1. Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 8.2.2. For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk Early Action Area, surface sediment data presented in Section 9.2.2 represent samples collected before dredging, capping, or thin-layer capping in 1999 and before sediment removal or capping at the Boeing Developmental Center storm drain in 2003.

Map 4-1. Locations of surface sediment samples analyzed as part of discrete events
Surrounding text content is not available for this image.
Map 4-4a. Surface sediment sampling locations, RM 0.0 to RM 0.4

Surface sediment sampling location
- Duw/Diag-1
- Duw/Diag-1.5
- Duw/Diag-2
- Duw/Diagonal-October2003
- EPA SI
- LDWR Benthic
- LDWR Surface Sediment Round 1
- LDWR Surface Sediment Round 2
- LDWR Surface Sediment Round 3
- NOAA SiteChar

- Bridge
- Building
- Dock/Pier
- Marina
- Road
- Early Action Area
- Navigation channel
- River mile
- Tax parcel

* Several of the EAA/boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2. For the Duwamish/Diagonal Early Action Area, surface sediment sampling locations in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005.

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

* Map of Duwamish/Diagonal Early Action Area

* For more information, refer to the original document or contacting the relevant authorities.

* Created by Windward Environmental LLC

* Map credit: Windward Environmental LLC

* Map created by [Software Name]
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 9.2.2 of "Duw/Diag-2 Early Action Area:
Baseline and Assessment Data." A comprehensive survey of property-owner records was not conducted before dredging, capping, or thin-layer placement in 2003 to 2005.

* The base information was provided in CUBIC (a tax parcel database for King County). The base parcel data for the EAA was edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.
Map 4-4c. Surface sediment sampling locations, RM 0.9 to RM 1.4

Surface sediment sampling locations
- Duwamish Shipyard
- EPA Site
- KC WQA
- LDWRI-Benthic
- LDWRI-SurfaceSedimentRound1
- LDWRI-SurfaceSedimentRound2
- LDWRI-SurfaceSedimentRound3
- NOAA SiteChar
- Tax parcel
- Building
- Dock/Pier
- Road
- Navigation channel
- River mile

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were added to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.
Map 4-4d. Surface sediment sampling locations, RM 1.4 to RM 2.0

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA location, RM 2.0 to RM 2.6

Surface sediment sampling location
- Boyer Towing
- EPA SI
- LDWRI-Benthic
- LDWRI-SurfaceSedimentRound1
- LDWRI-SurfaceSedimentRound2
- LDWRI-SurfaceSedimentRound3
- NOAA SiteChar
- Bridge
- Building
- Dock/Pier
- Marina
- Road
- Early Action Area
- Navigation channel
- River mile
- Tax parcel

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

* Tax parcel information was provided by Seattle Public Utilities and King County. Tax parcel information was input into the database. It may not conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.
A comprehensive survey of property-owner records was not conducted. Some tax parcel polygons were edited to conform to the LDW shoreline presentation.

Slip 4 Early Action Area

Boeing Plant 2/Jorgensen Forge Early Action Area

Map 4-4f. Surface sediment sampling locations, RM 2.6 to RM 3.3

Surface sediment sampling location:
- Boeing SiteChar
- EPA SI
- KC WQA
- LDWRI Benthic
- LDWRI SurfaceSedimentRound1
- LDWRI SurfaceSedimentRound2
- LDWRI SurfaceSedimentRound3
- NOAA SiteChar
- Plant 2 RFJ-1
- Plant 2 RFJ-2a
- Plant 2 RFJ-2b
- Slip 4 Early Action Area

Several of the EAA boundaries are approximate and have not been finalized by EPA/ECology; a description of each EAA boundary is presented in Section 9.2.2.

Tax parcel information was provided in 2006 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.
EAA boundary is presented in Section 9.2.2.

Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

Surface sediment sampling location
- Boeing SiteChar
- EPA SI
- JorgensenAugust2004
- LDWRI-Benthic
- LDWRI-SurfaceSedimentRound1
- LDWRI-SurfaceSedimentRound2
- LDWRI-SurfaceSedimentRound3
- NOAA SiteChar
- Plant 2 RFS 1
- Plant 2 RFS 2a
- Plant 2 Transformer/Phase 1
- Plant 2-Transformer/Phase 2
- Plant 2
- Plant 2-1117 Boundary/Definition

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 9.2.2.

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

Map 4-4g. Surface sediment sampling locations, RM 3.3 to RM 3.9
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology or described in each EAA boundary is not fully understood. Surface sediment sampling locations represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain removal area in 2003.

Surface sediment sampling location:
- Boeing SiteChar
- EPA SI
- Ecology-Norfolk
- LDWRI-Banftvic
- LDWRI-SurfaceSedimentRound1
- LDWRI-SurfaceSedimentRound2
- LDWRI-SurfaceSedimentRound3
- NOAA SiteChar
- Norfolk-cleanup1
- Norfolk-cleanup2
- Norfolk-cleanup3
- Norfolk-mon11
- Norfolk-mon12a
- Norfolk-mon12b
- Norfolk-mon13
- Norfolk-mon14
- Norfolk-mon15

a Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology or described in each EAA boundary is not fully understood. Surface sediment sampling locations represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain removal area in 2003.

b Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were added to conform to the LDW shoreline presentation. A comprehensive survey of property owner records was not conducted.
Map 4-4j. Surface sediment sampling locations, RM 5.1 to RM 6.0

Surface sediment sampling location
- EPA SI
- LDWR-SurfaceSedimentRound2
- NOAA SiteChar
- Norfolk-cleanup1

- Tax parcel
- Dock/Pier
- Road
- Navigation channel
- River mile

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property owner records was not conducted.
Subsurface sediment sampling event:
- Boyer/Towing (2004)
- DSO4/DSOAvertchar (2001)
- Doug/Diag-1 (1994)
- Doug/Diag-2 (1996)
- Doug/YachtClub (1999)
- Glacier NW (2002)
- Hurley-Boyer (1999)
- Lone Star 32 (1992)
- Lone Star Hardie Gypsum (1995)
- Norfolk-clean-up1 (1994)
- Norfolk-clean-up2 (1995)
- Plant 2 RFI-1 (1994, 1995)
- Plant 2 RFI-2b (1996)
- Plant 2-Transformer/Phase1 (2003)
- Rhône-Poulenc (2004)
- Slip4-Crowley (1996)
- Slip4-EarlyAction (2004)
- South Park Bridge (2003)
- SouthParkMarina (1994)
- T117BoundaryDefinition (2003, 2004)
- Terminal-105 (1985)
- Turning-basin (2003)
- Early Action Area*

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

a Subsurface sediment data at locations in dredged areas were collected prior to dredging.
Map 4-6. Locations of subsurface sediment cores analyzed as part of LDW-wide events

Scale is the same for each inset map

Subsurface sediment sampling event
- EPA SI (1998)
- LDWRRI - Subsurface Sediment (2006)

Early Action Area
- Dredged area
- Dredged and capped area
- Dredged and thin-layer placement
- Thin-layer placement
- Road
- Navigation channel
- River mile

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging.
Subsurface core location
- Dredged area
- Dredged and capped area
- Thin-layer placement
- Bridge
- Building
- Dock/Pier
- Marina
- Intertidal zone
- Road
- Navigation channel
- River mile

Samples at locations within dredged areas were collected prior to dredging. Labels adjacent to each dredged area indicate the project name and the year of dredging (and capping or thin-layer placement, where applicable).

Map 4-7a. Subsurface sediment core locations and dredging events, RM 0.0 to RM 1.2
Map 4-7b. Subsurface sediment core locations and dredging events, RM 1.2 to RM 2.4

- Subsurface core location
- Dredged area
- Dredged and thin-layer placement
- Bridge
- Building
- Dock/Pier
- Marina
- Intertidal zone
- Road
- Navigation channel
- River mile

* Samples at locations within dredged areas were collected prior to dredging. Labels adjacent to each dredged area indicate the project name and the year (and capping or thin-layer placement, where applicable).
Samples at locations within dredged areas were collected prior to dredging. Labels adjacent to each dredged area indicate the project name and the year of dredging (and capping or thin-layer placement, where applicable).
Map 4-7d. Subsurface sediment core locations and dredging events, RM 3.7 to RM 5.0

- Subsurface core location
  - Dredged area
  - Dredged and capped area
  - Bridge
  - Dock/Pier
  - Marina
  - Intertidal zone
  - Road
  - Navigation channel
  - River mile

* Samples at locations within dredged areas were collected prior to dredging. Labels adjacent to each dredged area indicate the project name and the year of dredging (and capping or thin-layer placement, where applicable).
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Subsurface core location with empirical data for specified core interval

Subsurface core location with calculated data for specified core interval

Subsurface core location with no data for specified core interval

Early Action Area

Dredged area

Dredged and capped area

Dredged and thin-layer placement

Thin-layer placement

Road

Navigation channel

River mile

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Subsurface sediment data at locations in dredged areas were averaged for an estimated concentration in each 2-foot interval. The 0-to-2-foot interval was calculated from the 0-to-1-foot and 1-to-2-foot intervals, the 2-to-4-foot interval was calculated from the 2-to-3-foot and 3-to-4-foot intervals, and the 4-to-6-foot interval was calculated from the 4-to-5-foot and 5-to-6-foot intervals.

Map 4-8a. Locations with subsurface sediment data within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8
Subsurface core location with empirical data for specified core interval
Subsurface core location with calculated data for specified core interval
Subsurface core location with no data for specified core interval

If data were available for 1-foot intervals, concentrations were averaged for an estimated concentration in each 2-foot interval. The 0-to-2-foot interval was calculated from the 0-to-1-foot and 1-to-2-foot intervals, the 2-to-4-foot interval was calculated from the 2-to-3-foot and 3-to-4-foot intervals, and the 4-to-6-foot interval was calculated from the 4-to-5-foot and 5-to-6-foot intervals.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-8c. Locations with subsurface sediment data within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0

Prepared by CEH, 07/13/2010; MAP 2683; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval

Dredging information provided by AECOM.
Map 4-9. Fish tissue sampling locations

Tissue sample locations by sampling event
LDWG trawl lines for stary flounder, perch, Pacific staghorn sculpin, and English sole
- 2007
- 2005
- 2004
Juvenile chinook salmon beach seine location (2003)
LDWRI tissue sampling areas (2004-2005)

T1
T2
T3
T4

East Waterway; Windward (2002)
- Juvenile chinook salmon beach seine location (2002)
Waterway Sediment Operable Unit; ESG (1999)
- Striped perch hand-collected (SCUBA) location (1998)
- English sole trawl line (1998)
King County Water Quality Assessment; King County (1999b)
- English sole and shiner perch trawl line (1996-1998)
EVS95
- English sole trawl line (1995)
Puget Sound Ambient Monitoring Program; West et al. (2001)
- English sole trawl line (1992, 1995)
Road
- Navigation channel
River mile

* Pacific staghorn sculpins were also collected in a subset of shrimp traps shown on Map 4-10.

Map 4-9. Fish tissue sampling locations

Scale is the same for each inset map
were not captured at all crab trap locations. In addition, crabs and shrimp traps. Crabs were also captured in a subset of LDW RI trawls and LDW RI tissue sampling areas (2004, 2005, 2007).

Map 4-10. Benthic invertebrate and shellfish tissue sample locations by sampling event

LDW RI Dungeness and slender crabs* (2007)
LDW RI Dungeness and slender crabs* (2005)
LDW RI Dungeness and slender crabs* (2004)
LDW RI Benthic invertebrates (2004)
LDW RI Clams (2007)
LDW RI Clams (2004)

Waterway Sediment Operable Unit; ESG (1998)
LDW RI Dungeness and red rock crabs (1998)
King County Water Quality Assessment; King County (1999b)
LDW RI Dungeness crabs (1997)
LDW RI Amphipods (1997-1998)
LDW RI Wild mussels (1996-1997)
LDW RI Transplanted mussels (1996-1997)
LDW RI Road
LDW RI Navigation channel
LDW RI River mile

* Each location represents an individual crab trap or a pair of crab and shrimp traps. Crabs were also captured in a subset of LDW RI trawls and LDW RI tissue sampling areas (2004, 2005, 2007). In addition, crabs were not captured at all crab trap locations.
Map 4-11a. Seep water and surface water sampling locations

Seep sampling event
- Boeing Plant 2
- Great Western
- LDW RI
- Rhône-Poulenc
- T-117
- Boeing Isaacson

Surface water sampling event
- KC WQA
- KC PCB congener survey
- CSO
- CSO/storm drain

* CSO or CSO/SDs are only shown if located near KC WQA stations.
### Chemical Unit Filtered Result

#### Analyte Unit N

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Unit</th>
<th>N</th>
<th>Detected Result</th>
<th>Range of Detects</th>
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<tbody>
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<td>Acetone µg/L</td>
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<td>6</td>
<td></td>
<td>5.6</td>
</tr>
<tr>
<td>Acetone µg/L</td>
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<td>3</td>
<td></td>
<td>6.4</td>
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<tr>
<td>Acetone µg/L</td>
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<td></td>
<td>5.6</td>
</tr>
<tr>
<td>Acetone µg/L</td>
<td></td>
<td>10</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>Acetone µg/L</td>
<td></td>
<td>5</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Benzene µg/L</td>
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<td>Chlorobenzene µg/L</td>
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<td>8.8</td>
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<td>1,2-Dichloroethane µg/L</td>
<td></td>
<td>10</td>
<td>1.0 - 8.0</td>
<td></td>
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<td>cis-1,2-Dichloroethene µg/L</td>
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<td>62 - 190</td>
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<td>3</td>
<td>62 - 190</td>
<td></td>
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<td>10</td>
<td>1.0 - 47</td>
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<td>10</td>
<td>1.0 - 47</td>
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<td>1.0 - 47</td>
<td></td>
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<td>1.0 - 8.0</td>
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<td>1.0 - 8.0</td>
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<tr>
<td>1,2-Dichloroethane µg/L</td>
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<td>1.0 - 8.0</td>
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<tr>
<td>1,2-Dichloroethane µg/L</td>
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<td>1.0 - 8.0</td>
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<tr>
<td>1,2-Dichloroethane µg/L</td>
<td></td>
<td>10</td>
<td>1.0 - 8.0</td>
<td></td>
</tr>
</tbody>
</table>

Note: All results are presented if single samples were analyzed at a given location; if multiple samples were analyzed, the concentration range and number of detects are presented. Only chemicals with detected concentrations are shown (in either filtered or unfiltered samples).
Prepared CEH 07/13/2010; MAP #3794; W:\Projects\00-08-06_Duwamish_RI\data\GIS\Phase2 RI\Nature and Extent\Seeps and porewater

Note: Only chemicals with detected concentrations are shown (in either filtered or unfiltered samples). At some locations between RM 2.2 and RM 2.5, multiple samples were collected over time. At those locations, the range of concentrations is presented for detected chemicals.
Map 4-11d. Seep water sampling data (only detected chemicals), RM 3.4 to RM 4.0

Seep sampling event
- Boeing Plant 2
- LDW RI
- T-117
- Road
- Navigation channel
- River mile

Note: Only chemicals with detected concentrations are shown (in either filtered or unfiltered samples).
Map 4-11e. Seep water sampling data (only detected chemicals), RM 4.0 to RM 5.0

Note: Only chemicals with detected concentrations are shown (in either filtered or unfiltered samples).
Map 4-12b. Porewater sampling data (only detected chemicals), RM 0.0 to RM 2.0

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<thead>
<tr>
<th>Analyte Unit</th>
<th>Result</th>
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</thead>
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<tr>
<td>Benzene µg/L</td>
<td>0.040 J</td>
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<tr>
<td>Toluene µg/L</td>
<td>0.020 J</td>
</tr>
<tr>
<td>Ethylbenzene µg/L</td>
<td>0.010 J</td>
</tr>
<tr>
<td>n-Heptane µg/L</td>
<td>0.020 J</td>
</tr>
<tr>
<td>o-CPH µg/L</td>
<td>0.020 J</td>
</tr>
<tr>
<td>m-CPH µg/L</td>
<td>0.020 J</td>
</tr>
<tr>
<td>p-CPH µg/L</td>
<td>0.020 J</td>
</tr>
<tr>
<td>Triphenylmethane µg/L</td>
<td>0.040 J</td>
</tr>
<tr>
<td>Xylene µg/L</td>
<td>0.010 J</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analyte Unit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead µg/L</td>
<td>0.4 J</td>
</tr>
<tr>
<td>Silver µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Copper µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Antimony µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Vanadium µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Zinc µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Polyaromatic hydrocarbons µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Phenol µg/L</td>
<td>0.000 J</td>
</tr>
<tr>
<td>Chlorinated hydrocarbons µg/L</td>
<td>0.000 J</td>
</tr>
</tbody>
</table>

Note: Only detected chemical concentrations are shown.
Note: No VOCs were detected in the piezometer (PZ) samples.

Analyte Unit Result
1,1-Dichloroethane µg/L 0.4
1,4-Dichlorobenzene µg/L 0.4
1,2-Dichloroethane µg/L 0.4
1,1-Dichloroethene µg/L 0.4
1,2-Dichloropropane µg/L 0.4
Benzene µg/L 0.4
Carbon disulfide µg/L 0.4
Chlorobenzene µg/L 0.4
cis-1,2-Dichloroethene µg/L 0.4
Isopropylbenzene µg/L 0.4
Toluene µg/L 0.4
trans-1,2-Dichloroethene µg/L 0.4
Vinyl chloride µg/L 0.4

Sampling event
- EPA SI
- PSDDA99
- LDW RI
- Road
- Navigation channel
- River mile

Map 4-12c. Porewater sampling data (only detected chemicals), RM 2.0 to RM 3.5
Map 4-12d. Porewater sampling data (only detected chemicals), RM 3.5 to RM 5.5

Note: Only chemicals with detected concentrations are shown (in either original or field replicate samples).
Windward Environmental LLC

Map 4-13. Exceedances of SGS and CSL criteria for all chemicals with SMS criteria in the RI baseline surface sediment dataset.
Dredging information provided by AECOM.

Windward environmental (2001)


glacier ready-mix (2001)

jghsa-sd1-comp33-00

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Surface sediment samples were collected at depths represented by circles or squares. Samples were analyzed for all SMS chemicals. These locations were later surveyed for lead concentrations. One sample within the Boeing Plant 2/Jorgensen Forge EAA had a lead concentration (1,300 mg/kg dw) greater than the CSL. However, according to data management notes (Section 9.2.2), these locations were compared instead to the LAET and 2LAET. A lead concentration (1,300 mg/kg dw) greater than the CSL was not analyzed for lead. Only locations with detected exceedances are included in the EAA boundaries. These locations are listed with exceedance format. SDS/CSL categories for all SMS chemicals at surface sediment locations:
- CSL, detect
- SQS and CSL, detect
- SQS and CSL, non-detect
- CSL, non-detect

SDS/CSL categories for PCBs at locations where only PCBs were analyzed:
- CSL, detect
- SQS and CSL, detect
- SQS and CSL, non-detect
- CSL, non-detect

Outfall classification:
- CSO
- EOD
- Public storm drain
- Pipe of untested origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale
- Early Action Area
- dredged area
- River mile
- Navigation channel

A lead concentration (1,300 mg/kg dw) greater than the CSL was not analyzed for lead. Only locations with detected exceedances are included in the EAA boundaries. These locations are listed with exceedance format.
Dredging information provided by AECOM. Wind to serve as a snapshot of outfall conditions at the time the boundary is presented in Section 9.2.2.

SQS/CSL categories for all SMS chemicals
- SMS designation based on toxicity tests
  - CSL, detect
  - CSL, non-detect
  - SQS and ≤ CSL, detect
  - SQS and ≤ CSL, non-detect
- SMS designation based on toxicity tests
  - > CSL, detect
  - > CSL, non-detect

Duwamish Yacht Club (1999)


T-117 Early Action Area

Boeing Plant Z/Jorgensen Forge Early Action Area

USACE (1990, 1992, 1999)

Map 4-14e. Chemical and toxicity test results compared to SMS criteria for baseline surface sediment sampling locations, RM 3.7 to RM 4.5
Windward Environmental

Map 4-14f. Chemical and toxicity test results compared to SMS criteria for baseline surface sediment sampling locations, RM 4.5 to RM 5.8
Map 4-15. Surface sediment sampling locations with non-detect RLs greater than SQS or CSL chemical criteria (and no detected exceedances) and locations with detected 1,2,4-trichlorobenzene, 2,4-dimethylphenol, and hexachlorobenzene

1.2,4-Trichlorobenzene
- CSL, detect
- CSL, non-detect
- SQS and s CSL, non-detect

2,4-Dimethylphenol
- SQS and CSL, detect
- SQS and CSL, non-detect

Hexachlorobenzene
- CSL, detect
- SQS and s CSL detect
- SQS and s CSL, non-detect

Other chemicals
- CSL, non-detect
- SQS and s CSL, non-detect
- Early Action Area
- Dredged and capped area
- Thin-layer placement

Outfall classification
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- CSO/storm drain
- Permitted private
- Storm drain
- Private storm drain
- Public storm drain
- Pipe of unassessed origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale
- Road
- River mile
- Navigation channel

Notes:
1. SGS and CSL, from the same value for 2,4-dimethylphenol.
2. Some of the EAA boundaries are approximate and have not been finalized by EPA.Diking a description of each EAA boundary is presented in Section 2.2.2. In each EAA, some locations were sampled before drilling, capping, and thin-layer placement. For all EAA locations in 2003 and 2005, the locations were sampled after drilling or capping. The locations in 2005 were sampled after drilling or capping and before thin-layer placement. Some locations were sampled more than once. Sampler locations marked with a small circle are thin-layer placement.

Outfall locations were identified during a USGS Seattle Tide-Tide Survey in 2003. While most of these locations were confirmed during the data collection period, some were identified through EDGAR or other relevant agency databases. These locations were marked on the map. Sampling of agency files and interviews with agency and CSO/Diker personnel determined the baseline, and the outfall was sampled. In some cases, the baseline was determined based on these additional considerations. The outfall plan is typically developed by another party.

More recent information, when available, is reflected in the 2009 descriptions in Appendix A. Multiple symbols are shown at a single location if more than one of these events were conducted; the RLs were above the SGS or CSL chemical criteria.
Map 4-16. Exceedances of SGS and CSL (chemical criteria and toxicity combined) using Thiessen polygons for the baseline surface sediment dataset.

- > CSL toxicity or > CSL chemistry if no toxicity data
- > SGS and ≤ CSL toxicity or > SGS and ≤ CSL chemistry if no toxicity data
- ≤ SGS toxicity or ≤ SGS chemistry if no toxicity data
- Outside LDW study area

*Exceedances of the SGS and CSL chemical criteria are based on detected concentrations. For chemicals whose SGS and CSL are on an organic carbon normalized basis, if the TOC was < 0.5% or > 4.0%, the dry weight concentration of that chemical was compared to the LAET and 2LAET, and exceedances of the LAET and 2LAET were equated with exceedances of the SGS and CSL, respectively.*
Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment

- **Subsurface sediment core**
  - SOS/CSL categories for all SMS chemicals at surface sediment locations:
    - > CSL, detect
    - > CSL, non-detect
    - > SOS and ≤ CSL, detect
    - > SOS and ≤ CSL, non-detect
    - ≤ SOS, detect and non-detect
    - Not analyzed

- **SQS/CSL categories for all SMS chemicals in subsurface core intervals**
  - > CSL, detect
  - > CSL, non-detect
  - > SOS and ≤ CSL, detect
  - > SOS and ≤ CSL, non-detect
  - ≤ SOS, detect and non-detect
  - Not analyzed

Exceedances of SQS and CSL in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

* When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/ECology; a description of each EAA boundary is presented in Section 9.2.2.

* Subsurface sediment data in the Duwamish/Diagonal Early Action Area were collected prior to dredging and capping or thin layer placement. In other dredged areas subsurface data were collected prior to dredging.

Note: This map does not include samples in the Duwamish/Diagonal dredged and capped area.

Map 4-17a. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 0.0 to RM 1.4
Map 4-17b. Comparisons of concentrations of total PCBs, BEHP, SVOCs, and metals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 0.0 to RM 1.4

**Total PCBs**

**BEHP**

**SVOCs (excluding BEHP)**

**Arsenic and other metals**

---

*When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.*
Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment

- Subsurface sediment core
- SQS/CSL categories for all SMS chemicals at surface sediment locations:
  - > CSL, detect
  - > CSL, non-detect
  - > SQS and ≤ CSL, detect
  - > SQS and ≤ CSL, non-detect
  - ≤ SQS, detect and non-detect
  - Not analyzed

SQS/CSL categories for all SMS chemicals in subsurface core intervals:
- Early Action Area
- Dredged area
- Navigation channel
- River mile

**Exceedances of SQS and CSL in subsurface sediment cores and co-located (within 10 ft) surface sediment samples**

Labeled values represent a surface sediment location within 10 ft of the subsurface sediment core.

**Notes:**
- When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.
- Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.
- Subsurface sediment data in dredged areas were collected prior to dredging.

**Map 4-17c. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 1.4 to RM 2.3**
### Arsenic and other metals

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<tr>
<th>Depth below mudline (ft)</th>
<th>LDW-SC28 (RM 1.4)</th>
<th>LDW-SC29 (RM 1.4)</th>
<th>SCDMMU2 (RM 1.5)</th>
<th>SCDMMU2R (RM 1.5)</th>
<th>C-1 (RM 1.5)</th>
<th>SCDMMU1 (RM 1.5)</th>
<th>SCDMMU3 (RM 1.4)</th>
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**Notes:**
- When OC-normalization was not appropriate because TOC content was ≤ 0.1% or > 45%, dry weight concentrations for these locations were reported instead to the LAET and 2LAET.
- > CSL, detected
- > CSL, non-detect
- > SQS or CSL, detected
- > SQS and ≤ CSL, non-detect
- Not analyzed

### Total PCBs

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<tr>
<th>Depth below mudline (ft)</th>
<th>LDW-SC28 (RM 1.4)</th>
<th>LDW-SC29 (RM 1.4)</th>
<th>SCDMMU2 (RM 1.5)</th>
<th>SCDMMU2R (RM 1.5)</th>
<th>C-1 (RM 1.5)</th>
<th>SCDMMU1 (RM 1.5)</th>
<th>SCDMMU3 (RM 1.4)</th>
<th>SCDMMU1 (RM 1.5)</th>
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<th>LDW-SC29 (RM 1.4)</th>
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<th>SCDMMU2R (RM 1.5)</th>
<th>C-1 (RM 1.5)</th>
<th>SCDMMU1 (RM 1.5)</th>
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### SVOCs (excluding BEHP)

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<th>LDW-SC29 (RM 1.4)</th>
<th>SCDMMU2 (RM 1.5)</th>
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**Map 4-17d. Comparisons of concentrations of total PCBs, BEHP, SVOCs, and metals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 1.4 to RM 2.3**
Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment

- Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment cores and co-located (within 10 ft) surface sediment samples

- Labeled values represent a surface sediment location within 10 ft of the subsurface sediment core.

- Core recovered to a depth of 100 ft.

- This core was collected prior to dredging at that location.

- Map 4-17e. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 2.3 to RM 3.5

- When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

- Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

- Note: This map does not include samples in the Boeing Plant 2/Jorgensen Forge Early Action Area.
Map 4-17f. Comparisons of concentrations of total PCBs, BEHP, SVOCs, and metals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 2.3 to RM 3.5

**Total PCBs**

**BEHP**

**SVOCs (excluding BEHP)**

**Arsenic and other metals**

---

SOS/CSL categories for SMS chemicals in subsurface core intervals:
- > CSL, detected
- > SQS and ≤ CSL, non-detect
- ≤ SQS, detect and non-detect
- > CSL, non-detect
- Not analyzed

*When OC-normalization was not appropriate because TOC content was < 0.5% or > 40%, dry weight concentrations for these locations were compared instead to the SQS and CSL.
Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment

Map 4-17g. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 3.5 to RM 4.3

*When OC normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment core data in dredged areas were collected prior to dredging.

Note: This map does not include samples in the Boeing Plant 2/Jorgensen Forge or T-117 Early Action Areas.

**Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment**

**Legend**

- **Subsurface sediment core**
- **SQS/CSL categories for all SMS chemicals at surface sediment locations**
  - > CSL, detect
  - > SQS and ≤ CSL, detect
  - > CSL, non-detect
  - > SQS and ≤ CSL, non-detect
  - < CSL and < SQS, detect and non-detect
  - < SQS, detect and non-detect
  - Not analyzed

**Early Action Area**

- Dredged area
- Navigation channel
- River mile

**Map 4-17g. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 3.5 to RM 4.3**

**Exceedances of SQS and CSL in subsurface sediment cores and co-located (within 10 ft) surface sediment samples**

**Labeled values represent a surface sediment location within 10 ft of the subsurface sediment core.**

**Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment**

**Dredging information provided by AECOM.**

**Note:** This map does not include samples in the Boeing Plant 2/Jorgensen Forge or T-117 Early Action Areas.
When OC-normalization was not appropriate because TOC content was
< 0.5% or > 4.0%, dry weight concentrations for these locations were
compared instead to the LAET and 2LAET.

---

Map 4-17 h. Comparisons of concentrations of
total PCBs, BEHP, SVOCs, and metals to SMS
criteria (SQS or CSL) in subsurface sediment cores, RM 3.5 to RM 4.3
Subsurface sediment core locations and exceedances of SQS and CSL (chemical criteria and toxicity combined) in surface sediment

- **Subsurface sediment core**
  - SQS/CSL categories for all SMS chemicals at surface sediment locations:
    - > CSL, detect
    - > CSL, non-detect
    - > SQS and ≤ CSL, detect
    - > SQS and ≤ CSL, non-detect
    - ≤ SQS, detect and non-detect
    - ≤ SQS, detect and non-detect

- **Surficial sediment**
  - Early Action Area
  - Navigation channel
  - River mile

---

**Exceedances of SQS and CSL in subsurface sediment cores and co-located (within 10 ft) surface sediment samples**

Labeled values represent a surface sediment location within 10 ft of the subsurface sediment core.

---

*When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.*

*Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.*

*Subsurface data in the Norfolk Early Action Area were collected prior to dredging and capping. In other dredged areas, subsurface data were collected prior to dredging.*

---

Map 4-17l. Comparisons of concentrations of all SMS chemicals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 4.3 to RM 5.0
Map 4-17j. Comparisons of concentrations of total PCBs, BEHP, SVOCs, and metals to SMS criteria (SQS or CSL) in subsurface sediment cores, RM 4.5 to RM 5.0
Total PCB concentration (μg/kg dw)²
- 4,300
- > 390 and ≤ 4,300
- > 140 and ≤ 390
- > 58 and ≤ 140
- > 58
- Non-detect

For the Duwamish/Diagonal early action area, surface sediment data in the Duwamish River and Norfolk Slips 1-4 were collected during pre-dredging surveys collected after the Duwamish River Naval Shipyard (Duwamish River Channel north of the slip) and Norfolk (Norfolk CG) channel south storm drain were inlet and capping at the Duwamish River Channel north storm drain.

The Duwamish River Channel north early action area was identified during pre-dredging surveys collected after the Duwamish River Naval Shipyard (Duwamish River Channel north of the slip) and Norfolk (Norfolk CG) channel south storm drain were inlet and capping at the Duwamish River Channel north storm drain.

The Duwamish River Channel north early action area was identified during pre-dredging surveys collected after the Duwamish River Naval Shipyard (Duwamish River Channel north of the slip) and Norfolk (Norfolk CG) channel south storm drain were inlet and capping at the Duwamish River Channel north storm drain.

Map 4-18. Total PCB concentrations in surface sediment

Scale is the same for each inset map
Interpolated total PCB concentration (µg/kg dw)

- > 810
- > 210 and ≤ 810
- > 110 and ≤ 210
- > 48 and ≤ 110
- ≤ 48

<table>
<thead>
<tr>
<th>Early Action Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation channel</td>
</tr>
<tr>
<td>River mile</td>
</tr>
</tbody>
</table>

1. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 810 µg/kg dw). Total PCBs represent the sum of the concentrations of all detected Aroclors. For locations with non-detects for all individual Aroclors, a value equal to the highest RL of an individual Aroclor at that location was used.

2. Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2. For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk Early Action Area, surface sediment data are based on samples collected in 1999 and before sediment removal and capping at the Boeing Development Center south storm drain in 2003.
More recent information, when available, is reflected in the outfall discussions by LDWG members; some additional outfall locations were identified during additional outfall-specific information. Some locations were field-verified by (NPDES) permit files and other relevant agency databases. These locations compared instead to the LAET and 2LAET.

For the Duwamish/Diagonal Early Action Area, surface sediment data in 2003 (Herrera 2004). Some locations were initially identified using drainage compared to the LAET.

When OC-normalization was not appropriate because TOC content was ≤ 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 4.2.2.

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represented samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk, Alki, and Early Action Areas, surface sediment data represents samples collected after dredging and capping. Consequently, surface sediment data is not directly comparable to the previously collected and capping at the Boeing Development Center south storm drain in 2005.

Outfalls shown were identified during a City of Seattle low-ride survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later confirmed in the field. Review of agency files and interviews with LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a tool for data collection and verification at the time of risk assessment. The final accuracy of the layer of outfall data is dependent upon its use in future studies of the study area. This dataset provides recent information when available, is reflected in the outfall discussions in Appendices.

**Map 4.20. Exceedances of SMS criteria (SOx or CSL) for total PCBs in surface sediment**

**SOS/CSL categories for total PCBs**
- CSCL detect
- SGS and ≤ CSL detect
- ≤ SGS, detect and non-detect
- Early Action Area
- Dredged and capped area
- Thin-layer placement
- Road
- Navigation channel
- River mile

**Outfall classification**
- CSO
- storm drain
- EOF
- EOF/CSO storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

When OC-normalization was not appropriate because TOC content was ≤ 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.
Map 4-21. PCB TEQ values in surface sediment

- Outfall classification:
  - CSO
  - CSOd/storm drain
  - EOF
  - EOF/storm drain
  - Permitted private storm drain
  - Private storm drain
  - Public storm drain
  - Pipe of unresolved origin and/or use
  - Abandoned
  - Not an outfall
  - Stream, channel, or swale
  - Road
  - Navigation channel
  - River mile

- Some of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

- Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. TEQs were calculated with mammalian TEFs for individual PCB congeners (Van den Berg et al. 2006), using one-half the FL for undetected congeners.

- For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk Early Action Area, surface sediment data in the baseline dataset represent samples collected before thin-layer capping and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

- Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Stemmer 2003). Some locations were initially identified using data from the Local Enhanced Water Quality System (LPWQS) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWGW) personnel provided additional outfall-specific information. Some locations were field-verified by LDWGW members; some additional outfall locations were identified during these subsequent verifications.

- When available, is reflected in the outfall discussions in Appendix I.
Map 4-22. Differences in total PCB concentrations in surface sediment at locations that have been resampled

A location was considered to have been resampled if the new location was within 10 ft of the old location.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.C.

Outfalls shown were identified during a City of Seattle low-tide survey in 1993 (Wright et al. 2000). Some locations were likely identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later reviewed in the field. Review of agency files and interviews with various city and county agency personnel were used to verify locations. Each location was then plotted using Geographic Information Systems equipment. Locations known to be unconsolidated were not plotted. Locations along Lower Duwamish Waterway Group (LDWG) mornings; some additional outfall locations were identified during these subsequent verifications. The qualitative layer is meant to serve as a qualitative indication of the presence and location of outfalls. Refer to Chapter 3 for more specific information on the data sources.

Appendix I, the Norfolk removal.
Total PCB concentration ([µg/kg dw])

- 95th percentile = 13,000
- 75th percentile = 3,100
- 50th percentile = 620
- 25th percentile = 200

- > 13,000
- > 3,100 and ≤ 13,000
- > 620 and ≤ 3,100
- > 200 and ≤ 620
- ≤ 200

**Event Name**
- Landau (1990)
- Boeing SiteChar (1997)
- NOAA SiteChar (1997)
- EPA SI (1998)
- Slip4-EarlyAction (2004)

**Outfall classification**
- EOF
- EOF/storm drain
- Permitted private storm drain
- Public storm drain
- Tax parcel
- Road

**Insufficient data for interpolation**

**Slip4-Early action area**

**Crowley dredged area (1996)**

**Areas evaluated in Section 4.2.3.1**

---

* Percentiles were calculated on a numerical basis for the Slip 4 area using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects for all elements, a value equal to the highest Rr of an individual element at that location was used.

* Area with insufficient data was estimated visually based on density of existing data points.

* Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time of the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.

* Tax parcel information was provided in 2008 by Seattle Public Utilities and King County. Some tax parcel polygons were edited to conform to the LDW shoreline presentation. A comprehensive survey of property-owner records was not conducted.

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Grain size category
- Gravel
- Sand
- Silt
- Clay

Because of the inherent imprecision in measuring each grain size category using multiple sieves, it is common for the calculated total of all size categories to range between 90% and 110% for any given sample.

Outfall classification:
- CSO/storm drain
- EOF
- Permitted private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale
- Tax parcel

Navigation channel
- WWTP - wastewater treatment plant
- (Sampling location)

Map 4-24. Surface sediment data at Duwamish/Diagonal perimeter monitoring locations

The data shown were identified during a survey of Port facilities (see text). In 2000 (Herrera 2000), some locations were initially described as waste-water-related CSO storms using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later reported in the Final Report of Agency files and interviews with agency and Lower Duwamish Waterway Group (LDW) personnel provided additional specific information. Some locations were later verified by field work, some additional outfall sections were identified during these subsequent verifications. The outfall shown is meant to serve as a snapshot of outfall conditions at the time the survey was completed (2000). More recent information, when available, is reflected in the outfall discussions in Appendix.

Some parcel information was provided in 2000 by Seattle Public Utilities and King County. Some tax parcel programs were unable to produce data for the 100-foot channel presentation. A comprehensive survey of property owner records was not undertaken.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Total PCB concentration (μg/g dw)

- > 4,300
- > 390 and ≤ 4,300
- > 140 and ≤ 390
- > 58 and ≤ 140
- ≤ 58
- Non-detect

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. Total PCBs represent the sum of the concentrations of all detected Aroclors. For locations with non-detects for all Aroclors, a value equal to the highest RL of an individual Aroclor at that location was used.

Not analyzed in that sampling interval

Other subsurface sampling location analyzed for total PCBs, but not in the illustrated sampling interval

Surveyed area

Prepared by CEH, 07/14/2010; MAP 2804; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\PCBs

Dredging information provided by AECOM.

Map 4-25a. Total PCB concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8
Subsurface core locations with 2-to-4-ft sampling intervals

Sampling interval

<table>
<thead>
<tr>
<th>Area</th>
<th>Left panel</th>
<th>Middle panel</th>
<th>Right panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-to-2 ft</td>
<td>0-to-1 ft</td>
<td>2-to-4 ft</td>
<td>4-to-6 ft</td>
</tr>
<tr>
<td>0-to-1 ft</td>
<td>2-to-3 ft</td>
<td>4-to-5 ft</td>
<td>5-to-6 ft</td>
</tr>
</tbody>
</table>

Other subsurface sampling location analyzed
- for total PCBs, but not in the illustrated sampling interval
- Early Action Area
- Dredged area

- Road
- Navigation channel
- River mile

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sampling, an assumption of normal distribution of all detected Aroclors. For locations with non-detects for all Aroclors, a value equal to the highest FL of an individual Aroclor at that location was used.

Data from 2-foot sampling intervals: some locations show an average of data from both 1-foot intervals within that 2-foot interval.

Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

Several of the EAA boundaries are approximate and have not been finalized by SHC/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-25b. Total PCB concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7
Total PCB concentration (µg/kg dw)
- > 4,300
- > 390 and ≤ 4,300
- > 140 and ≤ 390
- > 58 and ≤ 140
- ≤ 58
- Non-detected

Percentile = 4,300
95th percentile = 4,300
75th percentile = 390
50th percentile = 140
25th percentile = 58

Not analyzed in that sampling interval
Other subsurface sampling location analyzed:
- for total PCBs, but not in the illustrated sampling interval:
  - Early Action Area
  - Dredged area
  - Dredged and capped area

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface samples for each Aroclor at that location. A value equal to the highest value of an individual Aroclor at that location was used.

Data from 2-foot sampling intervals; some locations show an average of data from both 1-foot intervals within the 2-foot interval. Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface core locations with 0-to-2-ft sampling intervals
Subsurface core locations with 2-to-4-ft sampling intervals
Subsurface core locations with 4-to-6-ft sampling intervals

Map 4-25c. Total PCB concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0

Prepared by CEH, 07/14/2010; MAP 2804; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\PCBs

Dredging information provided by AECOM.
Dredging information provided by AECOM.

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in the baseline dataset represent samples collected prior to dredging.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Interpolated total PCB concentrations (µg/kg dw) in surface sediments

Interpolated total PCB concentration (µg/kg dw) in surface sediment

- 95th percentile = 810
- 75th percentile = 210
- 50th percentile = 110
- 25th percentile = 46
- ≤ 210 and ≤ 810
- > 110 and ≤ 210
- > 48 and ≤ 110
- > 810
- Non-detected
- Not analyzed

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Map 4-26a. Total PCB concentrations in surface sediment and subsurface sediment cores, RM 0.0 to RM 1.0
Interpolated total PCB concentrations (µg/kg dw) in surface sediments

- Subsurface sediment core SQS/CSL categories for total PCB concentration (mg/kg OC) in surface sediment
  - SQS = 12
  - CSL = 65
  - > CSL, detect
  - > SQS and s CSL, detect
  - s SQS, detect
  - s SQS, non-detect
  - Dredged area
  - River mile
  - Navigation channel

Interpolated total PCB concentration (µg/kg dw) in surface sediment
- 95th percentile = 810
- 75th percentile = 210
- 50th percentile = 48
- 25th percentile = 110
- 10th percentile = 48
- 5th percentile = 110
- 0th percentile = 48
- Not analyzed

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Map 4-26b. Total PCB concentrations in surface sediment and subsurface sediment cores, RM 1.0 to RM 2.2
Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

** Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Interpolated total PCB concentrations (µg/kg dw) in surface sediments

- Subsurface sediment core
- SQS/CSL categories for total PCB concentration (mg/kg OC)
- In surface sediment

<table>
<thead>
<tr>
<th>Interpolated total PCB concentration (µg/kg dw) in surface sediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th percentile = 810</td>
</tr>
<tr>
<td>75th percentile = 210</td>
</tr>
<tr>
<td>50th percentile = 110</td>
</tr>
<tr>
<td>25th percentile = 48</td>
</tr>
<tr>
<td>≤ 810</td>
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<tr>
<td>&gt; 210 and ≤ 810</td>
</tr>
<tr>
<td>&gt; 110 and ≤ 210</td>
</tr>
<tr>
<td>&gt; 48 and ≤ 110</td>
</tr>
<tr>
<td>&gt; 48</td>
</tr>
<tr>
<td>Non-detect</td>
</tr>
<tr>
<td>Not analyzed</td>
</tr>
</tbody>
</table>

Interpolated total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Interpolated values less than or equal to that concentration (e.g., the 95th percentile). For locations with non-detects for all individual Analyses, a value equal to the highest TL of an individual Analysis that that location used. Interpolated surface does not show non-detects.

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

Map 4-25c. Total PCB concentrations in surface sediment and subsurface sediment cores, RM 2.2 to RM 3.0
1. Subsurface sediment core
   SQS/CSL categories for total PCB concentration (mg/kg OC)
   in surface sediment
   SQS = 12
   CSL = 65
   X > CSL, detect
   = SQS and ≤ CSL, detect
   ≤ SQS, non-detect
   Early Action Area
   River mile
   Navigation channel

2. Interpolated total PCB concentration (µg/kg dw) in surface sediment
   90th percentile = 810
   75th percentile = 210
   50th percentile = 48
   ≤ 810
   > 810
   ≤ 210 and ≤ 810
   > 210 and ≤ 810
   ≤ 110 and ≤ 210
   > 110 and ≤ 210
   ≤ 48
   > 48
   Non-detect
   Not analyzed

3. Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

4. Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

5. Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 50th percentile is the concentration at which 50% of the LDW area has interpolated concentrations ≤ 810 µg/kg dw). Total PCBs represent the sum of the concentrations of all detected Arsenic. For locations with non-detects for all individual Arsenics, a value equal to the highest TL of an individual Arsenic at that location was used. Interpolated surface does not show non-detects.

6. Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core. Other cores with no co-located surface sediment grab samples show the NAW concentration at the core location.
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Interpolated values less than or equal to that concentration (e.g., the 95th percentile). For locations with non-detects for all individual Aroclors, a value equal to the highest RL of an individual Aroclor at that location was used. Interpolated surface does not show non-detects.

Interpolated total PCB concentrations (µg/kg dw) in surface sediments

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Locations in the Boeing Plant 2/Jorgensen Forge Early Action Area

Map 4-26e. Total PCB concentrations in surface sediment and subsurface sediment cores from the Boeing Plant 2/Jorgensen Forge Early Action Area, RM 3.0 to RM 3.3
Boeing Plant 2/
Jorgensen Forge
Early Action Area

Interpolated total PCB concentrations (µg/kg dw) in surface sediments

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Locations in the Boeing Plant 2/Jorgensen Forge Early Action Area

Map 4-26f. Total PCB concentrations in surface sediment and subsurface sediment cores from the Boeing Plant 2/Jorgensen Forge Early Action Area, RM 3.5 to RM 3.7
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

c. Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Interpolated total PCB concentrations (µg/kg dw) in surface sediments

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Subsurface sediment data are represented by a horizontal line with a value above it representing the concentration in the subsurface sediment. In some cases, data are presented as two values (e.g., 810 ≤, > 210). The symbol ≤ is used to represent concentrations equal to or less than the given value (e.g., ≤ 810) and ≥ is used to represent concentrations equal to or greater than the given value (e.g., ≥ 210). The symbol > 810 indicates concentrations greater than 810 µg/kg.

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labelled values represent surface sediment grab samples located within 10 ft of the subsurface sediment core. Other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.
Interpolated total PCB concentrations (µg/kg dw) in surface sediments

- Subsurface sediment core
- SPS/SCL categories for total PCB concentration (µg/kg OC) in surface sediment
  - SPS = 12
  - CSL = 65
  - > CSL, detect
  - > SPS and ≤ CSL, detect
  - ≤ SPS, detect
  - ≤ SPS, non-detect
- Early action area
- Dredged area
- River mile
- Navigation channel

Interpolated total PCB concentration (µg/kg dw) in surface sediments:
- 95th percentile = 810 µg/kg dw
- 75th percentile = 210 µg/kg dw
- 50th percentile = 110 µg/kg dw
- > 810 µg/kg dw
- > 110 and ≤ 810 µg/kg dw
- > 48 and ≤ 110 µg/kg dw
- ≤ 48 µg/kg dw
- Non-detect
- Not analyzed

For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Early Action Area.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Total PCB concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the N/A concentration at the core location.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.
* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated values ≤ 810 µg/kg dw). Total PCBs represent the sum of the concentrations of all detected Analogs. For locations with non-detects for all detected Analogs, a value equal to the highest RL of an individual Analog at that location was used. Vented surface does not show non-detects.
For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.

Mapping:

- **SOS/CSL categories for total PCB concentration (µg/kg OC) in surface sediment:**
  - SOS = 12
  - CSL = 65
  - > CSL, detect
  - > SOS and ≤ CSL, detect
  - ≤ SOS, detect
  - ≤ SOS, non-detect

- **Interpolated total PCB concentration (µg/kg dw) in surface sediment:**
  - 95th percentile = 810
  - 75th percentile = 210
  - 50th percentile = 110
  - 25th percentile = 48

- **Dredging information provided by AECOM.**

- **Co-located (within 10 ft) surface sediment data**

*When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 3LAET.*

*Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 810 µg/kg dw). Total PCBs represent the sum of the concentrations of all detected Arcticns. For locations with non-detects for all individual Arcticns, a value equal to the highest FC of an individual Arcticn at that location was used. Interpolated surface does not show non-detected.*

*Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.*

*For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.*
Total PCB concentrations (µg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data

- Subsurface sediment core
  - SQS/CSL categories for total PCB concentration (mg/kg OC) in surface sediment:
    - SQS = 12
    - CSL = 65
    - > CSL, detect
    - > SQS and ≤ CSL, detect
    - ≤ SQS, detect
    - ≤ SQS, non-detect

- Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated concentrations.
- When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

- Total PCB concentrations (µg/kg dw) in surface sediments:
  - 95th percentile = 810
  - 75th percentile = 210
  - 50th percentile = 110
  - 25th percentile = 48

- Interpolated total PCB concentration (µg/kg dw) in surface sediments:
  - > 810
  - > 210 and ≤ 810
  - > 110 and ≤ 210
  - > 48 and ≤ 110
  - ≤ 48
  - Non-detect
  - Not analyzed

*When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

*Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to the concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 810 µg/kg dw). Total PCBs represent the sum of the concentrations of all detected Aroclors.

*Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

*For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south arm of the River in 2003. Subsurface sediment data in dredged areas were collected prior to dredging.

Map 4-27b. Comparison of PCB concentrations in subsurface cores to co-located surface sediment locations, RM 2.5 to RM 5.0
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**Map Legend**

- Interpolated total PCB concentration (μg/kg dw) in surface sediment:
  - > 810
  - 210 and ≤ 810
  - 110 and ≤ 210
  - 48 and ≤ 110
  - ≤ 48
- Co-located benthic invertebrate and sediment sampling location (2004)
- Co-located softshell clam and sediment sampling location (2004)
- Co-located softshell clam and sediment sampling location (2007)
- Tissue sampling area
- Navigation channel
- River mile

**SWAC = 320 μg/kg dw**

**SWAC = 300 μg/kg dw**

**SWAC = 1,200 μg/kg dw**

**SWAC = 170 μg/kg dw**

**Graph Legend**

- 2004 fish or crab PCB concentration
- 2005 fish or crab PCB concentration
- 2006 fish or crab PCB concentration
- 2007 fish or crab PCB concentration
- 2004 softshell clam, benthic invertebrate, or salmon PCB concentration
- 2007 softshell clam PCB concentration
- 2004 co-located PCB concentration in sediment

**Acronyms for species and tissue type**

- DC: Dungeness crab
- SC: Slender crab
- ES: English sole
- PS: Pacific staghorn scuplin
- SS: Shiner surfperch
- EM: Edible meal
- FL: Fillet with skin
- HP: Hepatopancreas
- WB: Whole body

**Species and Tissue Types**

<table>
<thead>
<tr>
<th>Species and Tissue Type</th>
<th>DC</th>
<th>SC</th>
<th>ES</th>
<th>PS</th>
<th>SS</th>
<th>EM</th>
<th>FL</th>
<th>HP</th>
<th>WB</th>
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<tr>
<td>Hepatopancreas</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingestive organs</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Whole body</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

**Note:** There are no data for DC, SC, EM or B2a in 2004, EM, DC, or DC in 2005, or EM or DC in 2006.

**Note:** There are no data for any tissue types in 2006 or for PS or WB in 2003.

**Note:** There are no data for any tissue types in 2006, for SC, HP, or WB in 2005, or PS or WB in 2007.

**Note:** There are no data for any tissue types in 2006, for SC, HP, or WB in 2007, or PS or WB in 2007. 4.28.2022 06:43:30 AM

**Map 4-28. Total PCB concentrations in composite tissue samples from 2004, 2005, 2006, and 2007 and the IDW interpolation of total PCB concentrations in surface sediment**
Arsenic concentration (mg/kg dw)*

- > 30
- > 15 and ≤ 30
- > 11 and ≤ 15
- > 7.9 and ≤ 11
- > 1.2 and ≤ 7.9
- Non-detect

Exceedance

- > CSL
- > SGS and ≤ CSL
- SGS

Early Action Area

- Dredged and capped area
- Thin-layer placement
- Road
- Navigation channel
- River mile

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For baseline with non-detects, a value of one-half the RL at that location was used.

** Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 3.2.2.

** For the Duwamish/Diagonal Early Action Areas, surface sediment data in the baseline dataset represent territories collected before drilling or thin-layer capping; thin-layer capping is 2003 to 2005. No baseline surface sediment data are available after Advance work surface sampling, thinned-layer sampling, or stone removal in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Gillman 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Additional locations were identified during this project, through discussions with agency and Lower Duwamish Watershed Group participants, and during site visits.

Some locations were field-verified by LDWGS members; some additional outfall locations were identified during these subsequent verifications, but these were not confirmed during this project.

If you have any questions or need further information, please contact the LDWGS at 206-788-0918. More recent information is available in the outfall atlas at http://www.gsws.wa.gov/factsheetsl.htm.

When available, is reflected in the outfall discussions in Appendix I.

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when available, is reflected in the outfall discussions in Appendix I.

when available, is reflected in the outfall discussions in Appendix I.
Map 4-30. IDW interpolation of arsenic concentrations in surface sediment

**Arsenic concentration (mg/kg dw)**

- > 25
- > 14 and ≤ 25
- > 11 and ≤ 14
- > 8.6 and ≤ 11
- ≤ 8.6

**SQS/CSL categories for arsenic**

- CSL
- SQS and ≤ CSL
- ≤ SQS

**Early Action Area**

- Road
- Navigation channel
- River mile

*Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LWQ area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LWQ area has interpolated concentrations less than or equal to that concentration)*. Interpolated concentrations were calculated using IDW. For each site, the Arsenic baseline was determined by calculating a median of all samples collected from that site before dredging and capping.

*Several of the EAA boundaries are approximate and have not been published. IDW methodology is described in Section 9.2. For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represents samples collected before dredging, capping, or thin-layer capping in 2003 to 2005.*

*For the Norfolk Early Action Area, surface sediment data is from surface sediments collected in 1999.*

*For the Norfolk Early Action Area, the upper Turning Basin samples collected in 1999 have been updated to reflect the final sediment profile resulting from the Norfolk Basin 2001 sediment capping report.*

*The Boeing Development Center south storm drain samples collected in 2003.*

Scale is the same for each inset map.
A location was considered to have been resampled if the new location was within 10 ft of the old location.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Outfall classification:
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale
- Road
- Navigation channel
- River mile

Map 4-31. Differences in arsenic concentrations in surface sediment at locations that have been resampled.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Arsenic concentration (mg/kg dry wt)

- > 30
- > 15 and ≤ 30
- > 11 and ≤ 15
- > 7.9 and ≤ 11
- ≤ 7.9
- Non-detected

Sampling interval

- 0-to-2-ft
- 2-to-4-ft
- 4-to-6-ft

- 0-to-1-ft
- 1-to-2-ft
- 2-to-3-ft
- 3-to-4-ft
- 4-to-5-ft
- 5-to-6-ft

- Early Action Area
- Dredged area
- Dredged and capped area
- Dredged and thin-layer placement
- Thin-layer placement
- Road
- Navigation channel
- River mile

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

Arsenic concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8

Map 4-32a. Arsenic concentrations in subsurface sediment within the Early Action Area, 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8
**Subsurface core locations**

- **0-to-2-ft sampling intervals**
- **2-to-4-ft sampling intervals**
- **4-to-6-ft sampling intervals**

**Arsenic concentration (mg/kg dw)**

- > 20
- > 15 and ≤ 30
- > 11 and ≤ 15
- > 7.9 and ≤ 11
- > 3.7
- > 0.9
- Non-detect

**Sampling interval**

- **Left panel**
  - 0-to-1-ft
  - 1-to-2-ft
- **Middle panel**
  - 2-to-3-ft
  - 3-to-4-ft
- **Right panel**
  - 4-to-5-ft
  - 5-to-6-ft

**Other subsurface sampling location**

- Analysis for arsenic, but not in the illustrated sampling intervals

**Percentiles were calculated on a numerical basis using both sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.**

**Data from 2-foot sampling intervals:** Some locations show an average of data from both 1-foot intervals within the 2-foot interval. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

**Subsurface sediment data at locations in dredged areas were collected prior to dredging.**

---

Map 4-32b. Arsenic concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7
OAA 20022h)
Arsenic concentration (mg/kg dw)

- > 30
- > 15 and ≤ 30
- > 11 and ≤ 15
- > 7.9 and ≤ 11
- ≤ 7.9

Non-detected
Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Generalized map showing arsenic concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0

Sample core locations with 0-to-2-ft sampling intervals

Sample core locations with 2-to-4-ft sampling intervals

Sample core locations with 4-to-6-ft sampling intervals

Map 4.32c. Arsenic concentrations in subsurface sediment: RM 3.7 to RM 6.0

Prepared by CEH, 07/15/2010; MAP 2813; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\Arsenic
Dredging information provided by AECOM.
For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Interpolated arsenic concentrations (mg/kg dw) in surface sediments were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used. Interpolated surface does not show non-detects.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

% 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Arsenic concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Map 4-33a. Arsenic concentrations in surface sediment and subsurface sediment cores, RM 0.0 to RM 1.0
Interpolated arsenic concentrations (mg/kg dw) in surface sediments

Interpolated arsenic concentrations (mg/kg dw) in surface sediment
Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile = 25 mg/kg dw).

Arsenic concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples
Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

Subsurface sediment core
SGS/CSL categories for arsenic concentration (mg/kg dw) in surface sediment
- > CSL, detect
- > SGS and ≤ CSL, detect
- ≤ SGS, detect
- ≤ SGS, non-detect

Dredged area
- River mile
- Navigation channel

* Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile = 25 mg/kg dw).

Interpolated concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used. Interpolated surface does not show non-detects.

Arsenic concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples
Labelled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

Locations west of the navigation channel
Locations in the navigation channel
Locations east of the navigation channel

* This core was collected prior to dredging at this location.

Map 4-33b. Arsenic concentrations in surface sediment and subsurface sediment cores, RM 1.0 to RM 2.2
Interpolated arsenic concentrations (mg/kg dw) in surface sediments

**Subsurface core**
- Subsurface core
- S5/S6 categories for arsenic concentration (mg/kg dw) in surface sediment
  - SQS = 57
  - CSL = 93
  - > CSL, detect
  - > SQS and ≤ CSL, detect
  - ≤ SQS, detect
  - ≤ SQS, non-detect

**Early Action Area**
- Early Action Area
- Not analyzed
- Non-detect
- ≤ 25
- > 25 and ≤ 50
- > 50 and ≤ 11
- > 11 and ≤ 14
- > 14 and ≤ 25

**Navigation channel**
- River mile

**Locations**
- Locations west of the navigation channel
- Locations in the navigation channel
- Locations east of the navigation channel

- This core was collected prior to dredging at this location.

**Arrest concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples**

- Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

**Map 4-33c. Arsenic concentrations in surface sediment and subsurface sediment cores, RM 2.2 to RM 3.0**

**Legend**
- Interpolated arsenic concentration (mg/kg dw) in surface sediment
  - 95th percentile = 25
  - 75th percentile = 14
  - 50th percentile = 11
  - 25th percentile = 8.6
  - > 25
  - > 14 and ≤ 25
  - > 11 and ≤ 14
  - > 8.6 and ≤ 11
  - > 5.7 and ≤ 11
  - > 3.5 and ≤ 11
  - > 1.7 and ≤ 11
  - Non-detect
  - Not analyzed

**Windward Environmental LLC**
Interpolated arsenic concentrations (mg/kg dw) in surface sediments

Arsenic concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

- Subsurface sediment core
- Interpolated arsenic concentration (mg/kg dw) in surface sediment
- CSL = 93
  - > CSL, detect
  - > SOS and ≤ CSL, detect
  - ≤ SOS, detect
  - ≤ SOS, non-detect
- Early Action Area
- Dredged area
- River mile
- Navigation channel

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Interpolated arsenic concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile = 25). Percentiles were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used. Interpolated surface does not show non-detects.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at that core location.

Locations west of the navigation channel
- Core recovered to a depth of 100 ft but not analyzed for arsenic below 10 ft.

Locations in the navigation channel

Locations east of the navigation channel
- Core recovered to a depth of 100 ft but not analyzed for arsenic below 10 ft.

Locations in the Boeing Plant 2/ Jorgensen Forge Early Action Area

Locations in the T-117 Early Action Area

Map 4-33d. Arsenic concentrations in surface sediment and subsurface sediment cores, RM 3.0 to RM 4.0
For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003. Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Arsenic concentrations (mg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003. Subsurface sediment data at locations in dredged areas were collected prior to dredging.

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 25th percentile is the concentration at which 25% of the LDW area has interpolated concentrations ≤ 25 mg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used. Interpolated surface does not show non-detects.

** At the Norfolk EAA, surface sediment data, which were collected after the removal action at the Norfolk CSO/SD area in 1999 but before the removal action at the BDC south storm drain outfall area in 2003, do not reflect conditions at the time subsurface cores were collected in 1999.

Map 4-33e. Arsenic concentrations in surface sediment and subsurface sediment cores, RM 4.0 to RM 5.0
For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.

When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

Interpolated arsenic concentrations (mg/kg dw) in surface sediment:
- 95th percentile = 25
- 75th percentile = 14
- 50th percentile = 11
- 25th percentile = 8.6

For locations with non-detects, a value of one-half the RL at that location was used.

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.
Arsenic concentrations (mg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data

- Subsurface sediment core SQS/CSL categories for arsenic concentration (mg/kg dw) in surface sediment:
  - SQS = 57
  - CSL = 93
  - > CSL, detect
  - ≤ SQS and ≤ CSL, detect
  - ≤ SQS, non-detect

Interpolated arsenic concentration (mg/kg dw) in surface sediment:
- 95th percentile = 25
- 75th percentile = 14
- 50th percentile = 11
- 25th percentile = 8.6

- > 25
- > 14 and ≤ 25
- > 11 and ≤ 14
- > 8 and ≤ 11
- ≤ 8.6
- Non-detect
- Not analyzed

Subsurface sediment core data were collected after finalization of the dredging operations. Subsurface sediment data in dredged areas were collected prior to dredging.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Northern boundary

Map 4-34b. Comparison of arsenic concentrations in subsurface cores to co-located surface sediment locations, RM 2.5 to RM 5.0

*When OC-normalization was not appropriate because TDC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 25 mg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. For locations with non-detected, a value of one-half the RL at that location was used.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2005. Subsurface sediment data in dredged areas were collected prior to dredging.
Seep sampling event Outfall classification
Boeing Plant 2 CSO
Great Western CSO/storm drain
LDW RI EOF
Rhône-Poulenc EOF/storm drain
T-117 Permitted storm drain
Boeing Issacson Private storm drain
Navigation channel Public storm drain
River mile Pipe of unresolved origin and/or use
Abandoned Not an outfall
Stream, channel, or swale

Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Hermes 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.
Map 4-37. cPAH concentrations in surface sediment

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PPARs for sixteen individual PAH compounds (California EPA 1994), using one-half the RI for undetected compounds.

1. Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PPARs for sixteen individual PAH compounds (California EPA 1994), using one-half the RI for undetected compounds.

2. Several of the EIA boundaries are approximate and have not been finalized by EPA/ECotrust; a description of each EIA boundary is presented in Section 9.2.2.

3. For the Duwamish/Duane Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk Early Action Area, surface sediment data for the Boeing Plant 2/General Forge area represent samples collected before dredging and capping at the Norfolk C50 removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

4. Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Henderson 2003). Some locations were initially identified using the sewer inspection database, the Storm Drain Interactive Database (SDID), and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Watershed Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. As of the time the survey was completed (2003), the actual condition of the outfall(s) may or may not have been the same as displayed on the map. More recent information, when available, is reflected in the outfall discussions in Appendix I.
Map 4-38. IDW interpolation of cPAH concentrations in surface sediment

Carcinogenic PAH concentration (µg/kg dw)

- > 1,100
- > 460 and ≤ 1,100
- > 260 and ≤ 460
- > 130 and ≤ 260
- ≤ 130

Early Action Area

Navigation channel

River mile

- 95th percentile = 1,100
- 75th percentile = 460
- 50th percentile = 260
- 25th percentile = 130

Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area had interpolated concentrations less than or equal to that concentration. For example, the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations less than or equal to 1,100 µg/kg dw. Interpolated concentrations were calculated including locations with non-detected values. cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA is presented in Section 9.2.2. For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer capping in 2003 to 2005. For the Norfolk Early Action Area, surface sediment data represent samples collected before dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.
Difference in cPAH concentrations (µg/kg dw)\textsuperscript{a}  
New value minus old value  
\begin{itemize}  
  \item ≤ -1,000  
  \item -1,000 and ≤ -500  
  \item > -500 and ≤ -100  
  \item > -100 and ≤ 0  
  \item > 0 and ≤ 100  
  \item > 100 and ≤ 500  
  \item > 500 and ≤ 1,000  
  \item > 1,000  
\end{itemize}  
\textsuperscript{a}\textsuperscript{a} A location was considered to have been resampled if the new location was within 10 ft of the old location. TEQs were calculated with mammalian PIFs or seven individual PAH compounds (California EPA 1994), using inter-habitat unit conversion factors.  
\textsuperscript{b} Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.  
\textsuperscript{c} Outfall classification  
- CSO  
- CSO/storm drain  
- EOF  
- EOF/storm drain  
- Permitted private storm drain  
- Private storm drain  
- Public storm drain  
- Pipe of unresolved origin and/or use  
- Abandoned  
- Not an outfall  
- Stream, channel, or swale  
- Road  
- Navigation channel  

Map 4-39. Differences in cPAH concentrations in surface sediment at locations that have been resampled

\textsuperscript{c} Outfalls shown were identified during a City of Seattle low-tide survey in 2002 (Kheman 2004). Some locations were indirectly identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Thanks to Bobby Cluck, Kyle Casey, and other Seattle Bureau of Utilities staff for their assistance with agency and Lower Duwamish Watershed Group (LDWG) personnel providing additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during Phase 1 sampling. Several locations were removed during Phase 2 to reflect updated legal descriptions. The table below reflects locations not sampled in Phase 1 or Phase 3 and reflects newly re-identified locations in Phase 2. More recent information, when available, is reflected in the outfall boundaries in Appendix A.

Note: Samples collected in the Duwamish/Diagonal and Norfolk EAAs were not included in this evaluation.
Subsurface core locations with 4-to-6-ft sampling intervals

---

### Percentile Calculations

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. cPAH concentrations are based on benzo(a)pyrene equivalents. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the ML for undetected compounds.

### Sampling Intervals

- **0-to-2-ft**: 4-to-6-ft
- **0-to-1-ft**: 2-to-3-ft, 4-to-5-ft, 5-to-6-ft
- **1-to-2-ft**: 3-to-4-ft, 4-to-5-ft

Other subsurface sampling location analyzed:
- Early Action Area
- Dredged area
- Dredged and capped area
- Dredged and thin-layer placement
- Thin-layer placement
- Navigation channel
- River mile

---

### Map 4-40a. cPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8

---

Dredging information provided by AECOM.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

cPAH concentration (µg/kg dwf)

- > 1.500 95th percentile = 1,500
- > 540 and ≤ 1,500 75th percentile = 540
- > 260 and ≤ 540 50th percentile = 260
- > 100 and ≤ 260 25th percentile = 100
- ≤ 100 Non-detected

Sampling interval

- 0-to-2-ft
- 2-to-4-ft
- 4-to-6-ft

Not analyzed in that sampling interval

Other subsurface sampling location analyzed
- for cPAH, but not in the illustrated sampling intervals

Map 4-00b. cPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7

Prepared by CEH, 07/15/2010; MAP 2812; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\Other COCs

Dredging information provided by AECOM.
cPAH concentration (µg/kg dw)

- < 1.500, 95th percentile = 1,500
- > 1.500 and ≤ 540, 75th percentile = 540
- > 540 and ≤ 260, 50th percentile = 260
- > 260 and ≤ 100, 25th percentile = 100
- ≤ 100, Non-detected

Sampling interval:

- 0-2-ft
- 2-4-ft
- 4-6-ft

Other subsurface sampling location analyzed for cPAH, but not in the illustrated sampling intervals:

- Early Action Area
- Dredged area
- Dredged and capped area
- Navigation channel
- River mile

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. cPAH concentrations are based on benzo(a)-pyrene equivalents. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds.

Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval are also shown.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface core locations with 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals.
Depth below mudline (ft)

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in
dredged areas were collected prior to dredging.

cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Interpolated cPAH concentrations (µg/kg dw) in surface sediments

38° percentiles = 1,100
75° percentile = 460
50° percentile = 292
25° percentile = 130

< 1,100
≥ 460 and ≤ 1,100
≥ 260 and ≤ 460
≥ 130 and ≤ 260
≥ 130
Non-detected
Non-detected

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentile values were calculated on an area basis as the concentration at which a particular percentage of the LDW area has
interpolated concentrations less than or equal to that concentration (e.g., the 38° percentile is the concentration at which 38% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface data does not show non-detects.

cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Legend values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.3.

* For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in
dredged areas were collected prior to dredging.

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentile values were calculated on an area basis as the concentration at which a particular percentage of the LDW area has
interpolated concentrations less than or equal to that concentration (e.g., the 38° percentile is the concentration at which 38% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface data does not show non-detects.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

Interpolated cPAH concentrations (µg/kg dw) in surface sediments

38° percentiles = 1,100
75° percentile = 460
50° percentile = 292
25° percentile = 130

< 1,100
≥ 460 and ≤ 1,100
≥ 260 and ≤ 460
≥ 130 and ≤ 260
≥ 130
Non-detected
Non-detected

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentile values were calculated on an area basis as the concentration at which a particular percentage of the LDW area has
interpolated concentrations less than or equal to that concentration (e.g., the 38° percentile is the concentration at which 38% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface data does not show non-detects.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.
Interpolated cPAH concentrations (µg/kg dw) in surface sediments

- Subsurface sediment core
- Interpolated cPAH concentration (µg/kg dw) in surface sediment
- 90th percentile = 1,100
- 75th percentile = 460
- 50th percentile = 260
- 25th percentile = 130
- ≤ 460 and ≤ 1,100
- ≤ 260 and ≤ 460
- ≤ 130 and ≤ 260
- ≤ 130
- Non-detect
- Field analyzed

* Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with the mean MDLs for seven individual PAH compounds (California EPA 1994), using one-half the MDL for undetected compounds. Interpolated cPAH data may show non-detections.

cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Map 4-41b. cPAH concentrations in surface sediment and subsurface sediment cores, RM 1.0 to RM 2.2
Interpolated cPAH concentrations (µg/kg dw) in surface sediments

Subsurface sediment core cPAH surface sediment sampling location.

- Early action area
- Dredged area
- River miles

Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Interpolated cPAH concentrations (µg/kg dw) in surface sediments:
- 95th percentile = 1,100
- 75th percentile = 460
- 50th percentile = 260
- 25th percentile = 130
- > 1,100
- > 460 and ≤ 1,100
- > 260 and ≤ 460
- > 130 and ≤ 260
- ≤ 130
- Non-detect
- Not analyzed

Interpolated cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

Locations west of the navigation channel

Locations in the navigation channel

Locations east of the navigation channel

This core was collected prior to dredging at this location.

Map 4-41c. cPAH concentrations in surface sediment and subsurface sediment cores, RM 2.2 to RM 3.0
Interpolated cPAH concentrations (µg/kg dw) in surface sediments

**Boeing Plant 2/ Jorgensen Forge Early Action Area**

- Subsurface sediment core
- cPAH concentration (µg/kg dw)
- Early action area
- Dredged area
- Surface sediment sample
- Navigation channel

Interpolated cPAH concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated values show non-detects.

Surface sediment and subsurface sediment cores, RM 3.0 to RM 4.0

### cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the IDW concentration at the core location.

- Core recovered to a depth of 100 ft
- Non-detected
- Not analyzed

Map 4-41d. cPAH concentrations in surface sediment and subsurface sediment cores, RM 3.0 to RM 4.0
**Interpolated cPAH concentrations (µg/kg dw) in surface sediments**

**Subsurface sediment core**
- cPAH surface sediment sampling location
  - Early action area
  - Dredged area
  - River mile
  - Navigation channel

**Interpolated cPAH concentration (µg/kg dw) in surface sediment**

<table>
<thead>
<tr>
<th>River mile</th>
<th>Concentration (µg/kg dw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
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<td>800</td>
</tr>
<tr>
<td>4.8</td>
<td>900</td>
</tr>
</tbody>
</table>

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

**For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003. Subsurface sediment data at locations in dredged areas were collected prior to dredging.**

**cPAH concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples**

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the LDW concentration at the core location.

**Map 4-41e. cPAH concentrations in surface sediment and subsurface sediment cores, RM 4.0 to RM 5.0**

- Early action area
- Dredged area
- River mile
- Navigation channel

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

**For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO/SD removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003. Subsurface sediment data at locations in dredged areas were collected prior to dredging.**

**Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated concentrations. For the 95th percentile = 1,100 µg/kg dw. Interpolated concentrations were calculated including locations with non-detected values.**

**TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface data does not show non-detects.**

* At the Norfolk EAA, surface sediment data, which were collected after the removal action at the Norfolk CSO area in 1999 but before the removal action at the BDC south storm drain outfall area in 2003, do not reflect conditions at the time subsurface cores were collected in 1995.
cPAH concentrations (µg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data

Interpolated cPAH concentration (µg/kg dw) in surface sediment
95th percentile = 1,100
75th percentile = 460
50th percentile = 260
25th percentile = 130
> 1,100
> 460 and ≤ 1,100
> 260 and ≤ 460
> 130 and ≤ 260
≤ 130
≥ 260
≥ 460
≥ 1,100
Non-detect
Not analyzed

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g. the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface does not show non-detects.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.

Map 4-42a. Comparison of cPAH concentrations in subsurface cores to co-located surface sediment locations, RM 0.0 to RM 2.5
cPAH concentrations (µg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data

Interpolated cPAH concentration (µg/kg dw) in surface sediment:
95th percentile = 1,100
75th percentile = 460
50th percentile = 260
25th percentile = 130
> 1,100
> 460 and ≤ 1,100
> 260 and ≤ 460
> 130 and ≤ 260
≤ 130
Non-detect
Not analyzed

- Subsurface sediment core
- cPAH surface sediment
- sampling location
- Early Action Area
- Dredged area
- Navigation channel
- River mile

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has interpolated concentrations ≤ 1,100 µg/kg dw). Interpolated concentrations were calculated including locations with non-detected values. TEQs were calculated with mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected compounds. Interpolated surface does not show non-detects.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Plant 2, Jorgensen Forge Early Action Area.

Map 4-42b. Comparison of cPAH concentrations in subsurface cores to co-located surface sediment locations, RM 2.5 to RM 5.0
**Map Legend**
- Co-located cPAH concentration in sediment
- Co-located cPAH concentration in benthic invertebrate or clam tissue
- Mean cPAH concentration (in fish)
- cPAHs were not detected for this tissue type in this area; half the RL was used.

**Acronyms for species and tissue type**
- DC - Dungeness crab
- SC - Slender crab
- ES - English sole
- SS - Shiner surfperch
- EM - Edible meat
- FL - Fillet with skin
- HP - Hepatopancreas
- WB - Whole body

**Map**
- SWAC = 450 µg/kg dw
- SWAC = 350 µg/kg dw
- SWAC = 250 µg/kg dw
- SWAC = 200 µg/kg dw

**Map 4-43**
- cPAH concentrations in composite tissue samples of fish, crabs, clams, and benthic invertebrate community superimposed on the IDW interpolation of cPAH concentrations in surface sediment
Prepared by CEH, 07/15/2010; MAP 2771; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Surface Sediment\Other COCs

Map 4-44. BEHP concentrations in surface sediment

- Percentiles were calculated on a numerical basis using both detected and nondetected values from the invention surface sampling plan. For samples with nondetected values, the 95th percentile is shown as 2,400 µg/kg dw and the 25th percentile is shown as 95 µg/kg dw. For samples with detected values, the 95th percentile is shown as greater than 2,400 µg/kg dw and the 25th percentile is shown as greater than 95 µg/kg dw. The 75th, 50th, and 25th percentiles are reported in the outfall table.

- Several of the EAA boundaries are approximate and have not been updated. For further information, please consult the most recent EAA boundary map.

- For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or the baseline mapping in 2000. For the Norfolk Early Action Area, samples taken at the Tacoma (TAC) were collected in 2006 after the baseline mapping of the Boeing Development Center south storm drain in 2005.

- Outfalls shown were identified during a City of Seattle lidar survey in 2003. Storm drains are marked by black, dashed lines. Public storm drains are marked by blue lines. Additional storm-drain data are from a 2007 lidar survey. Additional outfall-specific information, storm-drain locations, and other relevant agencies' data are included in the outfall table. The outfall lower is not shown on the map. The proposed outfall conditions at the time this survey was completed (2003) are also included in the outfall table.

- Scale is the same for each inset map.
A location was considered to have been resampled if the new location was within 15 ft of the old location.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Outfalls shown were identified during a City of Seattle low-tide survey in 2002 (Herna 2004). Some locations were likely identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) non-tidal and other non-storm drainage. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lowen Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during subsequent field work and verifications. The locations in non-green characters, with an outfall identifier of less than 100, had no resampling or new location data.

Change in BEHP dry weight values (µg/kg dw)

Difference of BEHP dry weight values (µg/kg dw)

New value minus old value

-2,000

-2,000 and ≤500

-500 and ≤1,500

1,500 and ≤5,000

5,000 and ≤10,000

>10,000

Outfall classification

CSO

CSO/storm drain

EOF

EOF/storm drain

Permitted private storm drain

Private storm drain

Public storm drain

Pipe of unresolved origin and/or use

Abandoned

Not an outfall

Stream, channel, or swale

Road

Navigation channel

River

Early Action Area

Dredged and capped area

Thin-layer placement

1 A location was considered to have been resampled if the new location was within 15 ft of the old location.

2 Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

3 Outfalls shown were identified during a City of Seattle low-tide survey in 2002 (Herna 2004). Some locations were likely identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) non-tidal and other non-storm drainage. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lowen Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during subsequent field work and verifications. The locations in non-green characters, with an outfall identifier of less than 100, had no resampling or new location data.

Note: Samples collected in the Duwamish/Diagonal and Norfolk EAA were not included in this evaluation.

Map 4-45. Differences in BEHP concentrations in surface sediment at locations that have been resampled
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

BEHP concentration (µg/kg dw):

- > 2.400
- > 230 and ≤ 2.400
- > 230 and ≤ 490
- > 95 and ≤ 230
- > 95 and ≤ 490
- > 490 and ≤ 95
- ≤ 95
- Non-detected

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

Map 4-46a. BEHP concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8

Prepared by CEH, 07/15/2010; MAP 2811; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\PCBs

Dredging information provided by AECOM.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

BEHP concentration (µg/kg dw)\textsuperscript{a}

- \( > 2,400 \) 95\textsuperscript{th} percentile = 2,400
- \( ≥ 490 \) 75\textsuperscript{th} percentile = 490
- \( > 230 \) and ≤ 490 50\textsuperscript{th} percentile = 230
- \( > 95 \) and ≤ 230 25\textsuperscript{th} percentile = 95
- ≤ 95
- Non-detected

Percentile is the 24th percentile of the distribution.

Sampling interval

<table>
<thead>
<tr>
<th>Left panel</th>
<th>Middle panel</th>
<th>Right panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-to-2-ft\textsuperscript{b}</td>
<td>2-to-4-ft\textsuperscript{b}</td>
<td>4-to-6-ft\textsuperscript{b}</td>
</tr>
<tr>
<td>0-to-1-ft\textsuperscript{c}</td>
<td>2-to-3-ft\textsuperscript{c}</td>
<td>4-to-5-ft\textsuperscript{c}</td>
</tr>
<tr>
<td>1-to-2-ft\textsuperscript{c}</td>
<td>3-to-4-ft\textsuperscript{c}</td>
<td>5-to-6-ft\textsuperscript{c}</td>
</tr>
</tbody>
</table>

Other subsurface sampling locations
- Analyzed for BEHP but not in the illustrated sampling intervals
- Not analyzed in that sampling interval

**Early Action Area**

**Dredged area**

- Navigation channel
- River mile

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one half the RL at that location was used.

* Data from 2-foot sampling intervals: some locations show an average of data from both 1-foot intervals within that 2-foot interval, and the average of the two intervals is also shown.

* Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 9.2.2.

* Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-46b. BEHP concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7

[Prepared by CEH, 07/15/2010; MAP 2811; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval\PCBs Dredging information provided by AECOM.]
BEHP concentration (µg/kg dw)\(^a\)
- \(> 2,400\)
- \(95^{th}\) percentile = 2,400
- \(75^{th}\) percentile = 490
- \(> 490\) and \(≤ 2,400\)
- \(> 230\) and \(≤ 490\)
- \(> 95\) and \(≤ 230\)
- \(≤ 95\)
- Non-detect

Sampling interval

<table>
<thead>
<tr>
<th>Left panel</th>
<th>Middle panel</th>
<th>Right panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-to-2'-ft</td>
<td>2-to-4'-ft</td>
<td>4-to-6'-ft</td>
</tr>
<tr>
<td>0-to-1'-ft</td>
<td>2-to-3'-ft</td>
<td>4-to-5'-ft</td>
</tr>
<tr>
<td>1-to-2'-ft</td>
<td>3-to-4'-ft</td>
<td>5-to-6'-ft</td>
</tr>
</tbody>
</table>

\(^a\) Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

\(^b\) Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

\(^c\) Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

\(^d\) Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-46c. BEHP concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0

Prepared by CEH, 07/15/2010; MAP 2811; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Subsurface\Depth Interval Dredging information provided by AECOM.
BEHP concentrations (µg/kg dw) in surface sediments using Thiessen polygons

BEHP concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Subsurface sediment cores
SOS/CSL categories for BEHP concentration (mg/kg OC) in surface sediment
SOS = 47
CSL ≤ 78
> CSL, detect
> SOS and ≤ CSL, detect
> SOS and ≤ CSL, non-detect
≤ SOS, detect
≤ SOS, non-detect

BEHP concentration (µg/kg dw)*
95% percentile = 990
75% percentile = 440
50% percentile = 200
≤ 990
≤ 440 and ≤ 990
≤ 200 and ≤ 440
≤ 84 and ≤ 200
≤ 84
Non-detect
Not analyzed

* Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon values less than or equal to that concentration (e.g., 95% percentile = the concentration at which 95% of the LDW area has Thiessen polygon concentrations ≤ 990 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in dredged areas were collected prior to dredging.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.

Locations west of the navigation channel
Locations in the navigation channel
Locations east of the navigation channel
Locations in the Duwamish/Diagonal Early Action Area

Windward LLC
Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

BEHP concentrations (µg/kg dw) in surface sediments using Thiessen polygons

- Subsurface sediment core BEHP concentration (µg/kg dw)
- SOS/CISL categories for BEHP concentration (mg/kg OC) in surface sediment
  - SOS = 47
  - CSL = 78
  - CSL, detect
  - > CSL, detect
  - CSL, non-detect
  - > CSL, non-detect
  - SOS, detect
  - > SOS, detect
  - SOS, non-detect
  - > SOS, non-detect
  - Not analyzed

*Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has Thiessen polygon concentrations ≤ 990 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.*

*Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.*

BEHP concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

*Flow values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.*

Map 4-67b. BEHP concentrations in surface sediment and subsurface sediment cores, RM 1.0 to RM 2.2
BEHP concentrations (µg/kg dw) in surface sediments using Thiessen polygons

BEHP concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Subsurface sediment core
SQS/CSL categories for BEHP concentration (µg/kg OC) in surface sediment
- SQS ≥ 47
- CSL ≥ 78
- > SQS and ≤ CSL, detect
- > CSL, not-detect
- > SQS and ≤ CSL, non-detect
- ≤ SQS, detect
- ≤ SQS, non-detect

Early action area
Dredged area
River mile
DMMU 1
DMMU 2
DMMU 3
DMMU 4
Map 4-47c. BEHP concentrations in surface sediment and subsurface sediment cores.

BEHP concentration (µg/kg dw)*
95th percentile = 990
75th percentile = 440
50th percentile = 200
25th percentile = 84
> 990
> 440 and ≤ 990
> 200 and ≤ 440
> 84 and ≤ 200
≤ 84
Non-detect
Not analyzed

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

** Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has Thiessen polygon concentrations ≤ 990 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

This core was collected prior to dredging at this location.
Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.

Subsurface sediment data at locations in dredged areas were collected prior to dredging; surface sediment data were collected after dredging.

Core recovered to a depth of 100 ft but not analyzed for BEHP below 10 ft.
Dredging information provided by AECOM.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Interpolated concentrations are based on data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon concentrations ≤ 590 (µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

BEHP concentrations (µg/kg dw) in surface sediments using Thiessen polygons

BEHP concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.

BEHP concentration (µg/kg dw)
95th percentile = 990
75th percentile = 440
50th percentile = 200
25th percentile = 84
≤ 990
≤ 440 and ≤ 990
≤ 200 and ≤ 440
≤ 84 and ≤ 200
≤ 84
Non-detect
Not analyzed
Early action area
Dredged area
River mile
Navigation channel

Map 4-47e. BEHP concentrations in surface sediment and subsurface sediment cores, RM 4.0 to RM 5.0
For the Duwamish/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2003 to 2005. Subsurface sediment data in several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon values less than or equal to that concentration (e.g., the 95th percentile = 440 mg/kg OC). Thiessen polygon concentrations were calculated including locations with no-detected values. For locations with non-detected values, a value of one-half the RL at that location was used. 

When OC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 2LAET.

BEHP concentrations (µg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data
BEHP concentrations (µg/kg dw) in surface sediments, subsurface core data, and co-located (within 10 ft) surface sediment data

- Subsurface sediment core SQS/CSL categories for BEHP concentration (µg/kg OC) in surface sediment:
  - SQS = 47
  - CSL = 78
  - > CSL, detect
  - > SQS and ≤ CSL, detect
  - > SQS and > CSL, non-detect
  - ≤ SQS, detect
  - ≤ SQS, non-detect

BEHP concentration (µg/kg dw)
- 90th percentile = 990 µg/kg dw
- 75th percentile = 440 µg/kg dw
- 50th percentile = 200 µg/kg dw
- 25th percentile = 84 µg/kg dw
- > 990 µg/kg dw
- > 440 and ≤ 990 µg/kg dw
- > 200 and ≤ 440 µg/kg dw
- > 84 and ≤ 200 µg/kg dw
- ≤ 84 µg/kg dw
- Non-detect
- Not analyzed

* When OC-normalization was not appropriate because TDOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations were compared instead to the LAET and 3LAET.

Interpolated concentrations are based on the data from the baseline surface sediment dataset. Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has Thiessen polygon values less than or equal to that concentration (e.g., the 3rd percentile is the concentration at which 97% of the LDW area has Thiessen polygon concentrations ≤ 990 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

* For the Norfolk Early Action Area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSI removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south arm (then in 2005). Subsurface sediment data in dredged areas were collected prior to dredging.
Dioxin and furan TEQs are present in Section 9.2.2. Several of the EAA boundaries are approximate and have not been finalized by EPA/OSWER. A description of each EAA boundary is presented in Section 9.2.2.

For the Dungeness/Diagonal early action area, surface sediment data in the baseline dataset were collected before dredging, capping, and capping of the Boeing Developmental Waterway and the Dungeness/Diagonal waterway area. Surface sediment data represent samples collected after dredging, capping, and capping of the Boeing Developmental Waterway and the Dungeness/Diagonal waterway area, and samples collected in the 2002 remap area of 1.1000 after before sediment removal and capping at the Boeing Developmental Waterway and the Dungeness/Diagonal waterway area in 2003.

Outfalls shown were identified during a City of Seattle tide-lane survey in 2000 (Hemmings 2004). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit data and other relevant agency databases. Some locations were identified by biologists and others were identified by the USGS using hydrographic data and other available data. The confidence level and completeness of the data is high at 95% or 90% confidence level. Multiple locations were identified during these subsequent verifications.

In the case of the Boeing Developmental Waterway and the Dungeness/Diagonal waterway area, samples were collected after sediment removal and capping at the Boeing Developmental Waterway and the Dungeness/Diagonal waterway area in 2003.

Several samples shown on this map were not included in the PA baseline dataset for reasons discussed in Section 4.2.1.7. The samples were collected at RM 0.4 (0.878 and 24.2 ng/kg dw), RM 0.5 (21.1 ng/kg dw), and RM 0.6 (1.3 ng/kg dw) and were excluded from the baseline dataset because they exceeded the 95th percentile for the Dioxin and furan TEQ (ng/kg dw) for reasons discussed in Section 4.2.1.7. The samples were collected at RM 0.4 (0.878 and 24.2 ng/kg dw), RM 0.5 (21.1 ng/kg dw), and RM 0.6 (1.3 ng/kg dw) and were excluded from the baseline dataset because they exceeded the 95th percentile for the Dioxin and furan TEQ (ng/kg dw) for reasons discussed in Section 4.2.1.7.

Several samples shown on this map were not included in the PA baseline dataset for reasons discussed in Section 4.2.1.7. The samples were collected at RM 0.4 (0.878 and 24.2 ng/kg dw), RM 0.5 (21.1 ng/kg dw), and RM 0.6 (1.3 ng/kg dw) and were excluded from the baseline dataset because they exceeded the 95th percentile for the Dioxin and furan TEQ (ng/kg dw) for reasons discussed in Section 4.2.1.7.

Map 4.49. Dioxin and furan TEQs in surface sediment and subsurface sediment cores
Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

For the Duwamish/Diagonal and Duwamish/Flatwater area, surface sediment data is the baseline dataset representing samples collected before dredging, capping, or thin-layer placement in 2003 and 2004. For the Norman Park area, data was collected before an area-wide effort by the city of Seattle to eradicate private storm drain outfall locations identified during these subsequent verifications. For locations where a RL was not established, a value of 1.0 was used. The RLs were established after only baseline samples were collected, prior to implementation of sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 9.2.2.

Cadmium concentration (mg/kg dw):

- > 1.8
- > 0.66 and ≤ 1.8
- > 0.39 and ≤ 0.66
- > 0.20 and ≤ 0.39
- ≤ 0.20

Non-detect:

- > CSL
- > SGS and ≤ CSL

Outfall classification:

- CSL
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

Map 4-50. Cadmium concentrations in surface sediment
Chromium concentration (mg/kg dw) 

- > 70
- > 38 and ≤ 70
- > 22 and ≤ 29
- > 22
- Non-detect
- > CSL
- > SQS and ≤ CSL
- ≤ SQS

Early Action Area:
- Dredged and capped area
- Thin-layer placement
- Road
- Navigation channel
- River mile

* Percentile were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one half the LL at that location was assigned.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.4.2.

* For the Duwamish/Duoréal early area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2009. For the Norfolk early area, surface sediment data in the baseline dataset represent samples collected after dredging and capping at the Boeing Developmental Center south storm drain in 2003.

* Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Hemery 2003). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Additional locations were identified through discussions with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were verified by LDWG members, some additional outfall locations were identified during these subsequent verifications. Outfalls that were not identified by this survey are not included in the survey results. LDWG members provided updated outfall information to the extent possible at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix B.

Map 4-51. Chromium concentrations in surface sediment.
Windward Environmental LLC

Prepared by CEH, 07/15/2010; MAP 2775; W:\Projects\00-08-06_Duwamish_RI\data\gis\Phase2 RI\Nature and Extent\Surface Sediment\Other COCs

The outfall layer is meant to serve as a snapshot of outfall conditions at outfall locations were identified during these subsequent verifications. (LDWG) personnel provided additional outfall-specific information.

Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For baseline with non-detects, a value of one-half the ND at that location was assigned. The non-detects were considered in the calculation of percentiles.

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.1.2.

For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2000 to 2005. For the Norfolk early action area, surface sediment data represent samples collected before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

Outfalls shown were identified during a City of Seattle tide survey (2003) (Hembry 2006). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were subsequently verified by public meetings attended with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were held void by LDWG members, some additional outfall locations were included during these subsequent verifications. More recent information, when available, is reflected in the outfall discussions in Appendix C.

Map 4-52. Copper concentrations in surface sediment

Copper concentration (mg/kg dw*)

95th percentile = 150
75th percentile = 81
50th percentile = 52
25th percentile = 34
CSL = SGS = 390

Outfall classification*:
- CSL
- CSO/storm drain
- EOF
- SGS/storm drain
- Permitted private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For baseline with non-detects, a value of one-half the ND at that location was assigned. The non-detects were considered in the calculation of percentiles.

† Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.1.2.

‡ For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2000 to 2005. For the Norfolk early action area, surface sediment data represent samples collected before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

§ Outfalls shown were identified during a City of Seattle tide survey (2003) (Hembry 2006). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were subsequently verified by public meetings attended with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were held void by LDWG members, some additional outfall locations were included during these subsequent verifications. More recent information, when available, is reflected in the outfall discussions in Appendix C.
Map 4-53. Lead concentrations in surface sediment

- The map illustrates the location of the Duwamish/Drayton Harbor Early Action Area.
- The map includes various symbols and lines indicating different areas and features.
- The map uses a scale of 0 to 2.5 miles (0 to 1.25 kilometers) to depict distances.

Legend:
- **Harbor 1**
- **Slip 1**
- **Slip 2**
- **Slip 3**
- **Slip 4**
- **Slip 5**
- **Slip 6**
- **North Basin**
- **Early Action Area**

Map notes:
- The map shows the location of the Early Action Area and its boundaries.
- The map includes a scale in miles and kilometers for reference.

Additional information:
- The map is designed to provide a clear visual representation of the lead concentrations in surface sediment within the highlighted areas.
- The map is intended for use in understanding the environmental impact of lead in the area.

References:
- The map references sections 2.1.2.3.1 and 2.1.2.3.2 of the original document.
- The map credits Windward Environmental for its design and preparation.

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*Percentile values are calculated using a normal distribution, and non-detect values are included in the calculations. The values presented represent lead concentrations in surface sediment within the Early Action Area.*

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*The map is a visual representation of the lead concentrations in surface sediment within the Early Action Area.*
Nickel concentration (mg/kg dry) ≤ 22 and > 22 and ≤ 27 > 27 and ≤ 43 > 43

Non-detect

Early Action Area

Dredged and capped area

Thin layer placement

Road

Navigation channel

River mile

96th percentile = 43
75th percentile = 27
50th percentile = 22
25th percentile = 17

Outfall classification
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detections, a value of one-half the NL at that location was used.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 6.12.

* For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003-2005. For the Norfolk early action area, surface sediment data in the baseline dataset represent samples collected before sediments were removed by dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

* Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Hemmer 2005). Some locations were initially identified using the National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWWG members; some additional outfall locations were identified during these subsequent verifications. This information was current as of the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.

Map 4-55. Nickel concentrations in surface sediment
Map 4-56. Silver concentrations in surface sediment

*Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. Percentiles were not calculated for samples with non-detects, a value of one-half the MQL at the time of sampling.

1 Several of the EAA boundaries are approximately and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 4.1.2.

2 For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2006. For the Norfolk early action area, surface sediment data in the baseline dataset represent sampling prior to the start of the project in 2000. For the Upper Turning Basin and Boeing Plant/2nd Avenue/Flagstaff areas, surface sediment data in the baseline dataset represent samples collected before sediment removal and capping at the Boeing Development Center south storm drain in 2003.

Outfalls shown are identified during a City of Seattle low tide survey in 2002 (Koehne 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Permit files and other relevant databases were checked and updated by permit monitoring staff. Permit data were checked against agency projects and/or visit field and/or permits. Some locations were identified during these subsequent verifications.

When available, is reflected in the discussion in Appendix 4.1.2.
Vanadium concentration (mg/kg dry)

- > 81
- > 68 and ≤ 81
- > 57 and ≤ 68
- > 48 and ≤ 57
- ≤ 48
- Non-detect

Early Action Area
- Dredged and capped area
- Thin layer placement
- Road
- Navigation channel
- River mile

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 4.5.3.

* For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005. Data for early action area boundaries in the Duwamish/Diagonal area were collected after completion of the EAA in 2006 and reflect EAA removal and removal of the prior Duwamish/Diagonal area in 2003 before sediment removal and capping at the Boeing Development Center south storm drain in 2003.

* Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Perna 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Further verification and coordination with regulatory and community organizations and Long-Term Ecosystem Recovery (LTER) project participants (2013) with agency and Lower Duwamish Waterway Group members added additional outfall-specific verification. Some locations were re-identified by LTER members, and some additional outfall locations were identified during these subsequent verifications. The outfalls shown represent locations within 300 feet of the water’s edge along the shoreline at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix 1.

Map 4-57. Vanadium concentrations in surface sediment
Map 4-58. Zinc concentrations in surface sediment

Zinc concentration (mg/kg dry)

95th percentile = 410
75th percentile = 160
50th percentile = 110
25th percentile = 79

SOS = 410

Outfall classification

- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with no detections, a value of one-half the RL at that location was used.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 4.2.3.

* For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005. The early action area was chosen because this sampling area was collected after the baseline surface sediment dataset. The dataset includes samples collected before sediment removal and capping at the Boeing Development Center south storm drain in 2003.

* Outfalls shown were identified during a City of Seattle low tide survey in 2003 (Herrera 2004). Some locations were initially identified using generic maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other available agency databases, and later verified through discussions with project stakeholders and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were held verified by LDWG members; some additional spatial locations were identified during these subsequent verifications. At most outfalls, the survey was conducted by one person during tidal and low tide conditions. However, some locations were not accessible for surveys, and therefore some locations could not be verified.

* The EAA boundary shown was verified during the actual field survey at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.
Map 4-59. TBT concentrations in surface sediment

- **TBT concentration (µg/Kg dry)**
  - > 250
  - > 88 and ≤ 250
  - > 22 and ≤ 88
  - > 4.0 and ≤ 22
  - > 4.0

- **Outfall classification**
  - CSO
  - CSO/Storm drain
  - EOF
  - EOF/Storm drain
  - Permitted private storm drain
  - Private storm drain
  - Public storm drain

- **Early Action Area**
  - Dredged and capped area
  - Thin-layer placement
  - Road
  - Navigation channel
  - River mile

- **Percentile values**: 95th percentile = 250, 75th percentile = 88, 50th percentile = 22, 25th percentile = 4.0

---

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For baselines with non-detects, a value of one-half the RL was used.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.1.2.

* For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement; data from 2003 represents conditions after dredging and thin-layer placement in 2003 and before capping.

* For the Norfolk early action area, surface sediment data in the baseline dataset represent samples collected before capping, thin-layer placement, or dredging and capping in 2003 to 2005. For the Norfolk early action area, sub-area within the surface sediment data presented represent sample locations after dredging and capping in 2003 to 2005.

---

* Outfalls shown were identified during a City of Seattle low tide survey in 2000 (Hammers 2000). Some locations were initially identified using drainage maps from Ecology's National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases, and reviewed and updated by EPA/Ecology and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were held valid by LDWG members; some additional outfall locations were identified during these subsequent verifications. Some outfall locations were subsequently identified with comments at the time the survey was completed (2000). More recent information, when available, is reflected in the outfall discussions in Appendix 6.
Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

For the Dawson/Diagonal Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, and thin-layer placement in 2002-2003. For the Norfolk Early Action Areas, subsurface sediment data represent pre-dredging analysis after sampling and capping at the Norfolk CUS/CSU remove area in 1998 and before subsequent removal and capping at the Bowling Developmental Center south of the channel in 2002.

TBT concentrations (µg/kg dw) in surface sediments using Thiessen polygons

Depth below mudline (ft)

Subsurface sediment core

TBT surface sediment sampling location

Early action area

Dredged area

River mile

Tributyltin concentration (µg/kg dw)

95th percentile = 230
75th percentile = 81
50th percentile = 44
25th percentile = 4

> 230

> 81 and ≤ 230

> 4 and ≤ 81

≤ 4

Non-detect

Not analyzed

Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.

TBT concentrations (µg/kg dw) in subsurface sediment cores and co-located (within 10 ft) surface sediment samples

Labeled values represent a surface sediment grab sample located within 10 ft of the subsurface sediment core; other cores with no co-located surface sediment grab samples show the Thiessen polygon concentration at the core location.

Core recovered to a depth of 100 ft but not analyzed for TBT below 10 ft.

Map 4-60. TBT concentrations in surface sediment and subsurface sediment cores
Map 4-61. Total HPAH concentrations in surface sediment

**Legend**
- HPAH concentration (µg/kg dw)
  - > 13,000
  - > 4,200 and ≤ 13,000
  - > 2,000 and ≤ 4,200
  - > 830 and ≤ 2,000
  - < 830
- Non-detect
  - > CSL
  - > SQS and ≤ CSL
  - ≤ SQS
- Early Action Area
- Dredged and capped area
- Thin-layer placement
- Road
- Navigation channel
- River mile

**Percentiles**

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Concentration (µg/kg dw)</th>
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<tbody>
<tr>
<td>95%</td>
<td>&gt; 13,000</td>
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<tr>
<td>75%</td>
<td>&gt; 4,200 and ≤ 13,000</td>
</tr>
<tr>
<td>50%</td>
<td>&gt; 2,000 and ≤ 4,200</td>
</tr>
<tr>
<td>25%</td>
<td>&gt; 830 and ≤ 2,000</td>
</tr>
<tr>
<td></td>
<td>&lt; 830</td>
</tr>
</tbody>
</table>

**Outfall classification**
- CSL
- SQS
- EOF
- Private storm drain
- Public storm drain
- Permittee storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall

**Early Action Areas**
- Duwamish/Diagonal early action area
- Norfolk early action area
- Slip 1
- Slip 2
- Slip 3
- Slip 4
- Slip 5
- Slip 6

**Notes**
- Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset.
- For locations with non-detects, one-half of the non-detect value was used. When OC normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations are compared instead to the LAET and 2LAEET.
- Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.5.
- For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2002 to 2003. For the Norfolk early action area, surface sediment data represent samples collected after dredging and capping at the Norfolk CSS removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.
- Outfalls shown were identified during a City of Seattle tree-like survey (2005) as well as during field surveys by Lower Duwamish Waterway Group (LDWG) personnel, lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information.
- The locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. These locations may not represent all outfalls of the area at the time the survey was completed (2005). More recent information, when available, is reflected in the outfall discussions in Appendix A.
LPAH concentration (μg/kg dry)  
- > 2,300  
- 550 and ≤ 2,300  
- 230 and ≤ 550  
- 84 and ≤ 230  
- < 84  
- Non-detect  
- > CSL  
- > SGS and ≤ CSL  
- SGS  

Early Action Area  
- Dredged and capped area  
- Thin-layer placement  
- Road  
- Navigation channel  
- River mile  

*Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detect value was used. When OC normalization was not appropriate because TOC content was ≤ 0.5% or > 4.0%, dry weight concentrations for these locations are compared instead to the LAET and 2LAET.*

1 Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each EAA boundary is presented in Section 4.2.

2 For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2000 to 2003. For the Norfolk Early Action Area, baseline samples were collected after thin-layer placement and prior to dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

3 Outfalls shown were identified during a City of Seattle low-tide survey (2003) through WDFW (2004). Storm drain boundaries were identified using National Elevation Dataset (NED) provided by the National Geodetic Survey (NGS). The Puget Sound Monitored Discharge System (PSMDS) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG personnel; some additional outfall locations were identified during these subsequent verifications. For locations identified through these multiple sources, the primary source of information is cited in the section on EAA boundaries. More recent information, when available, is reflected in the outfall discussions in Appendix 1.
Map 4-63. BBP concentrations in surface sediment

**BBP concentration (µg/kg dw)**

- > 230
- > 50 and ≤ 230
- > 28 and ≤ 50
- > 10 and ≤ 28
- > 9.0 and ≤ 10
- Non-detect
  - > CSL
  - > SQS and ≤ CSL
  - ≤ SQS

**Early Action Areas**

- Dredged and capped area
- Thin-layer placement
- Road
- Navigation channel
- River mile

**Map 4-63 Notes:**

1. Percentiles were calculated on a cumulative basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with no-detects, a value of one-half the TL at that location was used. When QC-normalization was not appropriate because TOC content was < 0.5% or > 4.0%, dry weight concentrations for these locations are compared instead to the LAET and 2LAET.

2. Several of the DAA boundaries are approximate and have not been finalized by EPA/Ecology. A description of each DAA boundary is presented in Section 5.3.2.

3. For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005. For the Norfolk early action area, samples were collected before dredging and capping at the Norfolk CSG removal area in 1999 and before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

4. Outfalls shown were identified during a City of Seattle low-tide survey (2003) and located using the Naval Oceanographic Office (NOAA) Atlas of the Ocean Environment (NOE) permit file and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional locations were verified during these subsequent verifications. Locations identified during these surveys may differ from the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix A.
Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

* Several of the EA/A boundaries are approximate and have not been finalized by EPA/Ecology, a description of each EAA boundary is presented in Section 4.2.3.

For the Duwamish/Draycut early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005. For the Norfolk early action area, surface sediment data represent samples collected after ‘no further action’ designation and thin-layer placement in 2003 to 2005. These locations were later surveyed in the field. Review of agency files or swale origin and/or use of swale, or swale origin and/or use of swale.

Outfall classification:
- CSL
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use of pipe
- Abandoned
- Not an outfall
- Stream, channel, or swale

Phenol concentration (µg/kg dw)
- 95th percentile = 320
- 75th percentile = 95
- 50th percentile = 31
- 25th percentile = 10
- ≤ CSL (≤ 1,200)
- SGS (≤ 420)

Outfall concentrations in surface sediment

Map 4.64. Phenol concentrations in surface sediment
Map 4-65. Benzoic acid concentrations in surface sediment

- **Benzoic acid concentration** (µg/kg dwt)
  - > 640
  - > 190 and ≤ 640
  - > 100 and ≤ 190
  - > 95
  - Non-detect
- **Outfall classification**
  - CSO
  - CSO/storm drain
  - EOF
  - EOF/storm drain
  - Permitted private storm drain
  - Private storm drain
  - Public storm drain
  - Pipe of unresolved origin and/or use
  - Abandoned
  - Not an outfall
  - Stream, channel, or swale

*Percentages were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, a value of one-half the RL at that location was used.

1. Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.12.

2. For the Duwamish/Donajig early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005. For the Norfolk early action area, stream data represent samples collected before dredging and capping at the Norfolk CSO removal area in 1999 and before sediment removal and capping at the Boeing Development Center south storm drain in 2003.

3. Outfalls shown were identified during a City of Seattle low tide survey (2003) or were later identified using the Shellfish Habitat Evaluation Program System (SHEPS) and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWAG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWAG members; some additional outfall locations were identified during these subsequent verifications. Outfall locations may have been lost to the environment, particularly locations not detected during the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.
### Total HPAH concentration (μg/kg dw)

- **95th percentile = 13,000**
- **75th percentile = 4,200**
- **50th percentile = 2,000**
- **25th percentile = 830**
- **≤ 830**

**Non-detected**

**Sampling interval**

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<th>Middle panel</th>
<th>Right panel</th>
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<td>3-to-4-ft</td>
<td>5-to-6-ft</td>
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</tbody>
</table>

**Other subsurface sampling location analyzed**

- **for HPAHs, but not in the illustrated sampling intervals**

- **Early Action Area**
- **Dredged area**
- **Dredged and capped area**
- **Dredged and thin-layer placement**
- **Thin-layer placement**
- **Navigation channel**
- **River mile**

**Subsurface core locations**

- **0-to-2-ft sampling intervals**
- **2-to-4-ft sampling intervals**
- **4-to-6-ft sampling intervals**

**Slip 1**

- **Slip 2**

**Duwamish/Diagonal Early Action Area**

**Kellogg I.**

**Windward Environmental LLC**

Map 4-6a. Total HPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Total HPAH concentration (μg/kg dw)

- > 13,000
- > 4,200 and ≤ 13,000
- > 2,000 and ≤ 4,200
- > 830 and ≤ 2,000
- ≤ 830
- Non-detected

Sampling interval

<table>
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<th>Left panel</th>
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<th>Right panel</th>
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<td>3-to-4-ft</td>
<td>5-to-6-ft</td>
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</tbody>
</table>

- Not analyzed in that sampling interval
- Other subsurface sampling location analyzed
  - for HPAHs, but not in the illustrated sampling intervals

- Early Action Area
- Dredged area
- Navigation channel
- River mile

* In accordance with the Washington State DEQ, Total HPAH represents the sum of the concentrations of detected HPAHs plus the concentration of non-detected HPAHs using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detected value was used.
* Data from 2-foot sampling intervals; some locations show an average of data from both 1-foot intervals within that 2-foot interval.
* Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.
* Several of the EAA boundaries are approximate and have not been finalized by EPA/DEQ; a description of each 6A boundary is presented in Section 3.2.2.
* Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-66b. Total HPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7

Scale is the same for each map frame
In accordance with the Washington State SMS, Total HPAH compounds. Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detect value was used. Data from 2-foot sampling intervals; some locations show an average of data from both 1-foot intervals within that 2-foot interval. Not analyzed in that sampling interval for HPAHs, but not in the illustrated sampling intervals.

Other subsurface sampling location analyzed:
- Early Action Area
- Dredged area
- Dredged and capped area
- Navigation channel
- River mile

* In accordance with the Washington State SMS, Total HPAH represents the sum of the concentrations of detected HPAH congeners. HPAH data are considered to be background unless otherwise noted. Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detect value was used.

** Data from 2-foot sampling intervals; some locations show an average of data from both 1-foot intervals within that 2-foot interval.

*** Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology, or description of each EAA boundary is presented in Section 3.2.2.

* Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Map 4-6c. Total HPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0.
Subsurface core locations with 0-to-2-ft sampling intervals

Harbor I.

Duwamish/Diagonal

Early Action Area

Kellogg I.

Slip 1

Slip 1

Slip 1

Slip 2

Slip 2

Slip 2

Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Windward LLC

Map 4-67a. Total LPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 0.0 to RM 1.8

Sampling interval

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<td>5-to-6-ft</td>
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Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

Data from 2-foot sampling intervals: some locations show an average of data from both 1-foot intervals within that 2-foot interval at a given location.

<sup>a</sup> In accordance with the Washington State SMS, Total LPAH represents the sum of the concentrations of detected LPAH compounds. Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detect value was used.

<sup>b</sup> Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

<sup>c</sup> Several of the EAA boundaries are approximate and have not been finalized by FMR/ECOL. A description of each EAA boundary is presented in Section 9.2.2.

<sup>d</sup> Subsurface sediment data at locations in dredged areas were collected prior to dredging.
Subsurface core locations with 0-to-2-ft sampling intervals

Subsurface core locations with 2-to-4-ft sampling intervals

Subsurface core locations with 4-to-6-ft sampling intervals

Map 4-67b. Total LPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 1.8 to RM 3.7

**Total LPAH concentration**

(µg/kg dw)

- > 2,300
- > 550 and ≤ 2,300
- > 230 and ≤ 550
- > 84 and ≤ 230
- ≤ 84

**Not analyzed in that sampling interval**

- Early Action Area
- Dredged area
- Navigation channel
- River mile

* In accordance with the Washington State SMS, Total LPAH represents the sum of the concentrations of detected LPAH compounds. Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. For locations with non-detects, one-half the non-detected value was used.

* Data from 2-foot sampling intervals: some locations show an average of data from both 1-foot intervals within that 2-foot interval were collected. The average of the two intervals is also shown.

* Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* Subsurface sediment data at locations in dredged areas were collected prior to dredging.

Dredging information provided by AECOM.
Total LPAH concentration (µg/kg dw)

- > 2,300
- > 550 and ≤ 2,300
- > 230 and ≤ 550
- > 84 and ≤ 230
- ≤ 84
- Non-detect

**SAMPLING INTERVAL**

- **Left panel**: 9-to-2-ft
- **Middle panel**: 2-to-4-ft
- **Right panel**: 4-to-6-ft
- Not analyzed in that sampling interval

Other subsurface sampling location analyzed

- for LPAHs, but not in the illustrated sampling intervals

**Subsurface core locations with 0-to-2-ft sampling intervals**

**Subsurface core locations with 2-to-4-ft sampling intervals**

**Subsurface core locations with 4-to-6-ft sampling intervals**

**Upper Turning Basin**

**Slip 6**

**Early Action Area**

**Subsurface core locations with 0-to-2-ft sampling intervals**

**Subsurface core locations with 2-to-4-ft sampling intervals**

**Subsurface core locations with 4-to-6-ft sampling intervals**

**Norfolk Early Action Area**

**S. 102nd St. Bridge**

**Dredging information provided by AECOM.**

**Map 4-67c. Total LPAH concentrations in subsurface sediment within the 0-to-2-ft, 2-to-4-ft, and 4-to-6-ft sampling intervals, RM 3.7 to RM 6.0**

**In accordance with the Washington State SMS, Total LPAH represents the sum of the concentrations of detected LPAH compounds.**

**Percentiles were calculated on a numerical baseline surface sediment dataset.**

For locations with non-detects, one-half the non-detected value was used.

**Data from 1-foot sampling intervals are shown if available. If both 1-foot intervals within the 2-foot interval were collected, the average of the two intervals is also shown.**

**Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.**

**Subsurface sediment data at locations in dredged areas were collected prior to dredging.**
Map 4-68. Total DDT concentrations in surface sediment

Total DDT concentration (µg/kg dw)

95th percentile = 70
75th percentile = 7.8
50th percentile = 2.7
25th percentile = 1.0

Outfall classification
- CSO
- CSO/storm drain
- EOF
- EOF/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Stream, channel, or swale

* Percentiles were calculated on a numerical basis using both detected and non-detected values from the baseline surface sediment dataset. Total DDT values represent the sum of the concentrations of the DDT, DDE, and DDD congeners, using one-half the R/L for undetected values.

# Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.5.

- For the Duwamish/Diagonal early action area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2004. Several of these locations were later surveyed in the field. Review of agency files before sediment removal and capping at the Boeing Developmental Center south storm drain in 2003.

- Outfalls shown were identified during a City of Seattle low-tide survey in 2000. Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. Other locations may have been identified by field personnel provided additional outfall-specific information. Some locations were held verified by L2WIS members, some additional outfall locations were identified during these subsequent verifications. Post-survey data were included in sampling results as of the time the survey was completed (2003). More recent verifications and/or updated information may be available. It reflected in the outfall occurrences in Appendix E.

- Scale is the same for each inset map.
Interpretation of core chemistry profile:
- Consistent with assumptions:
  - Peak total PCB concentration as deep or deeper than expected
- Inconsistent with assumptions:
  - Peak total PCB concentration shallower than expected
- Core excluded from analysis
- Average annual net sedimentation rate from STM (cm/yr)

Average annual net sedimentation rate (cm/yr)

Outfall classification:
- CSO/storm drain
- EOD
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Stream, channel, or swale
- Early action area
- River mile
- Navigation channel

Peak total PCB concentrations in subsurface cores

Estimated depth of peak total PCB concentration

Analyzed core interval with actual peak total PCB concentration

* Cores from the RI surface sediment database were excluded from this analysis if at least one of the following conditions was met: 1) only one core interval was analyzed for total PCBs, 2) no core interval was analyzed within the depth range of the expected peak, 3) PCBs were not detected, or 4) dredging occurred prior to sampling.

* Analysis assumptions:
  - Annual average net sedimentation rates are from the STM report (QEA 2008)
  - Core units and releases of PCBs assumed to be 1974/1975 to 1974/1978
  - Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were then surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* Cores located within dredged areas were collected prior to dredging.

Map 4-69a. Comparison of actual and estimated depths of peak total PCB concentrations in cores based on annual average net sedimentation rates and source assumptions, RM 0.0 to RM 1.0
Average annual net sedimentation rate (cm/yr)

Peak total PCB concentrations in subsurface cores

Estimated depth of peak total PCB concentration

Analyzed core interval with actual peak total PCB concentration

Interpretation of core chemistry profile:
- Consistent with assumptions:
  - Peak total PCB concentration at least as deep or deeper than expected.
  - Average annual net sedimentation rates and source concentrations in cores based on annual average net sedimentation rates and source assumptions, RM 1.0 to RM 2.2
- Inconsistent with assumptions:
  - Peak total PCB concentration shallower than expected.
  - No localized disturbances (e.g., dredging, tug maneuvering).

Average annual net sedimentation rates from STM (cm/yr):
- Net sediment loss:
  - 0.1 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - 2.0 - 3.0
  - > 3.0
- Core excluded from analysis:
- Average annual net sedimentation rate from STM report (QEA 2008)
- Estimated depths of peak total PCB concentrations in cores based on annual average net sedimentation rates and source assumptions, RM 1.0 to RM 2.2
- Core excluded from analysis:
- Core interval analyzed:
  - Inside of STM modeling area
  - Outside of STM modeling area

Outfall classification:
- CSO
- CSO/storm drain
- EOF
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Early action area
- River mile
- Navigation channel

Analysis assumptions:
- Annual average net sedimentation rates are from the STM report (QEA 2008).
- Peak usage and release of PCBs assumed to be 1960, 1965, or 1974.
- No localized disturbances (e.g., dredging, tug maneuvering).

Outfalls shown were identified during a City of Seattle (low tide) survey in 2003 (Hernandez 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWW) personnel provided additional outfall-specific information. Some locations were field-verified by LDWW members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix A.

* Cones located within dredged areas were collected prior to dredging.

** Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 5.2.2.

± Indicates the actual peak concentration of PCBs was shallower than expected as deep or deeper than expected.

Map 4-69b: Comparison of actual and estimated depths of peak total PCB concentrations in cores based on annual average net sedimentation rates and source assumptions, RM 1.0 to RM 2.2
Average annual net sedimentation rate (cm/yr)

Interpretation of core chemistry profile
- Consistent with assumptions:
  - (peak total PCB concentration as deep or shallower than expected)
  - (peak total PCB concentration shallower than expected)
- Core excluded from analysis

Average annual net sedimentation rate from STM (cm/yr)
- Net sediment loss
  - 0.1 - 0.5
  - 0.5 - 1.0
  - 1.0 - 2.0
  - 2.0 - 3.0
  - > 3.0
- Outside of STM modeling area

Outfall classification
- CSO
- EOD/storm drain
- Permitted private storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned
- Not an outfall
- Early action
- Dredged area
- River mile
- Navigation channel

* Cones from the FI surface sediment dataset were excluded from this analysis if at least one of the following conditions was met: 1) only one core interval was analyzed for total PCBs, 2) no core interval was analyzed within the depth range of the expected peak, 3) PCBs were not detected, or 4) dredging occurred prior to sampling.

* Outfalls shown were identified during a City of Seattle low-tide survey in 2003 (Herrera 2004). Some locations were initially identified using drainage maps from Ecology’s National Pollutant Discharge Elimination System (NPDES) permit files and other relevant agency databases. These locations were later surveyed in the field. Review of agency files and interviews with agency and Lower Duwamish Waterway Group (LDWG) personnel provided additional outfall-specific information. Some locations were field-verified by LDWG members; some additional outfall locations were identified during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time the survey was completed (2003). More recent information, when available, is reflected in the outfall discussions in Appendix I.

* Several of the EAA boundaries are approximate and have not been finalized by EPA/Ecology; a description of each EAA boundary is presented in Section 9.2.2.

* Cones located within dredged areas were collected prior to dredging.

Peak total PCB concentrations in subsurface cores

Estimated depth of peak total PCB concentration

Analyzed core interval with actual peak total PCB concentration

Map 4-69c. Comparison of actual and estimated depths of peak total PCB concentrations in cores based on annual average net sedimentation rates and source assumptions, RM 2.2 to RM 3.5
Average annual net sedimentation rate (cm/yr)

Analysis assumptions
- Annual average net sedimentation rates are from the STM report (QEA 2008)
- Net sediment loss data were excluded from the analysis if at least one of the following conditions was met: 1) only one core interval was analyzed for total PCBs, 2) no core interval was analyzed within the depth range of net sediment loss, 3) cores were located within 30 ft of storm drain or effluent pipe, and 4) core interval was less than 30 ft.

Core excluded from analysis
- Core recovered to a depth of 100 ft but not analyzed for PCBs below 14.5 ft
- Core recovered to a depth of 100 ft but not analyzed for PCBs below 15.9 ft

Estimated depth of peak total PCB concentration
- Analyzed core interval with actual peak total PCB concentration

Peak total PCB concentrations in subsurface cores

Interpretation of core chemistry profile
- Consistent with assumptions
- Peak total PCB concentration as deep or greater than expected
- Inconsistent with assumptions
- Peak total PCB concentration shallower than expected
- Core excluded from analysis

Depth below mudline (ft) during these subsequent verifications. The outfall layer is meant to serve as a snapshot of outfall conditions at the time...
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Concentration Unit</th>
<th>95th Percentile</th>
<th>75th Percentile</th>
<th>5th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total PCB</td>
<td>µg/kg dw</td>
<td>25</td>
<td>14</td>
<td>810</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/kg dw</td>
<td>1,100</td>
<td>460</td>
<td>1,100</td>
</tr>
<tr>
<td>cPAH Concentration</td>
<td>µg/kg dw</td>
<td>&gt; 460 and ≤ 1,100</td>
<td>&gt; 460 and ≤ 1,100</td>
<td>&gt; 460 and ≤ 1,100</td>
</tr>
<tr>
<td>BEHP Concentration</td>
<td>µg/kg dw</td>
<td>&gt; 440 and ≤ 990</td>
<td>&gt; 440 and ≤ 990</td>
<td>&gt; 440 and ≤ 990</td>
</tr>
</tbody>
</table>

Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygons were created that had concentrations above these percentile values. Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detected values from the baseline surface sediment dataset, Percentiles were not calculated on an area basis as for the other chemicals because there were too few dioxin and furan congeners. Thiessen polygon concentrations were calculated including locations with non-detected values. TEQs were calculated including locations with non-detects for all individual Aroclors, a value equal to the highest RL of an individual Aroclor was used. For locations with non-detected values for individual PAH compounds, California EPA TEFs for individual dioxin and furan congeners (Van den Berg et al. 2006), using one-half the TEF for undetected compounds. TEQs were calculated using mammalian PEFs for seven individual PAH compounds (California EPA TEFs for individual dioxin and furan congeners). TEQs were calculated using mammalian PEFs for individual dioxin and furan congeners (Van den Berg et al. 2006), using one-half the reporting limit for undetected congeners.

For the Duwamish/Drayton Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 to 2005.
Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has IDW-interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. Thiessen polygon concentrations were calculated using mammalian PEFs for seven individual PAH compounds (California EPA 1994), using one-half the RL for undetected congeners. TEQs were calculated with one-half the RL at that location was used. TEQs were calculated using one-half the RL for undetected congeners.
Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygons were created that had concentrations calculated including locations with non-detected values. For locations with non-detects for all individual Aroclors, a value equal to the highest RL of an individual Aroclor was used.

Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the RL at that location was used.

Percentiles were calculated on an area basis as the concentration at which a particular percentage of the LDW area has concentrations less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value equal to the highest RL of an individual PAH compound was used.

Percentiles were calculated on a numerical basis using all interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value of one-half the reporting limit for undetected values was used.

Percentiles were calculated on a numerical basis using all interpolated values less than or equal to that concentration (e.g., the 95th percentile is the concentration at which 95% of the LDW area has concentrations ≤ 810 µg/kg dw). Thiessen polygon concentrations were calculated including locations with non-detected values. For locations with non-detects, a value equal to the highest RL of the individual Aroclor was used.

For the Norfolk Early Action Area, surface sediment data in the baseline dataset represent samples collected before dredging, capping, or thin-layer placement in 2003 and 2004.