. The compound is shown as non-detect for this location in Table 6-7.

[2] The field duplicate sample (QC-1) collected in 2004 was a duplicate of groundwater sample SB-SC-07. Nickel and Zinc were detected in the duplicate groundwater sample, however not detected in the original groundwater sample. The detected concentrations in the duplicate sample were low-level and well below the reference value.

[3] Refer to Table 6-2 for the derivation of the groundwater reference values based on equilibrium partitioning. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes

[4] The MTCA Method A cleanup levels are used conservatively as a surrogate for evaluation of total petroleum hydrocarbon data, because testing for specific petroleum-associated constituents (e.g., VOCs and PAHs) was not performed at all sampling locations.

[5] The detection limits were raised for diesel and heavy oil in groundwater samples. However, no diesel or oil contamination above MTCA Method A cleanup levels was noted in any soil samples collected. Based on this consideration, no data gaps are defined associated with the elevated detection limits.

[6] None of the EPA 8260 VOC compounds or EPA 8270 SVOC compounds, other than those indicated in Table 6-7, were detected in any of the groundwater samples analyzed.

[7] Selected gasoline-associated volatile organic compounds (alkylbenzenes) were detected in well MW-1C-03 during two sampling events at very low concentrations (maximum value 18 µg/L). These compounds were detected once in a second well (MW-2C-03), but were not detected during resampling. The compounds were not detected in five geoprobe groundwater sampling locations placed in upgradient and downgradient locations (relative to well MW-1C-03 location). Based on the low concentrations, isolated distribution, and the apparent lack of a complete pathway to the EW for these compounds, no additional reference values were defined for these compounds at this time.

[8] Washington State AWQC reference values are compared to discrete samples.

[9] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples. The reference value for arsenic has not been adjusted to account for naturally-occuring arsenic that may be present in groundwater or surface water.

b: Indicates MTCA Method B criteria. Method A and Method B groundwater criteria were used as part of the Pier 35 investigations for comparison of groundwater sample quality data.
NA: Not applicable, or chemical does not have the indicated reference value (AWQC, NTR, SQS, or no partitioning estimate was available from Table 6-2).
ND: Compounds not detected in any of the nearshore or downgradient sampling locations. No additional reference values defined.
NR: Reporting limits not reported.

Type of Site and Release: The USCG facility is located along the northeast nearshore area of the EW and near the current EW OU northern study boundary. Previous operations at the property included a milling company and a solid waste transfer company. Prior features at the property included three petroleum USTs used for truck refueling. The transfer station buildings and tanks were demolished and removed in 1990, and the USCG facility was subsequently built in 1992.

Document Presenting Groundwater Results: Hart Crowser 2004. (Draft - Sampling and Analysis Report - USCG ISC Seattle Pier 36 Site Investigation, December 27, 2004.)

Groundwater Sampling Network and Rationale: Groundwater sampling results from the 2003 and 2004 sampling events are summarized in this table. Groundwater sampling was performed to inform redevelopment decisions and confirm downgradient conditions from potential upland sources. Groundwater investigations identified arsenic as the only chemical exceeding the MTCA groundwater cleanup level. Concentrations of arsenic in groundwater samples ranged from 7 to 180 μg/L. In 2001, USCG performed development dredging adjacent to their facility, and arsenic was not identified as a sediment contaminant as part of the Puget Sound Dredged Disposal Analysis (PSDDA) characterization project.

Site-specific Cleanup Levels: The reference value for the USCG (Pier 35) facility is based on the MTCA Method A and Method B groundwater cleanup levels applicable at the time and referenced in the report (Hart Crowser 2004).

6.3.2 Pier 34 and Vicinity (Former GATX)

As described in the EISR (Anchor and Windward 2008b), the Pier 34 property (Former GATX bulk fuel terminal) has undergone extensive investigation and remediation activities. This work included completion of an RI/FS and Cleanup Action Plan, demolition of the former fueling facility, excavation and treatment of contaminated soils, operation of a groundwater treatment system, and implementation of a groundwater monitoring program.

The groundwater monitoring program at the Pier 34 property included multiple components. Some of the components were specifically associated with the operational control of the groundwater remediation system. These included location-specific action levels and trigger levels for different points within the site. Other aspects of the groundwater monitoring program were focused on establishing cleanup levels that were protective of groundwater discharges to surface waters in the EW. These latter analyses included the examination of monitoring results from a combination of nearshore groundwater wells and nearshore groundwater seep monitoring locations to assess the quality of groundwater discharging to the EW. The groundwater and seep monitoring locations were arranged generally along five transects running perpendicular to the EW shoreline (Figure 6-2).

Recent groundwater and nearshore seep monitoring data are summarized in Table 6-8 for each of the five transect locations. The specific data on which Table 6-8 is based are tabulated in Appendix E, Tables E-11 through E-16.

The groundwater monitoring program included testing for PAH compounds, BTEX compounds, petroleum hydrocarbons, and the heavy metals arsenic, copper, and lead. Groundwater results are available for multiple measuring dates along each of the transects, and method reporting limits were generally below the site-specific cleanup levels and the groundwater reference values developed in Table 6-2. The sampling data from the downgradient portion of each of the five transects including four seep samples and one nearshore monitoring well) included non-detect results for most of the PAH compounds. Pyrene was detected in one location, but at concentrations well below the site-specific cleanup level. None of the PAH compounds was detected above the groundwater reference values listed in Table 6-2.

Concentrations of BTEX and petroleum were below site site-specific cleanup levels along each of the five transect locations. The concentrations of petroleum were also below the current MTCA Method A concentrations.

Arsenic and lead concentrations were below the site-specific cleanup levels and the groundwater reference values along each of the five transect locations. Copper concentrations in two locations were detected at concentrations slightly above the site-specific groundwater cleanup level. However, these concentrations were less than corresponding background samples of surface water collected from the EW. Consistent with the groundwater monitoring plan, the concentrations were not considered to represent an exceedance of the cleanup level. Neither of the measured concentrations exceeded the groundwater reference value for copper.

During previous testing summarized in the EISR (Anchor and Windward 2008b), PAH concentrations in excess of the SQS and CSL were detected in surface sediments located near the Pier 34/Former GATX site. The source of the elevated PAH concentrations has not been determined, but could include historical petroleum spills from fueling operations at the former fuel pier, the presence of creosote-treated pilings and structures adjacent to Pier 34, and/or historical groundwater releases.

No ongoing groundwater monitoring is being conducted at the Pier 34 (Former GATX) site.

Table 6-8
Summary of GATX (Pier 34) Nearshore Groundwater Quality

Chemical	Chemical Detected at Nearshore Sampling Location [1]	Reporting Limit of Non-Detects		Detected Chemical Concentration Range at Nearshore Location [1] (µg/L)	Site Specific Cleanup Levels Applicable to Nearshore Groundwater Location (µg/L)	Chemical Exceeds Cleanup Level at Nearshore Sampling Location	Groundwater Reference Values [2] (µg/L)	Chemical Exceeds Reference Value at Nearshore Sampling Location	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)	Nearshore Concentration Exceeds AWQC Chronic Reference Value [6]	Nearshore Concentration Exceeds AWQC Acute Reference Value [6]	Nearshore Concentration Exceeds NTR Human Health Reference Value [7]
		Non-Detects (#)	Range (Min to Max)									
Metals (Dissolved)												
Arsenic	2 of 5	3	1 to 10	1	2.1	0 of 5	227	0 of 5	36 / 69 / 0.14	0 of 5	0 of 5	2 of 5
Copper	2 of 5	3	1 to 4	4 to 7	2.9 [3]	0 of 5 [3]	123	0 of 5	3.1 / 4.8 / NA	2 of 5 [3]	1 of 5 [3]	NA
Lead	1 of 5	4	1 to 10	3	5.6	0 of 5	11	0 of 5	8.1 / 210 / NA	0 of 5	0 of 5	NA
Petroleum Hydrocarbons												
Gasoline Range Hydrocarbons	0 of 5	5	250 to 250	--	1,000	0 of 5	NA [4]	ND	NA	NA	NA	NA
Diesel Range Hydrocarbons	2 of 5	3	250 to 250	340 to 420	1,000	0 of 5	NA [4]	ND	NA	NA	NA	NA
BTEX Compounds												
Benzene	0 of 5	5	1 to 1	--	700	0 of 5	180 [5]	ND	NA / NA / 71	NA	NA	0 of 5
Ethylbenzene	0 of 5	5	1 to 1	--	430	0 of 5	ND	ND	NA / NA / 29,000	NA	NA	0 of 5
m,p-Xylene	0 of 5	5	1 to 1	--	--	0 of 5	ND	ND	NA	NA	NA	NA
o-Xylene	0 of 5	5	1 to 1	--	--	0 of 5	ND	ND	NA	NA	NA	NA
Toluene	0 of 5	5	1 to 1	--	5,000	0 of 5	737 [5]	ND	NA / NA / 200,000	NA	NA	0 of 5
PAH Compounds												
Acenaphthene	0 of 5	5	1.8 to 1.8	--	710	0 of 5	2.6	0 of 5	NA	NA	NA	NA
Acenaphthylene	0 of 5	5	5.3 to 5.4	--	--	0 of 5	11	0 of 5	NA	NA	NA	NA
Anthracene	0 of 5	5	0.66 to 0.67	--	--	0 of 5	11	0 of 5	NA / NA / 110,000	NA	NA	0 of 5
Benzo(a)anthracene	0 of 5	5	0.05 to 0.05	--	0.93	0 of 5	0.48	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Benzo(a)pyrene	0 of 5	5	0.07 to 0.07	--	0.93	0 of 5	0.13	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Benzo(b)fluoranthene	0 of 5	5	0.04 to 0.4	--	0.93	0 of 5	0.29	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Benzo(g,h,i)perylene	0 of 5	5	0.11 to 0.11	--	--	0 of 5	0.012	0 of 5	NA	NA	NA	NA
Benzo(k)fluoranthene	0 of 5	5	0.06 to 0.06	--	0.93	0 of 5	0.29	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Chrysene	0 of 5	5	0.15 to 0.15	--	0.93	0 of 5	0.47	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Dibenzo(a,h)anthracene	0 of 5	5	0.1 to 0.1	--	0.93	0 of 5	0.0046	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Fluoranthene	0 of 5	5	0.49 to 0.49	--	16	0 of 5	2.3	0 of 5	NA / NA / 370	NA	NA	0 of 5
Fluorene	0 of 5	5	0.46 to 0.46	--	1,400	0 of 5	2.0	0 of 5	NA / NA / 14,000	NA	NA	0 of 5
Indeno(1,2,3-cd)pyrene	0 of 5	5	0.07 to 0.07	--	0.93	0 of 5	0.013	0 of 5	NA / NA / 0.0031	NA	NA	0 of 5
Naphthalene	0 of 5	5	2.5 to 2.5	--	2,470	0 of 5	54	0 of 5	NA	NA	NA	NA
Phenanthrene	0 of 5	5	0.64 to 0.65	--	--	0 of 5	4.8	0 of 5	NA	NA	NA	NA
Pyrene	1 of 5	4	0.21 to 0.27	0.21	6,480	0 of 5	14	0 of 5	NA / NA / 11,000	NA	NA	0 of 5

Notes:

Results presented above were evaluated on a location-by-location basis and there may be multiple sampling events (dates) per location.

[1] GATX groundwater monitoring data summarized in this table include the downgradient sampling locations along each of five transects. These locations include seeps S-1 through S-4 and nearshore monitoring well B-11. Refer to Appendix Tables E-11 through E-16 for a detailed tabular summary of groundwater data along each transect, including additional data for upland groundwater monitoring wells GMW-12, B-1, B-2, and CW-1.

[2] Refer to Table 6-2 for the derivation of the groundwater reference values based on equilibrium partitioning considerations. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes that likely limit the potential for sediment recontamination to occur.

[3] Cleanup levels for seeps and nearshore groundwater included a two-part test with comparison to surface water cleanup goals and also a comparison to background surface water metals concentrations. Copper was detected at two nearshore sampling locations (Seep 2 and well B-11) at concentrations in excess of the cleanup goal, but these concentrations did not exceed the concentrations measured in the adjacent surface water. Consistent with the compliance monitoring plan, these nearshore groundwater results were not considered to be cleanup level exceedances.

[4] No exceedances of groundwater reference values were noted for specific petroleum-associated constituents (e.g., BTEX and PAH compounds). Additionally, nearshore petroleum concentrations in groundwater were less than the MTCA Method A cleanup levels (1,000 µg/L gasoline and 500 µg/L diesel/oil) which represent conservative reference values for total petroleum hydrocarbon data.

[5] Refer to Table 6-3 for the derivation of toxicity-based groundwater reference values for volatile organic compounds.

[6] Washington State AWQC reference values are compared to discrete samples.

[7] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples. The reference value for arsenic has not been adjusted to take into account naturally-occuring arsenic that may be present in groundwater or surface water.

NA: Not applicable, or chemical does not have the indicated reference value (AWQC, NTR, SQS, or no partitioning estimate was available from Table 6-2). For total petroleum hydrocarbons, specific constituent testing data are available and are considered more relevant for evaluating potential impacts to EW sediments.

ND: Compound not detected in any of the relevant downgradient or nearshore sampling locations.

Type of Site and Release: The GATX terminal was an active bulk fuel terminal from the 1920s to 1995. The facility stored a variety of petroleum products, including but not limited to gasoline, jet fuel, diesel fuel, and heavy marine fuels. Extensive environmental investigations were performed at the GATX property beginning in the 1980s. The nature and extent of contamination at the site is described in the site RI/FS. The cleanup performed by GATX included terminal demolition, excavation of hydrocarbon- and lead-impacted soil, treatment of groundwater using an air sparging system, and installation and monitoring of a network of groundwater compliance monitoring wells.

Document Presenting Groundwater Results: RETEC 2004. (Letter Re: Pier 34 Annual Groundwater Compliance Monitoring Summary for 2003 and 5-Year Review.)

Groundwater Sampling Network and Rationale: The GATX groundwater monitoring program included a 5-year review requirement upon completion of active remediation activities and subsequent monitoring. Five years of groundwater monitoring data has been collected after completion of air sparging. Final groundwater monitoring was completed in 2003 and monitoring data have indicated that site-specific trigger levels were satisfied for all five years since the air sparging was ceased, and the presence of free product has not been detected.

Site-specific Groundwater Cleanup Levels: The cleanup levels applied at the Terminal 34 site were defined in the Compliance Monitoring Plan and are based on MTCA Method C, AWQC (Marine Chronic Criteria), and MTCA Method A groundwater cleanup levels (for petroleum) applicable at the time the Plan was established. The site groundwater compliance monitoring program also includes trigger levels that are used in site decision-making.

6.3.3 Terminal 30 (Former Chevron)

As described in the EISR (Anchor and Windward 2008b), the T-30 property (Former Chevron bulk fuel terminal) has undergone extensive investigation and remediation activities. This work was initiated in the 1980s by Chevron with the demolition of the former fueling facility, extraction of floating diesel-fuel hydrocarbons from the groundwater table, and then furthered by the Port with excavation and capping of the shoreline area, capping of the upland area with asphalt paving, and operation of a product recovery and groundwater monitoring program. Subsequent studies were conducted under a MTCA Agreed Order to evaluate the protectiveness of the original remedy and to establish a long-term groundwater compliance monitoring plan for implementation at the site.

The groundwater monitoring program at the T-30 property includes multiple components. In some upland areas, ongoing product recovery is continuing. The monitoring program includes data collection to inform these ongoing remediation efforts. Additional monitoring is performed to evaluate upland groundwater quality in former source areas. Studies have documented concentration thresholds for further evaluation for these areas, including Level 1 and Level 2 cleanup levels. The Level 1 values take into account the extent of tidally-influenced groundwater mixing that occurs between a given well and the shoreline, and the Level 2 values consider the extent of contaminant biodegradation that occurs based on site-specific natural attenuation studies that have been performed.

The T-30 groundwater monitoring program is ultimately based on protection of surface water quality within the EW. A series of groundwater wells is located in nearshore portions of the site upgradient from the EW as shown in Figure 6-2. Groundwater concentrations in these wells are currently monitored quarterly for BTEX, petroleum, and PAH compounds. Results are compared in Table 6-9 to site-specific cleanup levels established for protection of adjacent water quality, which are based on the MTCA Method A cleanup levels, MTCA Method B cleanup levels for surface water, and Washington State and federal water quality criteria for surface waters. The site-specific cleanup levels listed in Table 6-9 do not incorporate tidally-influenced groundwater mixing or contaminant biodegradation.

Recent groundwater monitoring data are summarized in Table 6-9 for each of the five monitoring locations. The specific data on which Table 6-9 is based are tabulated in Appendix E, Table E-17. None of the chemical concentrations measured in groundwater samples collected from the nearshore wells exceeded the site-specific cleanup levels or the applicable groundwater reference values listed in Table 6-2.

Groundwater monitoring activities are continuing at this site as part of the long-term monitoring program for the T-30 cleanup.

Table 6-9
Summary of Terminal 30 Nearshore Groundwater Quality

Chemical	Chemical Detected	Reporting Limit of Non-Detects		Detected Chemical Concentration Range (µg/L)	Site-Specific Cleanup Level Protective of Surface Water Quality (µg/L)	Chemical Concentration Exceeds Site-Specific Criteria	Groundwater Reference Value [1] (µg/L)	Chemical Concentration Exceeds Reference Value	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)	Exeedances of NTR Human Health Reference Values [4]
		Non-Detects (#)	Range (Min to Max)							
Petroleum Hydrocarbons										
Gasoline range hydrocarbons	0 of 5	5	250 to 250	--	800	0 of 5	ND [2]	ND	NA	NA
Diesel range hydrocarbons	0 of 5	5	250 to 250	--	500	0 of 5	ND [2]	ND	NA	NA
Motor oil range hydrocarbons	0 of 5	5	500 to 500	--	500	0 of 5	ND [2]	ND	NA	NA
BTEX Compounds										
Benzene	0 of 5	5	1 to 1	--	23	0 of 5	180 [3]	0 of 5	NA / NA / 71	0 of 5
Ethylbenzene	0 of 5	5	1 to 1	--	6,910	0 of 5	ND	ND	NA / NA / 29,000	0 of 5
o-Xylene	0 of 5	5	1 to 1	--	--	0 of 5	ND	ND	NA	NA
mp-Xylene	0 of 5	5	1 to 1	--	--	0 of 5	ND	ND	NA	NA
Total Xylene	0 of 5	5	2 to 2	--	1,000	0 of 5	ND	ND	NA	NA
Toluene	0 of 5	5	1 to 1	--	48,500	0 of 5	737 [3]	0 of 5	NA / NA / 220,000	0 of 5
PAH Compounds										
2-Methylnaphthalene	0 of 5	5	0.01 to 0.01	--	--	0 of 5	13	0 of 5	NA	NA
Acenaphthene	5 of 5	0	NA	0.074 to 2.1	643	0 of 5	2.6	0 of 5	NA	NA
Acenaphthylene	1 of 5	4	0.01 to 0.01	0.012	--	0 of 5	11	0 of 5	NA	NA
Anthracene	2 of 5	3	0.01 to 0.01	0.012 to 0.021	25,900	0 of 5	11	0 of 5	NA / NA / 110,000	0 of 5
Benzo(a)anthracene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.48	0 of 5	NA / NA / 0.031	0 of 5
Benzo(a)pyrene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.13	0 of 5	NA / NA / 0.031	0 of 5
Benzo(b)fluoranthene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.29	0 of 5	NA / NA / 0.031	0 of 5
Benzo(g,h,i)perylene	0 of 5	5	0.01 to 0.01	--	--	0 of 5	0.012	0 of 5	NA	NA
Benzo(k)fluoranthene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.29	0 of 5	NA / NA / 0.031	0 of 5
Chrysene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.47	0 of 5	NA / NA / 0.031	0 of 5
Dibenzo(a,h)anthracene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.0046	0 of 5	NA / NA / 0.0031	NA
Dibenzofuran	0 of 5	5	0.01 to 0.01	--	--	0 of 5	1.3	0 of 5	NA	NA
Fluoranthene	4 of 5	1	0.01 to 0.01	0.058 to 0.091	90	0 of 5	2.3	0 of 5	NA / NA / 370	0 of 5
Fluorene	2 of 5	3	0.01 to 0.01	0.012 to 0.084	3,460	0 of 5	2.0	0 of 5	NA / NA / 14,000	0 of 5
Indeno(1,2,3-cd)pyrene	0 of 5	5	0.01 to 0.01	--	0.018	0 of 5	0.013	0 of 5	NA / NA / 0.031	0 of 5
Naphthalene	0 of 5	5	0.01 to 0.037	--	4,940	0 of 5	54	0 of 5	NA	NA
Phenanthrene	0 of 5	5	0.01 to 0.01	--	--	0 of 5	4.8	0 of 5	NA	NA
Pyrene	4 of 5	1	0.01 to 0.01	0.051 to 0.76	2,590	0 of 5	14	0 of 5	NA / NA / 11,000	0 of 5

Notes:

Terminal 30 nearshore monitoring wells included in the evaluation are MW-72, MW-84, MW-85, MW-86, and MW-87. Refer to Appendix Table E-17 for a detailed tabular summary of nearshore groundwater monitoring data.

Results presented above were evaluated on a location-by-location basis and there may be multiple sampling events (dates) per location.

[1] Refer to Table 6-2 for the derivation of the groundwater reference values based on equilibrium partitioning considerations. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes that likely limit the potential for sediment recontamination to occur.

[2] Groundwater monitoring has included testing for specific petroleum-associated hazardous substances (e.g., PAH compounds and volatile organics). No exceedances of applicable references values have been noted for these compounds. Additionally, nearshore groundwater complies with the MTCA Method A cleanup levels which provide a conservative secondary groundwater reference value for petroleum hydrocarbons.

[3] Refer to Table 6-3 for the derivation of groundwater reference values for volatile organic compounds.

[4] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples.

NA: Not applicable. Chemical does not have the indicated reference value (AWQC, NTR, SQS, or no partitioning estimate was available from Table 6-2).

ND: Compound not detected at any of the nearshore groundwater sampling locations. No additional groundwater reference values defined for these compounds.

Type of Site and Release: The Port acquired the T-30 Site property from Chevron in January 1985. This area was formerly known as Pier 32 and was used by Chevron as a bulk petroleum storage and transfer terminal since the early 1900s. The facility was demolished by Chevron during 1984 and 1985 prior to property ownership transfer to the Port. In the mid 1980s, the Port developed the site for use as a deep-draft shipping terminal and storage facility. That work included implementation of a cleanup action prior to promulgation of the MTCA cleanup regulations. Recovery of free-phase hydrocarbons present on the groundwater, capping of the site, and dredging and capping of sediments along the shoreline were conducted as part of that cleanup action. Final remedial action requirements have been defined as part of subsequent MTCA studies conducted by the Port under an Agreed Order with Ecology.

Documents Presenting Groundwater Results: RETEC 2006b (Draft Terminal 30 Data Report) and RETEC 2007 (February 2007 Groundwater Sampling Event).

Groundwater Sampling Network and Rationale: Groundwater sampling results from the February 2007 quarterly monitoring event are summarized for those monitoring wells within the nearshore area of the EW. Groundwater analytical results showed that current conditions are below Site controlling Applicable or Relevant and Appropriate Requirements (ARARs) proposed as cleanup levels based on the protection of surface water. Level 1 and Level 2 groundwater standards have been developed for T-30 that take into account mixing and attenuation processes at nearshore areas. These levels were developed to calculate concentrations of groundwater chemicals that are protective of surface water at the point of exposure. Ongoing groundwater compliance monitoring is currently being performed by the Port.

Site-specific Groundwater Cleanup Levels: The reference value for T-30 is the Site-specified surface water ARAR as described in the 2006 Data Report. The Site-specified surface water ARAR was determined using the most stringent applicable criteria at the time including Washington State Surface Water Criteria, National Water Quality Criteria (Ecological and Human Health) and MTCA Method A/B Groundwater Criteria.

6.3.4 Terminal 25 LUST Removal

The T-25 site is the location of a former LUST removal. The LUST removal is described in site investigation reports developed on behalf of the Port and summarized in the EISR (Anchor and Windward 2008b). Additional information regarding the history of the property prior to its current use is limited, and soil and groundwater investigation data are limited to the area of the former LUST removal.

To supplement the information available from the LUST-associated documents, U.S. Army Corps of Engineers (USACE) maps for the EW that were used to develop the historical "deepest dredge" figure (Figure 4-4 of the EISR) contained in the EISR were reviewed. Other EISR figures included information relevant to historical land uses at the T-25 site and vicinity. As of 1918, T-25 was bordered on the north side by Slip 374, and the southern nearshore portion of the terminal consisted of a turning basin. Uses of buildings and wharves at the property identified on the USACE maps between the 1920s and the 1970s included grain elevators, construction firms, and an iron works. Usage at Pier 24 (located to the south, along Spokane Street), included a lumber company, a cold storage facility (Rainier Cold Storage, recently demolished) and a small facility (specific use not identified on the USACE maps) operated by Westinghouse Electrical Manufacturing Company. By the 1970s, the T-25 site had been redeveloped for its current land usage as a terminal facility, including the filling of the turning basin and slip. The LUST was associated with the former cold storage facility.

A leaking underground storage tank was removed from the cold storage facility at T-25, and subsequent investigations were performed to document site groundwater quality following completion of the removal. The most recent groundwater monitoring data for the site are summarized in Table 6-10. A detailed tabulation of the underlying data is provided in Appendix E, Table E-18.

Testing at T-25 included analysis of seven locations for TPHs, and analysis of four locations for BTEX compounds. None of the measured concentrations exceeded the site-specific cleanup levels, which were based on the MTCA cleanup levels applicable at the time of the cleanup action (Table 6-10). The groundwater data are also less than the current MTCA Method A cleanup level for gasoline-range petroleum in groundwater (1,000 μg/L).

There are no ongoing investigations or monitoring activities associated with the T-25 LUST site. Sediment investigations in the area adjacent to the T-25 site are ongoing as part of the SRI/FS.

Table 6-10
Summary of Terminal 25 Groundwater Quality Data

Chemical	Chemical Detected	Reporting Limit of Non-Detects		Detected Chemical Concentration Range (µg/L)	Site-Specific Cleanup Levels: MTCA Method A Groundwater Criteria (µg/L)	Downgradient Chemical Concentration Exceeds Site Cleanup Levels	Groundwater Reference Values (µg/L)	Downgradient Chemical Concentration Exceeds Reference Value	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)	Exeedances of NTR Human Health Reference Values [4]
		Non-Detects (#)	Range (Min to Max)							
Petroleum Hydrocarbons										
Total petroleum hydrocarbons	0 of 7	7	1,000 to 1,000	--	1,000	0 of 7	1,000 [1]	ND	NA	NA
BTEX Compounds										
Benzene	0 of 4	4	1 to 1	--	5	0 of 4	180 [2]	ND	NA / NA / 71	0 of 5
Ethylbenzene	0 of 4	4	1 to 1	--	700	0 of 4	ND	ND	NA / NA / 29,000	0 of 5
Toluene	0 of 4	4	1 to 1	--	1,000	0 of 4	737 [2]	ND	NA / NA / 200,000	0 of 5
Total Xylenes	2 of 4	2	1 to 1	1.1 to 1.3 [3]	1,000	0 of 4	ND	NA [3]	NA / NA / NA	NA

Notes:

The T-25 groundwater sampling locations summarized in this table include MW-1, MW-2, MW-3, MW-4, LW-1, LW-2, and LW-3. Refer to Appendix Table E-18 for a detailed tabular summary of site groundwater monitoring data.

[1] Groundwater monitoring at this UST cleanup site was focused on testing for TPH and BTEX compounds. No TPH compounds were detected in groundwater. The method reporting limits were sufficient to verify compliance with current MTCA Method A cleanup levels which are considered to be conservative groundwater reference values for petroleum hydrocarbons.

[2] Refer to Table 6-3 for derivation of groundwater reference values for selected volatile organic compounds.

[3] Low concentrations of xylenes (maximum concentration 1.3 µg/L) were noted in two source area wells, but xylene concentrations were below method reporting limits in the two wells located between the source area and the EW. Groundwater gradients could not be reliably measured at this site due to the effects of tidal influence on measured values, but groundwater gradients are expected to be toward the EW based on studies performed at the Terminal 30 and Terminal 104 sites. Based on the low detected xylene concentrations in the source area and the lack of detectable xylenes in the locations nearest the EW, there is no evidence of a complete pathway to the EW and no additional reference values for xylenes were developed at this time.

[4] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples.

NA: Not applicable. Chemical does not have the indicated reference value (AWQC, NTR, SQS, no partitioning estimate was available from Table 6-2 or no NOAEL was available from Table 6-3.)

ND: Compounds were not detected in any of the nearshore groundwater samples analyzed. No additional groundwater reference values were defined.

Type of Site and Release: T-25 is a 35-acre parcel owned by the Port of Seattle and located adjacent to the EW situated between T-30 to the north and Spokane Street to the south. The north areas of T-25 recently underwent an extensive modernization project and are utilized as a container transfer and storage facility. The southern portion of T-25, known as T-25 South (T-24), consists of approximately 18 acres and is the area of the former Rainier Cold Storage warehouse and freezer facility and the SeaBlends seafood processing company. The T-25 property was listed in the environmental database search as a leaking UST site.

Documents Presenting Groundwater Results: Landau 1990 (Soil and Groundwater Investigation) and Sweet-Edwards 1990 (Subsurface Investigation Report).

Groundwater Sampling Network and Rationale: Groundwater sampling results from the 1989 groundwater sampling events are summarized. All groundwater sampling locations were used in the evaluation, except for groundwater sample PS-7. Groundwater sample PS-7 was collected using a bailer directly from the excavation during UST removal activities. Additional groundwater sampling was performed to confirm downgradient conditions from upland UST sources.

Site-specific Groundwater Cleanup Levels: The reference value for T-25 is based on the MTCA Method A groundwater cleanup levels applicable at the time and referenced in the report (Landau 1990; Sweet-Edwards 1990).

6.3.5 Terminal 104 and Vicinity

Phase 1 and Phase 2 investigations have been performed by the Port to provide information regarding environmental conditions at the site. As documented in those reports, the T-104 property was undeveloped until the middle-1940s. Since that time, it has been used as a paper mill, lumber storage yard, auto repair shop, foundry supply warehouse, and cargo transfer and storage yard (Anchor and Windward 2008b).

As described in the EISR (Anchor and Windward 2008b), portions of the T-104 properties are being investigated and remediated by the Port prior to their use as part of a transportation improvement project. Extensive groundwater sampling has been performed throughout the properties, including the use of both geoprobe borings and permanent monitoring wells. The Port is actively remediating several areas of localized soil and groundwater contamination. These areas are located well away from the shoreline of the EW, and groundwater data are available to characterize the areas between the cleanup locations and the EW shoreline.

Figure 6-3 illustrates the locations of the T-104 properties and the various groundwater sampling locations. Table 6-11 summarizes the results of recent groundwater monitoring at representative downgradient sampling locations, located in between active cleanup areas and the EW. Data from ongoing cleanup work in upgradient source locations are not included, as they are not relevant to the analysis of sediment recontamination potential.

Groundwater monitoring has been performed for heavy metals, petroleum, VOCs, PAH compounds, and PCBs. The specific parameters tested in each location vary based on site conditions. Summary statistics are presented in Table 6-11.

Eleven of the downgradient groundwater locations have been tested for heavy metals. Some of these locations have been tested on multiple dates. No exceedances of either site-specific cleanup levels, AWQC, or the groundwater reference values from Table 6-2 have been noted.

Petroleum hydrocarbons have been tested in multiple sampling locations, including seven (gasoline) and 10 (diesel and lube oil) of the downgradient locations. Some of these locations have been tested on multiple dates. Concentrations of petroleum in these locations have been below MDLs. The detection limits were below the current Method A groundwater cleanup levels.

Full-list VOCs (EPA Method 8260) were tested in eight downgradient locations, and BTEX compounds were tested in one additional downgradient location. Very low levels of VOCs were detected in one of these locations, and toluene was detected in four locations. None of the measured concentrations exceeded the site-specific cleanup levels or the groundwater reference values developed in Table 6-2.

PAH compounds were tested in six of the downgradient well locations. None of these compounds were detected. PCB compounds were tested in groundwater at 11 locations throughout the site. These locations included two of the downgradient sampling locations as well as nine upgradient locations in other site areas. PCBs were not detected in any of the sampled locations throughout the site.

The Port's cleanup activities are ongoing at T-104. These activities include groundwater treatment in one upgradient area and soil cleanup in several localized areas. Some additional groundwater monitoring data for downgradient locations may be available for review and incorporation in the EW SRI/FS as discussed in Section 6.4.

Table 6-11
Summary of Terminal 104 Downgradient Groundwater Quality

Chemical	Chemical Detected	Reporting Limit of Non-Detects		Detected Chemical Concentration Range (µg/L)	Site-Specific Cleanup Levels (µg/L)	Downgradient Chemical Concentration Exceeds Site Cleanup Levels	Groundwater Reference Value [2] (µg/L)	Downgradient Chemical Concentration Exceeds Reference Value	AWQC/NTR Reference Values – Chronic / Acute / Human Health (µg/L)	Nearshore Concentration Exceeds AWQC Chronic Reference Value [7]	Nearshore Concentration Exceeds AWQC Acute Reference Value [7]	Nearshore Concentration Exceeds NTR Human Health Reference Value [8]
		Non-Detects (#)	Range (Min to Max)									
Metals (Dissolved)												
Arsenic	2 of 11	9	3 to 4	4.7 to 4.9	5	0 of 11	227	0 of 11	36 / 69 / 0.14	0 of 11	0 of 11	2 of 11
Barium	2 of 11	9	25 to 28	32 to 52	--	0 of 11	NA	NA	NA	NA	NA	NA
Cadmium	0 of 11	11	4 to 4.4	--	5	0 of 11	2.6	0 of 11	9.3 / 42 / NA	0 of 11	0 of 11	NA
Chromium	1 of 11	10	10 to 11	13	50	0 of 11	306	0 of 11	50 / 1,100 / NA	0 of 11	0 of 11	NA
Lead	1 of 11	10	1 to 2.5	1.8 to 4.1	15	0 of 11	11	0 of 11	8.1 / 210 / NA	0 of 11	0 of 11	NA
Mercury	0 of 11	11	0.5 to 0.5	--	2	0 of 11	0.0052	0 of 11	0.025 / 1.8 / 0.15	0 of 11	0 of 11	0 of 11
Selenium	0 of 11	11	5 to 7.5	--	180c	0 of 11	NA	ND	NA / 290 / NA	0 of 11	0 of 11	NA
Silver	0 of 11	11	10 to 11	--	180c	0 of 11	1.5	0 of 11	NA / 1.9 / NA	0 of 11	0 of 11	NA
Petroleum Hydrocarbons												
Gasoline range hydrocarbons	0 of 7	7	100 to 100	--	1,000	0 of 7	1,000 [6]	0 of 7	NA	NA	NA	NA
Diesel range hydrocarbons	0 of 10	10	250 to 270	--	500	0 of 10	500 [6]	0 of 10	NA	NA	NA	NA
Lube oil range hydrocarbons	0 of 10	10	400 to 430	--	500	0 of 10	500 [6]	0 of 10	NA	NA	NA	NA
Volatile Organic Compounds												
1,2-Dichlorobenzene	0 of 8	8	0.2 to 0.2	--	1,600c	0 of 8	5.2	0 of 8	NA /NA /17,000	NA	NA	0 of 8
1,1-Dichloroethane	0 of 8	8	0.2 to 0.2	--	1,800c	0 of 8	ND	ND	NA	NA	NA	NA
cis-1,2-Dichloroethene	1 of 8	7	0.2 to 0.2	0.4	180c	0 of 8	136	0 of 8	NA	NA	NA	NA
trans-1,2-Dichloroethene	0 of 8	8	0.2 to 0.2	--	350c	0 of 8	ND	ND	NA	NA	NA	NA
Ethylbenzene	0 of 9	9	0.2 to 1	--	700	0 of 9	ND	ND	NA / NA / 29,000	NA	NA	0 of 9
Trichlorothene (TCE)	1 of 8	7	0.2 to 0.2	0.89 to 4	5	0 of 8	2,200	0 of 8	NA	NA	NA	NA
Toluene	4 of 9	5	0.2 to 1	0.27 to 0.75	1,000	0 of 9	737	0 0f 9	NA / NA / 200,000	NA	NA	0 of 9
Xylenes	1 of 9	8	0.2 to 1	0.52 [4]	35,000c	0 of 9	ND	ND [4]	NA	NA	NA	NA
Other EPA 8260 VOCs [5]	0 of 8	8	0.2 to 0.2	--	--	0 of 9	ND	ND	NA	NA	NA	NA
PAH Compounds [5]	0 of 6	6	0.0096 to 0.0098	--	--	0 of 6	See Table 6-2	0 of 6	NA	NA	NA	ND
PCBs (all locations) [5]	0 of 11	11	0.048 to 0.049	--	--	0 of 11	See Table 6-2	0 of 11	NA	NA	NA	ND

Notes:

[1] Results presented above were evaluated on a location-by-location basis and there are multiple sampling events (dates) for some locations. T-104 and vicinity downgradient groundwater sampling locations summarized in this table include MW-13, MW-15, MW-16, MW-17, P-10, P-11, P-12, P-13, SW-6, SW-7, SW-8, and SW-9.

[2] Refer to Table 6-2 for the derivation of the groundwater reference values based on equilibrium partitioning considerations. Refer to Table 6-3 for development of groundwater reference values for selected volatile organic compounds. These values are intended only for preliminary use in this initial evaluation, as the reference values do not take into account site-specific fate and transport processes that likely limit the potential for sediment recontamination to occur.

[3] PCBs were analyzed in groundwater in two of these locations (MW-13 and MW-15) and in nine additional upgradient locations. Refer to Appendix Table E-19 for a detailed tabular summary of site groundwater monitoring data.

[4] The only detection of xylenes in the referenced groundwater sampling locations was at location P-10, which is located upgradient of sampling locations P-11, P-12 and P-13 at which no xylenes were detected (i.e., there is no complete pathway between the site and the EW for xylenes, so no additional groundwater reference values were evaluated for these compounds).

[5] Other EPA 8260 VOC compounds and all PAH and PCB compounds were non-detect. No totals were calculated due to the lack of detections

[6] The MTCA Method A cleanup levels were used as conservative reference values for petroleum because testing for specific petroleum-associated hazardous substances was not performed at all sampling locations.

[7] Washington State AWQC reference values are compared to discrete samples.

[8] Human Health – Marine – National Toxics Rule, 40 CFR 131 (µg/L) reference values are compared to discrete samples. The arsenic value has not been adjusted to take into account naturally-occuring arsenic that may be present in groundwater or surface water.

c: Indicates MTCA Method C cleanup level.

NA: Not applicable. Chemical does not have the indicated reference value (AWQC, NTR, SQS, or no partitioning estimate was available from Table 6-2).

ND: Compound not detected in any of the nearhsore or downgradient sampling locations. No additional groundwater reference values were defined for these compounds.

Type of Site and Release: Environmental sampling has been performed at the T-104 property and vicinity in conjunction with the East Marginal Way Grade Separation project. Properties included in the East Marginal Way Grade Separation project include an area of T-104, Poncho's Legacy, and Moss G. Milan properties. The Port is conducting ongoing cleanup activities to address localized cleanup issues in upgradient site areas.

Document Presenting Groundwater Results: Environmental Partners 2007. (Supplemental Investigation and Data Summary Report – East Marginal Way Grade Separation Project.)

Groundwater Sampling Network and Rationale: Groundwater sampling results from 2005 and 2006 investigation events are summarized for those monitoring wells downgradient of potential source areas identified for the project area. A majority of groundwater sampling at these properties was performed using temporary geoprobes and when available, adjacent monitoring well analytical results are used rather than geoprobe groundwater samples from nearby locations. Additional investigative groundwater sampling was conducted after the initial 2005 sampling to confirm downgradient conditions and better delineate area contaminants of concern.

Site-specific Groundwater Cleanup Levels: The reference value for the T-104 and vicinity is based on the MTCA Method A and Method C groundwater cleanup levels applicable at the time and referenced in the report (Environmental Partners 2007).

6.4 Cleanup Site Evaluations – Other Potential Pathways

In support of the SCE, evaluations are being conducted of two additional pathways by which chemicals from cleanup sites might impact EW sediments. The first of these is the bank erosion pathway, which is applicable to only nearshore cleanup sites. The second is the potential for contaminants to infiltrate into storm drains or combined sewers, which may occur at either nearshore cleanup sites or at those distant from the EW.

6.4.1 Bank Erosion Pathway

Under certain conditions, unstable shoreline banks/slopes can erode, resulting in deposition of soils onto waterway sediments and exposing underlying soils. Such bank erosion can represent an exposure pathway for contaminated soils at cleanup sites located in EW nearshore areas.

Most areas of the EW shoreline have been reinforced with armor stone and/or bulkheads and aprons as part of navigation and land use improvements. These types of improvements limit the potential for bank erosion to occur. However, further evaluation of this potential pathway is planned as part of the SRI/FS.

As part of the development of the SRI report, the shoreline conditions along the EW are to be mapped to document the location and condition of shoreline protection, and to identify areas of potentially unstable bank soils. Where potentially unstable materials are identified, SRI/FS sampling data for EW sediments and available testing data for upland soils will be reviewed to assess available information regarding the bank erosion pathway. If information suggests a potentially complete pathway, or if sufficient information is not available, then additional soil testing data will be collected prior to development of the FS report.

6.4.2 Groundwater to Stormwater/CSO Pathways

The solids and chemical inputs associated with stormwater and CSOs are being directly evaluated as described in Sections 4 and 5. These evaluations incorporate potential chemical inputs from multiple sources including indirect atmospheric deposition, stormwater runoff, permitted or non-permitted discharges to the storm drain or combined sewer systems, and spills occurring within the storm drain systems or combined sewer service areas. Cleanup sites can potentially contribute pollutants to storm drains and combined sewers through infiltration of groundwater and/or soils into damaged conveyance systems.

In support of the SRI report, an expanded database search is to be conducted documenting the cleanup sites located along the EW, and those located in the EW-associated storm drain and combined sewer service areas. The updated database search will be presented in the SRI, including the locations of the sites relative to stormwater and sewer conveyances, and available database outputs regarding the types of contaminants present or previously present at the cleanup sites.

6.5 Creosote-Treated Pile Structures

Creosote-treated pilings and structures can contribute chemical contamination to sediments, principally including PAH and dibenzofuran. These compounds are present in the treating solutions used to preserve the wood, and can be released to sediments through abrasion of the wood or through leaching.

The use of creosote-treated wooden structures was common historically, but has been nearly eliminated due to permitting limitations on in-water use of these materials, and through product substitutions. For example, most of the pilings used for construction of the terminal aprons and bridges along the EW are composed of concrete, rather than wood, and most bulkheads along the EW are composed of metal sheetpiling rather than treated wood.

However, creosote-treated wood pilings and bulkheads remain present along the EW shorelines. Based on a preliminary shoreline reconnaissance conducted in 2007 in preparation for the EISR, creosote-treated wood structures remain present in the following locations (shown in Figures 6-2 and 6-3):

- T-34/Pier 35: Former pier structures remain on state-owned land in these two areas as shown in Figure 6-3.
- T-25: A former wharf structure was recently removed from T-25 (see Figure 6-2). The wooden pilings remain in place but are to be removed in the future as part of a planned Port project.

- Spokane Street Public Access Area: Wooden pilings and timbers are in use as part of the public access area located adjacent to the Spokane Street Bridge at the southern end of the EW navigation channel (Figure 6-2).
- BNSF Railroad Bridge: The BNSF railroad bridge (Figure 6-2) includes creosote-treated pilings and timbers. The railroad ties were previously creosote-treated wood, but these have been replaced with composite materials.
- T-104 Bulkhead: A small section of wooden bulkhead (Figure 6-2) remains between T-104 and the EW, between the BNSF railroad bridge and the West Seattle Bridge.

Some treated wood fender pilings are also located along the outer edges of the Port terminal aprons. These fender piles are gradually being replaced with other materials as part of terminal maintenance and upgrade procedures.

6.6 Potential Data Gaps and Ongoing Data Collection

6.6.1 Creosoted Structures

In preparation for the SRI report, additional information will be developed for remaining creosote-treated structures within the EW, including the type and quantity of material remaining, a review of SRI/FS sediment quality data in the vicinity of the treated structures, and any source control measures currently in place or planned for the structures (e.g., pile wrapping or planned structure removal/replacements). A discussion will also be included in the SRI report regarding permitting limitations on treated wood uses for in-water applications, and on material substitution programs or alternatives.

6.6.2 Cleanup Sites

Table 6-12 summarizes the conclusions of the data gaps analysis for cleanup sites as described in Sections 6.3 and 6.4, above. For most of the nearshore cleanup sites, information is available to evaluate the groundwater to sediment pathway, and ongoing monitoring is being performed at several of the nearshore cleanup sites. Additional evaluations are to be conducted to evaluate the bank erosion pathway for nearshore sites.

Additional evaluations are also planned to identify and map cleanup sites located in the storm drain basins and combined sewer service areas associated with the EW. These evaluations will supplement the information being developed specifically for stormwater (Section 4) and for CSOs (Section 5).

As noted in Table 6-12, at most of the cleanup sites along the EW, the initial evaluation of the groundwater to sediment pathway did not identify a potential for groundwater to impact sediment quality. Groundwater chemical concentrations at nearshore or downgradient sampling locations were below applicable reference values developed for initial evaluation of sediment quality and benthic/aquatic organism protection. Potential issues for further evaluation were identified at only one of the sites (well HI-12 at Harbor Island). As noted in Table 6-12, further monitoring is being performed at that sampling location.

Additional sampling work is also ongoing at the T-30 and T-104 sites. Based on the data evaluated as described in this section, these sites did not present a risk of sediment recontamination.

Further evaluation of the cleanup site information, including each of the three pathways, will be conducted in the SRI report. That evaluation will incorporate updated reference values from the risk assessment, where applicable, for evaluation of the bank erosion or groundwater to sediment pathways. That evaluation will also include a review of SRI/FS sediment and porewater (or seep) sampling data collected in the vicinity of the cleanup sites.

Table 6-12
Summary of Existing Data, SRI/FS Data Gaps, and Ongoing Data Collection Efforts – Cleanup Sites

Cleanup Site	Summary of Initial Evaluation	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for SRI/FS	Remaining SRI/FS Data Gaps
Harbor Island Soil and Groundwater OU	For 6 of 7 wells located along the East Waterway, the groundwater data reviewed were below the groundwater reference values used in this initial evaluation. In the one remaining well (well HI-12), zinc concentrations were variable and exceeded the ROD cleanup goal and the groundwater reference value during three of six completed sampling events. Refer to the text in Section 6.3.1 for additional findings of the initial evaluation.	**Additional Monitoring at Well HI-12**: Ongoing groundwater monitoring data for well HI-12 will provide an improved understanding of zinc concentrations over time. These data may be used in conjunction with existing hydrogeologic information to assess the significance of the groundwater zinc concentrations.	**Ongoing Groundwater Compliance Monitoring**: Groundwater monitoring is continuing per the Compliance Monitoring Plan. These data will provide information regarding metals concentration trends over time in well HI-12. That monitoring also includes sampling of the other site groundwater wells.	**Potential Additional Evaluation**: If groundwater monitoring indicates steady or increasing groundwater zinc concentrations at well HI-12, then further evaluations may be appropriate. Because the groundwater reference values used are conservative and do not take into account site-specific attenuation properties such as tidally-influenced groundwater mixing, such evaluations could include an assessment of potential groundwater mixing factors in the nearshore area, review of SRI/FS sediment data from the area offshore of HI-12, or additional groundwater sampling. Results of ongoing groundwater monitoring should be reviewed prior to making a determination.
Terminal 102 LUST Site	All of the groundwater data reviewed were below the groundwater reference values used in this initial evaluation. PAHs at concentrations exceeding the SQS were noted in previous sediment samples collected near the BNSF railroad bridge. Additional sediment testing in this area is being performed as part of the SRI/FS.	None identified	None identified	None identified
Coast Guard (Pier 35)	All of the groundwater data reviewed were below the groundwater reference values used in this initial evaluation. No potentially complete pathways posing a risk of sediment recontamination were identified.	None identified	None identified	None identified
Former GATX (Pier 34)	All of the nearshore groundwater data representative of potential discharges to sediments were below the groundwater reference values used in this initial evaluation. No potentially complete pathways posing a risk of sediment recontamination were identified. PAH exceedances of the SQS and CSL have been observed in sediment samples collected offshore of the Former GATX site. The source of these contaminants has not been determined. Additional sediment testing is being performed in this area as part of the SRI/FS.	None identified	None identified	None identified
Terminal 25	Groundwater data for the Terminal 25 site are limited to the vicinity of the former LUST cleanup. All of the groundwater data reviewed were below the groundwater reference values used in this initial evaluation. No potentially complete pathways posing a risk of sediment recontamination were identified. Additional sediment testing is being performed as part of the SRI/FS in the EW adjacent to the Terminal 25 site.	None identified	None identified	None identified
Former Chevron (Terminal 30)	All of the nearshore groundwater data representative of potential discharges to sediments were below the groundwaterreference values used in this initial evaluation. No potentially complete pathways posing a risk of sediment recontamination were identified.	None identified	**Ongoing Groundwater Monitoring**: The Port is conducting ongoing groundwater cleanup and monitoring activities in upland areas at this site. Data generated during that work should be reviewed as part of the SRI/FS to verify that no new conditions of potential concern have been identified.	None identified
Terminal 104 and Vicinity	All of the nearshore groundwater data representative of potential discharges to sediments were below the groundwater reference values used in this initial evaluation. No potentially complete pathways posing a risk of sediment recontamination were identified.	None identified	**Ongoing Site Cleanup**: The Port is conducting ongoing soil and groundwater cleanup activities at this site. Data generated during that cleanup should be reviewed as part of the SRI/FS to verify that no new conditions of potential concern have been identified.	None identified

Cleanup Site	Summary of Initial Evaluation	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for SRI/FS	Remaining SRI/FS Data Gaps
Cleanup Sites (Overall)	Additional evaluations required to address bank erosion pathway, and to identify cleanup sites located within the storm drainage basins and the combined sewer service areas.	None identified	None identified	1) Groundwater data to be re-evaluated after completion of the risk assessment, as required to address potentially applicable reference values. 2) Mapping of potentially unstable bank areas will be developed for the SRI report, including a review of sediment and soil quality data in potentially unstable areas. 3) Database search to be conducted to identify cleanup sites located in EW storm drain basins and in EW combined sewer service areas. 4) SRI/FS sediment and porewater or seep data to be evaluated to assess whether additional evaluation of nearshore cleanup sites is warranted.

Notes:

CSL – Cleanup Screening Level
EISR – Existing Information Summary Report (Anchor and Windward 2008b)
EW – East Waterway
LUST – Leaking Underground Storage Tank
OU – Operable Unit
PAHs – polycyclic aromatic hydrocarbons
SQS – Sediment Quality Standards
SRI/FS – Supplemental Remedial Investigation/Feasibility Study

7 ATMOSPHERIC DEPOSITION

Airborne pollutants can reach sediments through the deposition of airborne particulate matter directly (i.e., onto the water surface) and indirectly (i.e., through deposition on terrestrial surfaces from which stormwater conveys them through drainage systems to the water body). Characterization of the stormwater component of atmospheric deposition is addressed through stormwater source characterization. Direct deposition is assessed separately. Information collected through various air quality monitoring programs can be used to assess the potential impact of atmospheric deposition in the EW. Information and potential data gaps relevant to the analysis of atmospheric deposition are described in this section.

7.1 Source Description

Direct deposition of airborne pollutants can be measured as wet deposition (i.e., measurement of particulates and chemicals contained within precipitation), dry deposition (i.e., particles settling as dust), and gas-phase transfer (i.e., gas exchange across the water surface) (King County 2008). Together, wet and dry deposition rates can be used to calculate a total atmospheric deposition rate. Pollutant deposition rates are ultimately expressed as average flux rates (e.g., nanograms per square meter per day [$ng/m^2/day$] or micrograms per square meter per day [$\mu g/m^2/day$]) during a measured time interval. Gas-phase transfer rates should also be considered when calculating atmospheric deposition to a water body for chemicals with relatively low molecular weights, such as LPAHs, lighter phthalates, and low- to mid-range PCBs (EPA 2001; King County 2008).

7.2 Existing Data Analysis

Table 7-3 summarizes existing data, data gaps, and ongoing data collection efforts relevant to analysis of atmospheric deposition within the EW. The existing atmospheric deposition datasets used for evaluating potential source input to the EW include:

- **Local Atmospheric Deposition Monitoring:** Atmospheric deposition monitoring data have been collected by the County for areas proximate to the EW. These data are described in Section 7.2.1.
- **Estimates of Deposition Rates from Air Quality Data:** Air concentration data from sampling stations located proximate to the EW are routinely collected by EPA and Ecology and are available from agency databases. These data can be converted into

atmospheric deposition flux values using a standard deposition velocity conversion factor. These existing data are described in Section 7.2.2.

A discussion of the ability of these datasets to represent conditions in the EW study area is contained in Section 7.3.

7.2.1 Local Atmospheric Deposition Monitoring

As part of the LDW source control project, the County conducted an atmospheric deposition monitoring study between October 2005 and April 2007. The study was conducted in order to evaluate the atmospheric deposition pathway to LDW sediments for PAHs, PCBs, and selected phthalates. Data from 12 sampling rounds (collected through December 2006) were included in the EISR (Anchor and Windward 2008b); however, since completion of the EISR, a final data report including four additional rounds of data was published by the County (King County 2008). The atmospheric deposition flux data presented in the final data report were used for the data summary in this report.

The County atmospheric deposition study used passive atmospheric deposition samplers to collect airborne particles deposited through both wet and dry deposition. A Phase I deposition study was conducted by the County prior to October 2005 (King County and SPU 2005); this study served as a pilot program that improved on sampler design and other field methodology for the second phase of sampling. The final monitoring report includes the results of the second sampling phase (King County 2008).

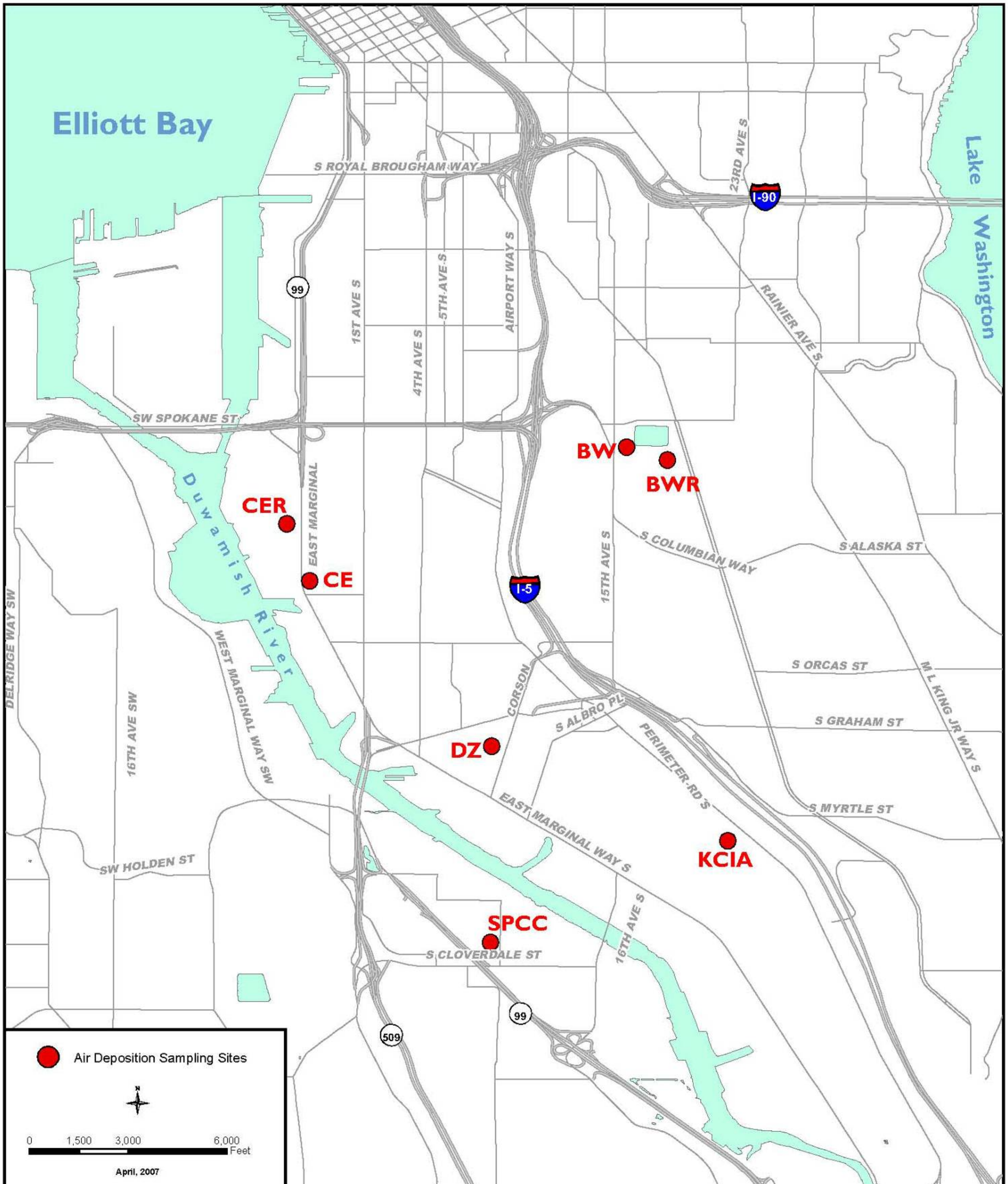
Deposition samplers were left in the field between 10 and 52 days per sampling round. Aqueous samples and wipe samples were collected from the samplers. Both sample types were analyzed for phthalates and PAHs by EPA Method 8270B. In addition, a solvent exchange to hexane was conducted on the methylene chloride extracts from the Method 8270 analysis. These hexane extracts were then analyzed for PCBs by EPA Method 8082.

Five sampling stations were used during the County study: Duwamish (station ID CE); Georgetown (ID DZ); South Park (ID SPCC); Beacon Hill (ID BW); and King County International Airport (KCIA) (Figure 7-1). Two of the sampling stations (CE and BW) were relocated during the study (after relocation, station CE was referred to as CER, and station BW as BWR). Data from the Duwamish (CE/CER), Georgetown (DZ), and South Park (SPCC) stations were pooled for summary in this report to represent the commercial/industrial neighborhood conditions near the EW. Data from the Beacon Hill (BW/BWR) station were summarized in this report to represent urban residential neighborhood conditions and to serve as a point of comparison to the commercial/ industrial neighborhood stations. The KCIA station was not included because mobile sources at the airport (i.e., aircraft engine exhaust) are thought to have a significant local impact on the measured deposition of some chemicals, particularly PAHs. Duplicate samples collected at the South Park station were not included in the data analysis.

Table 7-1 summarizes the measured flux values for detected chemicals. Detection frequencies for the combined Duwamish (CE/CER), Georgetown (DZ), and South Park (SPCC) stations dataset were above 60 percent for almost all chemicals (Table 6-2). Detection frequencies for the Beacon Hill station (BW/BWR) dataset were above 40 percent for almost all chemicals (Table 7-1). Based on the sampler design, smaller molecular weight chemicals (such as LPAHs) were difficult to sample; therefore, results for these chemicals are not included in Table 7-1. In addition, the majority of results for PCB Aroclors were non-detect; detection frequencies for Aroclors 1254 and 1260, the most frequently detected Aroclors, were low (13 and 17 percent, respectively).

Correlation coefficients were calculated for the atmospheric deposition data and other associated data provided by the Puget Sound Clean Air Agency (PSCAA), including wind rose data for wind speed and direction and wind rose data for particulate matter, in order to assess potential relationships between the deposition of air pollutants and the presence of particulate matter and wind patterns. Few strong correlations were identified through this comparison. At some stations, a correlation between deposition of PAHs and the presence of particulate matter was identified; however, a consistent relationship across stations was not identified.

The results of the County study were also compared to results from several other studies of airborne pollutants conducted both locally and in other regions of the world. The County data compared reasonably well to the data from other studies in most cases, but in some instances data from the LDW differed from data from other studies. With the acknowledgement of regional differences, this variability was also attributed to the type of deposition samplers used in the different studies and to the variable duration of the sampling rounds between the studies.



Note: Locations obtained from King County Department of Natural Resources and Parks, Wastewater Treatment Division.

Figure 7-1
Air Monitoring Stations
Initial Source Evaluation and Data Gaps Memorandum
East Waterway Operable Unit

Table 7-1
Deposition Flux Values Measured by King County in the LDW

Parameter	Sample Count	Count of Detected Values	Detection Frequency (%)	Detected Deposition Flux Values (µg/m^2/day)						Mean Deposition Flux Values Including Non-detected Data (µg/m^2/day)[a]	
				Min	Max	Mean	Median	25th percentile	75th percentile	½ MDL	MDL = 0
PCBs [b]											
Aroclor 1254	30	4	13	--[c]	0.044	--[c]	--[c]	--[c]	--[c]	0.019	0.004
Aroclor 1260	30	5	17	--[c]	0.034	--[c]	--[c]	--[c]	--[c]	0.019	0.004
PAHs											
Benzo(a)anthracene	47	38	81	0.003	0.243	0.063	0.051	0.024	0.077	na	na
Benzo(a)pyrene	47	29	62	0.008	0.265	0.095	0.072	0.052	0.135	na	na
Benzo(b)fluoranthene	47	40	85	0.010	0.317	0.119	0.103	0.082	0.154	na	na
Benzo(g,h,i)perylene	47	40	85	0.010	0.323	0.121	0.104	0.062	0.155	na	na
Benzo(k)fluoranthene	47	36	77	0.009	0.317	0.101	0.084	0.057	0.131	na	na
Chrysene	47	46	98	0.037	0.464	0.146	0.123	0.093	0.178	na	na
Dibenzo(a,h)anthracene	47	17	36	0.020	0.170	0.042	0.030	0.022	0.043	na	na
Indeno(1,2,3-cd)Pyrene	47	34	72	0.005	0.232	0.078	0.060	0.046	0.100	na	na
Pyrene	47	46	98	0.088	0.831	0.241	0.192	0.136	0.271	na	na
Phthalates											
Benzyl Butyl Phthalate	47	47	100	0.163	7.007	0.950	0.599	0.299	1.063	na	na
Bis(2-Ethylhexyl)Phthalate	47	47	100	0.261	12.240	2.940	2.255	1.396	3.609	na	na
Diethyl Phthalate	47	42	89	0.007	0.447	0.165	0.142	0.076	0.217	na	na
Dimethyl Phthalate	47	34	72	0.029	0.153	0.068	0.061	0.049	0.080	na	na
Di-N-Butyl Phthalate	47	39	83	0.002	0.678	0.177	0.093	0.034	0.249	na	na
Di-N-Octyl Phthalate	47	27	57	0.037	2.874	0.658	0.329	0.159	0.748	na	na

Notes:

Source: King County (2008)

Note: The data represented in this table were collected at the Duwamish (CE/CER), Georgetown (DZ) and South Park (PSCC) monitoring stations. Duplicate samples collected at the South Park station were not included in the data analysis.

a Mean deposition flux calculations that included non-detected data using an MDL substitution were only conducted for the PCB Aroclors. The majority of PCB Aroclor data were non-detected data.

b Samples were also analyzed for Aroclors 1016, 1221, 1232, 1242, and 1248. All sampling results were non-detect for these Aroclors; therefore, summary statistics were not calculated for these chemicals.

c Blank cells indicate that the calculation was not performed due to the lack of detected data.

na – not applicable

MDL – method detection limit

7.2.2 Estimating Deposition from Air Quality Data

In addition to the County study, ambient air concentration data for metals were obtained from EPA's Air Quality System (AQS; http://www.epa.gov/mxplorer/basic_info.htm). Average ambient air concentrations calculated from data collected in 2000 and 2001 for several chemicals, including metals, were included in the EISR (Anchor and Windward 2008b). For this report, raw air concentration data for metals collected between June 2002 and October 2004 were converted to atmospheric deposition flux values in order to estimate deposition of metals in the vicinity of the EW.

EPA and Ecology collect air concentration data throughout the country for several air pollutants that are considered to be toxic to human health. Air concentration data for arsenic, cadmium, copper, lead, mercury, and zinc were available from EPA's AQS. Air concentration data collected in 2007 for 1-4-DCB were also collected as part of the air toxics monitoring program and were available from Ecology. Metals data from two monitoring stations were included in this report to represent industrial/commercial neighborhood conditions: the Duwamish station (located at 4401 E. Marginal Way S., the same location as King County station CE), and the Georgetown station (located at 6431 Corson Avenue S. at the same location as King County station DZ). Data for 1,4-DCB are available from the Beacon Hill sampling station, located at 4103 Beacon Hill S. (at approximately the same location as King County station BW/BWR). This is the only station for which 1,4-DCB data are available. The Beacon Hill station is more representative of urban background conditions than industrial/commercial neighborhood conditions.

Table 7-2 summarizes deposition flux estimates developed from EPA and Ecology air quality monitoring data. For metals, data from the Duwamish station and the Georgetown station were selected and pooled for analysis in this report to represent conditions within the Duwamish industrial/commercial neighborhood conditions. The 1,4-DCB data collected at the Beacon Hill station are also included. Data collected from June 1, 2002 to October 30, 2004 were selected for all chemicals (with the exception of 1,4-DCB, for which data are only available from 2007) because data from all stations were consistently available within this timeframe.

Table 7-2
Deposition Flux Values Calculated from Air Concentration Data Provided by EPA and Ecology

Parameter	Sample Count	Count of Detected Values[b]	Detection Frequency (%)[b]	Deposition Flux Values (µg/m²/day)[a]						
				Detected Data and Non-detected Data at One-half MDL[c]						Detected Data and MDL = 0[c]
				Min	Max	Mean	Median	25th percentile	75th percentile	Mean
Metals										
Arsenic (total)	275	na	na	0.052	1.52	0.268	0.173	0.086	0.346	na
Cadmium (total)	276	na	na	--[d]	2.26	0.421	--[d]	--[d]	--[d]	0.054
Copper (total)	272	na	na	0.047	31.1	1.30	0.691	0.454	1.38	na
Lead (total)	276	na	na	0.095	8.81	1.22	0.855	0.432	1.54	na
Mercury (total)	276	na	na	--[d]	1.31	0.188	--[d]	--[d]	--[d]	0.032
Zinc (total)	276	na	na	0.346	27.8	3.95	2.55	1.56	4.49	na
VOCs										
1,4-Dichlorobenzene[e]	60	35	58	2.08	15.06	7.95	7.79	5.97	8.83	4.39

Notes:

Source: EPA's AQS database (http://www.epa.gov/mxplorer/basic_info.htm) and Williamson (2008)

The metals data represented in this table were collected at the Duwamish and Georgetown monitoring stations. The 1,4-dichlorobenzene data were collected at the Beacon Hill monitoring station.

a Deposition flux values were calculated from the reported air concentration values using a deposition velocity of 0.2 cm/sec.

b Downloaded metals data employed a one-half MDL substitution for all non-detected data; therefore, the number of detected vs. non-detected samples is not known.

c The MDL for each metal was estimated based on the distribution of the data for each. The MDL for 1,4-dichlorobenzene was reported by Ecology.

d Blank cells indicate that the calculation was not performed based on the conclusion of the MDL assessment indicating that the majority of the data were one-half MDL replacement values and, therefore, not accurate representations of actual air concentrations. For cadmium and mercury, mean calculations were conducted using both one-half MDL substitutions and by setting the MDL at zero for comparison purposes.

e Data for 1,4-dichlorobenzene were provided by Ecology and did not employ an MDL substitution for non-detected data (i.e., non-detected data were reported as such). The raw data did include duplicate samples and collocated field samples for some of the monitoring days. Duplicate samples were not included in the deposition flux calculations; collocated samples were averaged to produce one result for each monitoring day.

MDL – method detection limit

Key assumptions used in developing the air deposition estimates from the data in Table 7-2 are as follows:

- **Dry Deposition Rates:** The conversion of air concentration data to deposition flux values gives an estimate of dry deposition. Wet deposition and gas-phase transfer are not included in the measure of deposition flux when converting air concentration data, which is a limitation of this dataset.
- **Method Detection Limits and Corrections:** AQS reported non-detected metals data as half the MDL. The actual MDLs for each metal were not reported; however, based on a review of the dataset, it appeared that several of the reported values for mercury and cadmium likely represented a one-half MDL substitution. In an effort to estimate the MDL thresholds for each metal, the data were ranked and a visual assessment of the air concentration data distribution was conducted. MDLs estimated through this assessment were used in calculations of the summary statistics presented in Table 7-2.
- **Conversion Factors for Estimating Deposition Rates:** Air concentration data were converted to atmospheric deposition flux values using a deposition velocity conversion factor of 0.2 centimeters per second (cm/sec). This deposition velocity has been used to convert air toxics concentration data to deposition flux values in other studies, including the County study (King County 2008). The conversion of atmospheric concentration data to deposition flux values introduces uncertainty; however, this practice has been applied in numerous scientific studies and is discussed in the EPA Handbook on atmospheric deposition (EPA 2001). The deposition velocity of a particle depends on its size, source, and class (King County 2008).

7.3 Applicability of Available Air Data to the EW Study Area

The air monitoring data available to investigate the atmospheric deposition pathway for the EW were collected in the LDW basin and on Beacon Hill. No air data collected within the EW OU boundary were available; however, the data collected from the LDW basin and Beacon Hill can also be used to characterize conditions within the EW study area because they were collected in relatively close proximity to the EW and because the monitoring stations from which they were collected have been sited by the PSCAA to be representative of neighborhood-scale conditions (Himes 2009). The data from these stations are considered by PSCAA to represent conditions throughout the Duwamish Valley.

Of the air monitoring stations used to provide data for the EW, PSCAA's relocated Duwamish station (CER) is closest to the EW, approximately 0.7-mile to the southeast of the southern portion of the EW. The distances of the other stations to the southern portion of the EW range from approximately 1 to 3.5 miles.

Air pollution is generally wide-spread, and airshed studies will typically assess air quality at the neighborhood, urban, or regional scale, with the acknowledgement that localized microscale effects can elevate the concentrations of certain parameters when sampling outside of a station that has been sited to assess these neighborhood, urban, or regional conditions. Compared to most air quality studies, the number of monitoring stations and the amount of air data available to characterize air quality in the industrial neighborhood of south Seattle (including the EW) is relatively large.

Localized air emissions such as those from non-point, mobile sources are difficult to monitor because the presence and location of these sources constantly change. Two recent studies provide information on mobile sources of air emissions and their contribution to air pollutants in the Duwamish Valley and greater Puget Sound region. The Puget Sound Maritime Air Emissions inventory was published by the Puget Sound Maritime Air Forum (PSMAF) in 2007 (Starcrest Consulting Group 2007), and the Duwamish Valley Regional Modeling and Health Risk Assessment was published in 2008 (WSDOH 2008).

7.3.1 Puget Sound Maritime Air Emissions Inventory

PSMAF is a voluntary association of ports, air agencies, environmental and public health advocacy groups, and other entities with responsibilities related to air regulations. Members of the forum include the Ports of Seattle, Everett, and Tacoma; Washington State Ferries; Burlington Northern Santa Fe Railway; the Northwest Cruise Ship Association; PSCAA; Ecology; and EPA, among others. The emissions inventory produced through the forum identifies maritime-related activities that use diesel equipment and estimates emissions of EPA criteria pollutants (and their precursors) generated by the use of that equipment. The purpose of the inventory is to provide additional information on emissions related to maritime operations and to aid in planning for emissions reduction.

The pollutants included in the Puget Sound Maritime Air Emissions inventory are carbon monoxide, nitrogen oxides, sulfur dioxides, VOCs, fine particulate matter (FPM [includes PM2.5 and PM10]), diesel particulate matter (DPM; a subset of FPM), and the greenhouse gases carbon dioxide, methane, and nitrous oxide. Of these, VOCs and DPM will be discussed further in this Memorandum, as they are most relevant to EW source control (DPM is relevant because it includes PAHs).

The maritime activities/equipment included in the inventory were hotelling (time spent by vessels at berth or anchor), maneuvering (slow speed, in-port operation), and transiting (travelling) of ocean-going vessels, and use of harbor vessels, rail locomotive, cargo handling equipment, heavy-duty vehicles, and fleet vehicles.

The air emissions inventory presented data based on Clean Air Agency jurisdictional areas. The PSCAA area includes King County (and, therefore, the EW study area); however, it should be noted that the inventory did not include activities in the Duwamish River beyond those conducted at Port facilities (Starcrest Consulting Group 2007). The emissions inventory found that only 2 percent of VOC emissions in the PSCAA area are emitted from maritime sources. This 2 percent equates to approximately 2,100 tons per year (tpy) emitted from all inventoried maritime sources combined.[5] Of the maritime emission sources of VOCs, harbor vessels (including tug boats, ferries, and recreational vessels) contributed the largest amount.

For DPM, the emissions inventory found that maritime-related activities generate approximately 30 percent of the DPM emitted in the PSCAA area (Starcrest Consulting Group 2007). DPM emissions from all inventoried maritime sources were estimated to total approximately 780 tpy. Of the maritime emission sources of DPM, harbor vessels contributed the largest amount, followed by ocean-going vessel transiting and hotelling.

[5] The air emissions inventory used data from base year 2005 to estimate tpy emissions.

The findings of the emissions inventory indicate that harbor vessels and ocean-going vessels are potentially important sources of PAHs (due to their presence in DPM) in the EW study area and the greater PSCAA jurisdictional area. The potential contribution of PAHs from these vessels to EW sediments has not been studied and would be difficult to quantify due to the frequent temporal and spatial changes in air emissions from transient sources such as maritime vessels.

Similar maritime equipment is used in the EW and the LDW; however, the frequency and dispersal of the use of this equipment likely varies between the two study areas. One reason that differences in maritime equipment use between the two study areas are expected is that almost the entire EW shoreline consists of container terminals, whereas the LDW shoreline includes container terminals as well as many other types of industrial facilities.

7.3.2 The Duwamish Valley Regional Modeling and Health Risk Assessment

The Washington State Department of Health (WSDOH) published the Duwamish Valley Regional Modeling and Health Risk Assessment to assess human health risks from air pollutants (WSDOH 2008). Air emissions from several sources in the Georgetown and South Park residential neighborhoods of south Seattle were modeled in order to identify air pollutants, their sources, and the geographic areas where health risks may be increased due to air pollution. The study found that microscale effects from proximity to mobile sources (e.g., areas of high vehicle traffic along E Marginal Way S) were one of the greatest drivers of health risk, mainly based on the presence of FPM in air emissions. This study indicates that mobile sources are important contributors to particulate air pollutants.

The WSDOH health consultation study and the Maritime Air Emissions inventory indicate that mobile sources such as cargo vessels, tugboats, and motor vehicles are likely the factors creating the greatest variability in FPM air emissions throughout a neighborhood or region. The WSDOH study used air modeling to characterize these sources instead of actual monitoring data because modeling can estimate conditions for a wide geographic area and because "it is not practical or possible to sample continuously for numerous pollutants at an infinite amount of points in an area"

(WSDOH 2008). For source control purposes, it is also most practical to use data representative of neighborhood-scale conditions to evaluate the direct atmospheric deposition pathway.

7.3.3 Comparison of PAH Atmospheric Deposition Flux Results Between Stations

Based on information provided in the PSMAF emissions inventory and the WSDOH health consultation, FPM emissions from the burning of fossil fuels (e.g., DPM) are most likely to vary geographically based on emissions from mobile, localized sources. As noted, FPM emissions from fossil fuel combustion contain PAHs; therefore, a comparison of the PAH deposition flux values measured in the County study can be used to get a general sense of whether these types of sources may contribute to air pollution to varying degrees at different locations.

The median PAH atmospheric deposition flux values measured at the relocated Duwamish station (CER), the Georgetown station (DZ), and the South Park station (SPCC) were all within less than 0.05 $\mu g/m^2$/day of each other for each individual PAH measured. The consistency between these results indicates that the deposition flux values measured at these stations are representative of conditions at the neighborhood scale (i.e., localized, mobile sources do not seem to be contributing to significantly higher levels of PAHs at any one of these three stations over the others). The PAH atmospheric deposition flux values measured at the KCIA station indicate the presence of additional localized, mobile sources of PAHs present at the airport due to the burning of fuel; the KCIA results for all PAHs measured were at least four times greater than the next highest value for the same PAH measured at any other station. The PAH atmospheric deposition flux values measured on Beacon Hill (station BW and BWR) were lower than at any other station for all individual PAHs measured; this is consistent with the expectation that PAH (and FPM) pollutants would be lower for a residential neighborhood than for an industrial neighborhood or commercial airport.

Based on the information available, the air monitoring and deposition data available for use in this report to characterize the potential direct atmospheric deposition pathway to the EW likely accurately represent neighborhood-scale conditions in the EW, though they may not represent all of the localized microscale effects caused by emissions from mobile sources.

Overall, the available air monitoring and air deposition data is expected to adequately characterize the direct atmospheric deposition pathway for the EW study area as these data characterize neighborhood-scale conditions. Potential pollutant inputs from indirect atmospheric deposition are addressed through characterization of the stormwater and CSO source inputs.

7.4 Potential Data Gaps and Ongoing Data Collection

This section describes the conclusions of the data gaps analysis for atmospheric deposition. These findings are presented in Table 7-3.

Table 7-3
Summary of Existing Data, SRI/FS Data Gaps, and Ongoing Data Collection Efforts – Atmospheric Deposition

Information Needed to Support SR/IFS	EISR Datasets and Use in Initial Evaluation	Useful Data Identified Subsequent to the EISR	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for SRI/FS	Remaining SRI/FS Data Gaps
Site-Specific Atmospheric Deposition Measurements for PAHs, Phthalates, and PCBs	• **Phase 1 Testing for Phthalates and PAHs:** Atmospheric deposition rate data for PAHs and phthalate compounds are available from LDW Phase 1 deposition study developed by SPU and King County, including sampling from January and May 2005. • **Preliminary Phase 2 Testing for Phthalates, PAHs, and PCBs:** Atmospheric deposition rate data for PAHs, phthalates, and PCBs available from LDW Phase 2 deposition study conducted between October 2005 and December 2006.	• **Final Phase 2 Data Report**: Results of Phase 2 atmospheric deposition testing for phthalates, PAHs, and PCBs were summarized in the final Phase 2 study report published by King County in 2008.	None identified	• **Upcoming Air Deposition Monitoring**: Ecology and the Puget Sound Partnership will conduct a study of air deposition of PAHs in the nearshore areas of the Puget Sound region (http://www.ecy.wa.gov/programs/wq/pstoxics/3c_subtask.html); this study may provide information on air deposition that will be useful for the EW SRI/FS.	None identified
Air Quality Data	• **Air Quality Data Review:** The EISR described several sources of regional air quality data, including Ecology and PSCAA. Atmospheric flux estimates were not developed at that time from these data.	• **2002-2004 Air Quality Monitoring Data for Heavy Metals**: Air quality data collected by EPA and Ecology for six heavy metals were obtained from the EPA Air Quality System database. Data selected for evaluation of the commercial/industrial neighborhood surrounding the EW were those collected at the Duwamish and Georgetown stations between 2002 and 2004. • **2007 Air Quality Monitoring for 1,4-DCB:** Airborne concentration measurements collected in 2007 for 1,4-DCB were obtained from Ecology (Williamson 2008). These data were collected from the Beacon Hill monitoring station, which is representative of Seattle on an urban scale.	• **Deposition Data for Other Compounds**: Additional air quality monitoring data are available if needed for analysis of potential atmospheric deposition rates for other chemicals. • Information provided in the Puget Sound Maritime Emissions Inventory (Starcrest Consulting Group 2007) and the Duwamish Valley Regional Modeling and Health Risk Assessment (WSDOH 2008) regarding the contribution of mobile air emission sources in the Duwamish Valley.	• **Ongoing Air Quality Monitoring**: As part of state and federal air quality programs, Ecology and EPA continue to collect and compile air quality monitoring data for multiple chemicals. These data are available from agency databases and may be used as appropriate during the SRI/FS. In addition, in 2010, PSCAA will conduct an air toxics monitoring study and will measure the PAH, VOC, aldehyde, and fine metals fractions of $PM_{2.5}$ (Himes 2009).	None identified
Conversion Factors for Estimating Atmospheric Deposition Values	None identified	• **Generic Deposition Velocity Conversion Factor** [1]: Air quality monitoring data were used to develop preliminary estimates of atmospheric deposition using a deposition velocity conversion factor of 0.2 cm/sec.	None identified	None identified	None identified

Notes:

1. Deposition velocities of airborne particles depend on the size, source, and class of particle. The use of a generic deposition velocity correction factor introduces some uncertainty into the deposition estimate in comparison to measured deposition values.

1,4-DCB – 1,4-dichlorobenzene
EISR – Existing Information Summary Report (Anchor and Windward 2008b)
EW – East Waterway
LDW – Lower Duwamish Waterway
PAHs – polycyclic aromatic hydrocarbons
PCBs – polychlorinated biphenyls
PSCAA – Puget Sound Clean Air Agency
SPU – Seattle Public Utilities
SRI/FS – Supplemental Remedial Investigation/Feasibility Study

7.4.1 Local Atmospheric Deposition Monitoring

As discussed in Section 7.3, existing data are suitable for evaluation of potential deposition rates for HPAHs, phthalates, and PCBs. The data for PCBs show limited detections, resulting in some potential uncertainty associated with MDLs. These data may be bolstered using estimates of atmospheric deposition rates developed from air quality data (as performed for heavy metals) or using surrogate information from other deposition studies.

No additional atmospheric deposition sampling is recommended at this time, as data are available from existing studies or from other sources.

7.4.2 Estimating Deposition from Air Quality Data

Currently available air quality data for several of the preliminary source control focus compounds are limited, including LPAHs, phenol, and 1,4-DCB. Data for these chemicals are likely available from other stations across the country. Data could be selected from other urban areas to serve as a surrogate for the EW.

EPA and Ecology continue to collect atmospheric concentration data for air toxics as part of their regulatory programs for air quality control. In addition, an atmospheric deposition study is being conducted in the Puget Sound by Ecology, the Puget Sound Partnership, and Battelle Memorial Institute (Williamson 2008), and the PSCAA is planning to conduct a year-long study on air toxics concentrations in Seattle and Tacoma (Himes 2008). The PAH, VOC, aldehydes, and fine metals fractions of $PM_{2.5}$ will be monitored in the air toxics study (Himes 2009). Additional data will become available for potential use during the SRI/FS SCE.

Collection of new air quality monitoring data is not recommended at this time, as sufficient data are available from other site-specific and surrogate sources. Review and analysis of these existing data is recommended to develop deposition estimates for LPAHs, phenol, and other focus compounds.

8 SPILLS

Potential spills of hazardous materials to the EW were evaluated as part of the EISR (Anchor and Windward 2008b) as a potential source of sediment recontamination. Spills can occur either directly to the EW or via overland flow from adjacent shoreline areas, or they can enter the EW indirectly through conveyance with stormwater discharges, CSO discharges, or via groundwater. This section describes available information for documented spills directly to the EW. Additional information will be developed for the SRI report regarding documented spills in the EW storm drain basins and combined sewer service areas, as described below.

8.1 Source Description

The EISR (Anchor and Windward 2008b) contained a summary of historical land uses, including over-water uses. Changes in land use and materials handling practices have occurred that have reduced the potential for spills of hazardous substances to the EW (e.g., over-water shipyard uses no longer occur within the EW, and bulk petroleum handling operations at the former Shell, Chevron, and GATX terminals have been terminated). Current over-water handling of potential hazardous substances is largely limited to containerized cargo handling and petroleum use (including lubricants or hydraulic fluids) by vessels within the EW.

Since the 1970s, local, state, and federal environmental regulations have been promulgated that have resulted in improved spill prevention, contingency planning, and cleanup procedures. Federal spill control regulations are implemented by EPA and the U.S. Coast Guard. Washington State regulations are administered by Ecology. Additional local spill prevention and control programs are implemented by the City of Seattle, King County, and the Port of Seattle. Local business and vessel operators are required to comply with these spill prevention and control programs through a variety of regulatory programs and permits.

These same regulations have required virtually all spills to water to be reported, including very small spills that may be insignificant with respect to sediment recontamination. Therefore, the number of reported spill events does not necessarily correlate with the potential risk of sediment recontamination. Some spills may also have a reduced potential to impact sediments due to the properties of the materials (e.g., the tendency of petroleum to form a floating sheen that can be recovered, rather than sinking directly to the sediment surface).

Multiple databases are available that can be used to evaluate historical spills. While the information contained in these databases is often limited, it can be used to assess the frequency and types of spills occurring within an area. Only spills that are reported are captured in the databases. Information on spills occurring prior to the 1980s is generally not available through database review, and would not likely reflect contemporary EW uses.

8.2 Existing Data Analysis

Data analysis conducted for the EISR (Anchor and Windward 2008b) included a review of reported spills to the EW or to immediately adjacent upland properties. Spills in other areas located further inland are discussed in Section 8.2.2.

8.2.1 Spills to the EW

As described in the EISR (Anchor and Windward 2008b), a search of federal, state, and local spill reporting databases was conducted to assess the recent history of reported spills within the EW and at adjacent upland properties. These databases include the federal Emergency Response Notification System maintained by the U.S. Coast Guard, and the spills database maintained by Ecology's Spill Prevention, Preparedness, and Response Program. These data were analyzed to assess the numbers, types, and quantities of spills occurring directly to the EW, or to properties immediately bordering the EW (i.e., those in the nearshore storm drainage basins). Table 8-1 summarizes the results of the data analysis, by the number of spill events.

Table 8-1 includes a total of 96 spills. Of this total, only the reports for 46 spills contained information on estimated spill quantities. Spill quantity information for this subset is summarized in Table 8-2. No chemical sampling data were identified for the spill events listed in Table 8-1. Therefore, the only information available on the chemical composition of the spilled materials are details provided in the spill reports. Descriptions of the spill events as provided in the spill reports are provided in Appendix I.

Table 8-1
Summary of Reported Spills to the East Waterway
(All Spills – 1988-2007)

Type of Spill Reported	Number of Spills
Petroleum (Type Not Specified)	44
Fuel Oils & Diesel Fuel	15
Hydraulic Oil	13
Lubricating Oil & Waste Oil	8
Gasoline	2
Drill Oil	1
Crude Oil	1
Unspecified Materials	5
Sewage, Sludge or Human Waste	3
Paint & Thinners	2
Potassium Hydroxide & Silver	1
Xylenes & Cresols	1
Total All	**96**

Notes:
Based on April 2007 database search as summarized in Appendix I. Table includes only spills direct to the EW and to the adjacent properties within the nearshore stormwater drainage basins. Does not include a review of spills within the Lander partially-separated storm drainage basin or within the combined sewer service areas with CSOs located in the EW.

The majority of the reported spills included petroleum. For the majority of petroleum spills (44 of 84), the type of petroleum (e.g., gasoline or fuel oil) was not specified. Other types of petroleum released are documented as described in Tables 8-1 and 8-2. While the descriptions are general, they provide some limited insight into the potential chemical composition of the materials.

For non-petroleum spills, the greatest number were those of unspecified contents, followed by sewage. Two small spills of paints or thinners (type unspecified), one spill of potassium hydroxide and silver (concentration unspecified), and one spill of xylenes and cresol were noted.

Table 8-2
Summary of Reported Spills to the East Waterway
(Spills with Estimated Quantities – 1988-2007)

Depth Horizon	Total Volume Reported (Gallons)
Hydraulic Oil *(n = 8)*	504.3
Petroleum (Not specified) *(n = 7)*	63.6
Fuel Oil or Diesel *(n = 9)*	60.2
Drill Oil *(n = 1)*	50.0
Lubricating Oils *(n = 8)*	20.0
Crude Oil *(n = 1)*	1.0
Unspecified Materials *(n = 3)*	75.1
Potassium Hydroxide & Silver *(n = 1)*	42.0
Sewage/Sludge *(n = 3)*	1.3
Paints & Thinners *(n = 2)*	0.1
Total All	**817.6**

Notes:
Based on April 2007 database search as summarized in Appendix I. Table includes only spills direct to the EW and to the nearshore stormwater drainage basins. Does not include a review of spills within the Lander partially-separated storm drainage basin or within the combined sewer service areas with CSOs located in the EW.

Table 8-2 summarizes those spills that have estimated quantities included in the spill reports. The volumes reported in the table are the reported aggregate volume. Petroleum constitutes the largest portion of the reported spilled materials as measured by reported volumes (699 of the reported 818 gallons spilled). Hydraulic oils made up the largest proportion of the reported total. For non-petroleum materials, the largest proportion (75 of 119 gallons) represented materials with an unspecified chemical composition. The potassium hydroxide and silver spill had a total reported volume, but the concentration of silver in the material was not reported. Therefore, the total quantity of silver released is not known. The volumes of sewage and paint/thinner spills were small (1.3 and 0.1 gallons, respectively).

8.2.2 Spills in Upland Areas

The database evaluation of spill events performed for the EISR (Anchor and Windward 2008b) was not conducted for spills reported in upland areas distant from the EW. Spills in these areas were assumed to contribute to chemicals that may be contained in stormwater that may discharge to the EW via the separated storm drainage systems, or via CSO events (for spills occurring to stormwater drains within the combined sewer service areas). The evaluation of stormwater and CSOs (Sections 4 and 5 of this report, respectively) addresses chemicals that may have originated, in part, from these types of spill events.

One recent spill event was noted during the development of this Memorandum. That spill occurred at Industrial Plating Corporation, located within the Lander combined sewer system and to the Lander separated storm drainage systems. The spill event occurred due to the rupture of a large above-ground wastewater storage tank operated by the company. The spill volume exceeded the containment area capacity around the tank, resulting in the release of wastewater and associated metals-containing solids. Heavy metals detected in samples of the spilled solids collected at the facility included cadmium, chromium, copper, and zinc at concentrations in excess of SQS criteria. The spill was released to on-property and off-property areas. These areas drained both to the Lander combined sewer system and to the Lander separated storm drainage system. Some stormwater containing spilled materials was reportedly discharged to the EW via the Lander outfall. The precise volume and composition of spilled materials discharged to the EW is not known.

Subsequent to the Industrial Plating Corporation spill, sediment sampling was conducted by the Port in the area immediately offshore of the Lander Street outfall. The sampling included nine sampling stations. Elevated concentrations of cadmium were noted in the sample location closest to the outfall, and elevated concentrations of mercury were noted in three of the samples located near the outfall. The results of testing provide information on the lateral extent of sediments that may have been impacted by the particular spill event. A copy of the sediment sampling memorandum is attached in Appendix I.

As described below in Section 8.3, a database review will be conducted in support of the SRI report to identify spills that have occurred within the upland areas near the EW, including the storm drain basins and combined sewer service areas. The database search results will be incorporated into the SRI report.

8.3 Potential Data Gaps and Ongoing Activities

Table 8-3 summarizes the findings of the spills evaluation for the EW. The review of documented spills indicates that the EW has been subject to periodic small-quantity spill events from diverse sources. The examination of the past spill record does provides information on spill patterns, but cannot be used to predict the quantity, timing, or location of future spill events. The documented spill events have been typically small in volume, but may have the potential to contribute to localized contamination if the spill reaches the waterway. The Industrial Plating Corporation spill demonstrates that some spills occurring inland from the EW may be carried by stormwater conveyance systems to EW outfalls and can have an impact on EW sediments.

As part of the SRI/FS, an updated database search will be conducted to document spills that have been reported within the upland areas adjacent to the EW, including the storm drain basins and the combined sewer service areas. This search will also be used to document any new releases occurring to the EW during the period 2007 to 2009.

Table 8-3
Summary of Existing Data, SRI/FS Data Gaps, and Ongoing Data Collection Efforts – Spills

Information Needed to Support SR/IFS	EISR Datasets and Use in Initial Evaluation	Useful Data Identified Subsequent to the EISR	Additional Information Useful for Source Evaluation	Ongoing Data Collection Efforts Useful for SRI/FS	Remaining SRI/FS Data Gaps
Spills to the EW and EW-Associated Drainage Areas	• **Database Survey of Spills to the EW:** A search of regulatory databases was conducted to evaluate the number and types of spill events that have occurred within or immediately adjacent to the EW, and that have been reported.	• **Industrial Plating Spill:** A spill occurred in the upland drainage areas associated with the EW, and follow-up testing was conducted near the storm drain and CSO outfalls associated with this release area.	• **Updated Spill Survey:** An expanded spill summary is appropriate for the SRI/FS to assess the types and history of spills reported in the EW drainage areas, as well as to update information regarding spills to the EW between the time of the EISR and the SRI/FS.	None identified	• **Updated Spill Survey:** An updated spill summary will be performed as part of the SRI/FS for spills direct to the EW and to the EW storm drain basins and combined sewer service areas.
Information Relating to Recent Industrial Plating Corporation Spill	Not applicable (spill event occurred following EISR production).	• **Spill Event Sampling:** City and County enforcement programs conducted spill response activities, and also provided sampling information documenting the types of chemicals discharged to the stormwater and combined sewer systems. • **EW Sediment Sampling Near the Lander Outfall:** The Port conducted sediments sampling offshore of the Lander outfall. That sampling documented spill-associated heavy metals impacts in a limited area immediately adjacent to the Lander outfall.	None identified	None identified	None identified

Notes:

Information relating to the Industrial Plating Corporation spill is contained within Appendix I.
EW – East Waterway
EISR – Existing Information Summary Report
SRI/FS – Supplemental Remedial Investigation/Feasibility Study

9 EVALUATION SUMMARY

Sections 2 and 3 of this Memorandum provide a general discussion of the source/pathway types being evaluated for potential to recontaminate sediments within the EW. Those sections provide the following:

- Identification of the types of sources/pathways for further evaluation during the SRI/FS, and of the potential mechanisms by which inputs can reach EW sediments
- Introduction to the different data types and lines of evidence that may be useful in characterizing source-related inputs to the EW
- Summary of how the source evaluation data are to be used as part of the SRI/FS to accomplish the goals of the SCE

As described in Sections 4 through 8 of this Memorandum, much of the information necessary to estimate inputs of solids and chemicals from the different source types is available from previous work. Ongoing activities are in progress by EWG members to supplement this information for use in the EW SRI/FS. Table 9-1 provides a concise summary of the remaining information needs being addressed through ongoing activities of the individual EWG members. Data gaps not addressed by the ongoing data gathering activities are also summarized in that table. These remaining data gaps are to be filled as part of the EW SRI/FS activities. For more information regarding the ongoing work and any remaining data gaps, please refer to the indicated sections listed at the top of Table 9-1.

Table 9-1 also lists some activities that are ongoing as part of the source control programs operated by the individual EWG members, or by regulatory agencies including EPA, Ecology, PSCAA, and the U.S. Coast Guard. These ongoing activities are summarized in this Memorandum for information purposes. Some of these activities may generate information potentially useful for the evaluation of source control options. However, these activities are not considered necessary for completion of the EW SRI/FS documents.

Table 9-1
Summary of Key Ongoing Studies and Remaining SRI/FS Data Gaps
East Waterway SRI/FS Source Control Evaluation (1)

Information Need and SRI/FS Application	Ongoing Work and Data Gaps Associated with SRI/FS Information Needs					
	Stormwater Discharges (Table 4-14)	CSO Discharges (Table 5-9)	Cleanup Sites (Table 6-11)	Creosote-Treated Structures (Section 6.5)	Atmospheric Deposition (Table 7-3)	Spills (Table 8-3)
General Source Characterization Data Needs						
Source Descriptions – Information describing the source and useful for evaluating source-specific data needs	**Ongoing Work:** The Port is conducting field verifications of stormwater basin B-11. The City is updating the Connecticut and Hinds basins. **Remaining Data Gaps:** None defined	**Ongoing Work:** The City is updating basin information for the Hinds Street combined sewer service area. The SRI will include an updated list of permitted industrial discharges and a map of facility locations. **Remaining Data Gaps:** None defined	**Ongoing Work:** None **Remaining Data Gaps:** Database searches to be updated and expanded to identify potential cleanup sites within the storm drain basins and combined sewer service areas.	**Ongoing Work:** None **Remaining Data Gaps:** The SRI will include updated information regarding the types and locations of creosote-treated structures remaining in and adjacent to the EW	**Ongoing Work:** None **Remaining Data Gaps:** None defined	**Ongoing Work:** None **Remaining Data Gaps:** The spills inventory in Appendix I will be updated during the SRI to address the period 2007-2009. This search will be expanded to include the storm drain and combined sewer service areas.
Location data – Definition of pathways by which source materials can reach the EW sediments	**Ongoing Work:** None **Remaining Data Gaps:** The SRI report will include a database search showing reported cleanup sites and spills located in EW storm drain basins.	**Ongoing Work:** None **Remaining Data Gaps:** The SRI report will include a database search showing reported cleanup sites and spills located in combined sewer service areas associated with EW CSOs.	**Ongoing Work:** None **Remaining Data Gaps:** 1) Expanded database searches will be overlaid on stormwater and combined sewer basin maps. 2) As part of the SRI, areas of potentially unstable shorelines (e.g., non-armored areas) will be mapped, and soil and sediment quality in these areas will be reviewed to assess the potential bank erosion pathway.	**Ongoing Work:** None **Remaining Data Gaps:** The SRI will include updated information regarding the types and locations of creosote-treated structures remaining in and adjacent to the EW	**Ongoing Work:** None **Remaining Data Gaps:** None defined	**Ongoing Work:** None **Remaining Data Gaps:** The spills inventory in Appendix I will be updated during the SRI to address the period 2007-2009. This search will be expanded to include the storm drain and combined sewer service areas.
Quantity Information – Data used to estimate the volume of discharges and, combined with TSS data, the quantity of solids inputs from the source to the EW	**Ongoing Work:** The stormwater runoff analysis will be updated based on updated basin delineations. **Remaining Data Gaps:** Estimates of the stormwater runoff quantties from the Connecticut Street outfall can be developed using either 1) historical flow monitoring data recorded by the County (requires extensive processing), or 2) by conducting a runoff model for the Connecticut stormwater basin	**Ongoing Work:** CSO discharge frequencies and volumes are monitored by the City and County as part of ongoing CSO control programs **Remaining Data Gaps:** None	**Ongoing Work:** Groundwater monitoring activities are ongoing at Harbor Island, Terminal 30, and Terminal 104 **Remaining Data Gaps:** Additional information regarding groundwater/surface water transport and mixing processes may be warranted near Harbor Island well HI-12 depending on the results of ongoing groundwater monitoring for zinc.	**Ongoing Work:** None **Remaining Data Gaps:** Identify existing or planned factors that may limit potential creosote releases from existing structures (e.g., pile wrapping or planned removals/replacements).	**Ongoing Work:** None **Remaining Data Gaps:** None defined	**Ongoing Work:** None **Remaining Data Gaps:** The spills inventory in Appendix I will be updated during the SRI to address the period 2007-2009. This search will be expanded to include the storm drain and combined sewer service areas.

Information Need and SRI/FS Application	Ongoing Work and Data Gaps Associated with SRI/FS Information Needs					
	Stormwater Discharges (Table 4-14)	CSO Discharges (Table 5-9)	Cleanup Sites (Table 6-11)	Creosote-Treated Structures (Section 6.5)	Atmospheric Deposition (Table 7-3)	Spills (Table 8-3)
Chemical Quality Data – Information on the chemical quality of source material discharged to the EW and useful for SRI/FS evaluations of recontamination potential	**Ongoing Work:** The City and Port are conducting investigation and sampling of the Lander and nearshore stormwater drainage basins. This sampling includes collection of stormwater solids from catch basins, in-line samples, and from sediment traps placed in the larger stormwater conveyances **Remaining Data Gaps:** Evaluate SRI/FS sediment quality data in the vicinity of storm drain discharges, in conjunction with STE results and source characterization data as part of the SRI and FS recontamination predictions.	**Ongoing Work:** The County is conducting additional CSO effluent sampling for selected parameters and is collecting samples of combined sewer solids using a combination of in-line samples and sediment traps. The City is collecting samples of combined sewer solids from the S Hinds Street CSO. **Remaining Data Gaps:** Evaluate SRI/FS sediment quality data in the vicinity of CSO discharges, in conjunction with STE results and source characterization data as part of the SRI and FS recontamination predictions.	**Ongoing Work:** 1) Groundwater monitoring activities are ongoing at Harbor Island, Terminal 30, and Terminal 104. 2) As part of the SRI/FS, additional surface, subsurface, and porewater or seep testing data are being developed for the EW. **Remaining Data Gaps:** 1) Additional evaluations may be warranted near Harbor Island well HI-12 depending on the results of ongoing groundwater monitoring for zinc. 2) Groundwater conditions at the Terminal 102, Terminal 25, and Terminal 34 sites will be reviewed as additional data are developed for EW surface and subsurface sediments and for sediment porewater or seeps. 3) If potentially complete pathways exist for bank erosion, then supplemental testing or other evaluations could be required in these discrete areas.	**Ongoing Work:** None **Remaining Data Gaps:** Evaluate SRI/FS sediment quality data in the vicinity of existing creosote-treated structures	**Ongoing Work:** Collection of multi-parameter air quality monitoring data is ongoing by Ecology, EPA, and PSCAA. Ecology and the Puget Sound Partnership are to conduct a study of PAH deposition in the Puget Sound region. PSCAA will conduct an air toxics monitoring study during 2010. **Remaining Data Gaps:** Datasets may be reviewed as part of the SRI to evaluate most recent datasets or to address other chemicals if required	**Ongoing Work:** None **Remaining Data Gaps:** Based on an updated database search, a spills matrix will be included in the SRI report summarizing the types and quantities of spills reported along the EW, in the storm drain basins, and combined sewer service areas associated with the EW CSOs.
Additional Information Needs for Sediment Transport Evaluation [2]						
Particle Size Distribution – Size distribution data for suspended solids that may be discharged to the EW (particle size affects settling rate and sediment transport properties)	**Ongoing Work:** None **Remaining Data Gaps:** None defined	**Ongoing Work:** None **Remaining Data Gaps:** None defined	Not applicable (groundwater is not a significant source of suspended solids) [2]	Not applicable (creosote-treated structures are not a significant source of suspended solids) [2]	Not applicable (atmospheric deposition is not a significant source of suspended solids) [2]	Not applicable to spills of liquids. Potentially applicable to large-quantity spills of solid materials [2]
Activities Associated with Ongoing Source Control Programs [3]						
Localized Testing – Inspections or sampling focused on identification and analysis of specific localized source inputs	**Ongoing Work:** Facility and system inspections by the Port and City as part of stormwater and source control programs	**Ongoing Work:** Facility and system inspections by the County and City. The County is conducting sampling activities to evaluate the source of elevated 1,4-DCB concentrations in recent Hanford Street CSO discharges. The County has also initiated follow-up PCB sampling for stormwater discharges entering the combined sewer from the Rainer Commons property (former Rainier Brewery)	**Ongoing Work:** Cleanup and/or monitoring activities are ongoing at the Harbor Island, Terminal 30, and Terminal 104 sites. Conditions at the Terminal 102, Terminal 25, and Terminal 34 sites will be reviewed as additional data are developed for EW surface and subsurface sediments.	**Ongoing Work:** Ongoing creosote structure removal and replacement activities by the Port, Department of Natural Resources, and other parties, and material substitution programs for new construction.	**Ongoing Work:** Ongoing air quality monitoring by EPA, Ecology, the Puget Sound Clean Air Agency, and facility inspections and permitting associated with specific fixed or mobile sources	**Ongoing Work:** Ongoing facility inspections associated with spill control programs maintained by the Port, City, County, EPA, Coast Guard, and Ecology

Notes:

Data gaps conclusions may be updated during the SRI/FS process based on the observations from sediment testing and/or the risk assessment. Updates to data gaps conclusions will be discussed with EPA and project stakeholders during periodic source control briefings.

1 This table provides a summary of the remaining information needs associated with the SRI/FS source control evaluation. Refer to the indicated summary table for a more detailed discussion of the ongoing data collection activities and the remaining data gaps relevant to the SRI/FS.

2 Information needs are defined as those associated with the development of an EW sediment transport model incorporating regional sediment inputs (e.g., Green River and LDW) and significant sediment lateral loads entering the EW.

3 These additional activities are associated with ongoing source-tracing and source control activities, but may generate data useful for the SRI/FS source control evaluation.

1,4-DCB – 1,4-dichlorobenzene
CSO – combined sewer overflow
Ecology – Washington State Departent of Ecology
EPA – U.S. Environmental Protection Agency
EW – East Waterway
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PSCAA – Puget Sound Clean Air Agency
SRI/FS – Supplemental Remedial Investigation/Feasibility Study
STE – Sediment Transport Evaluation
TSS – total suspended solids

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APPENDICES (on CD)