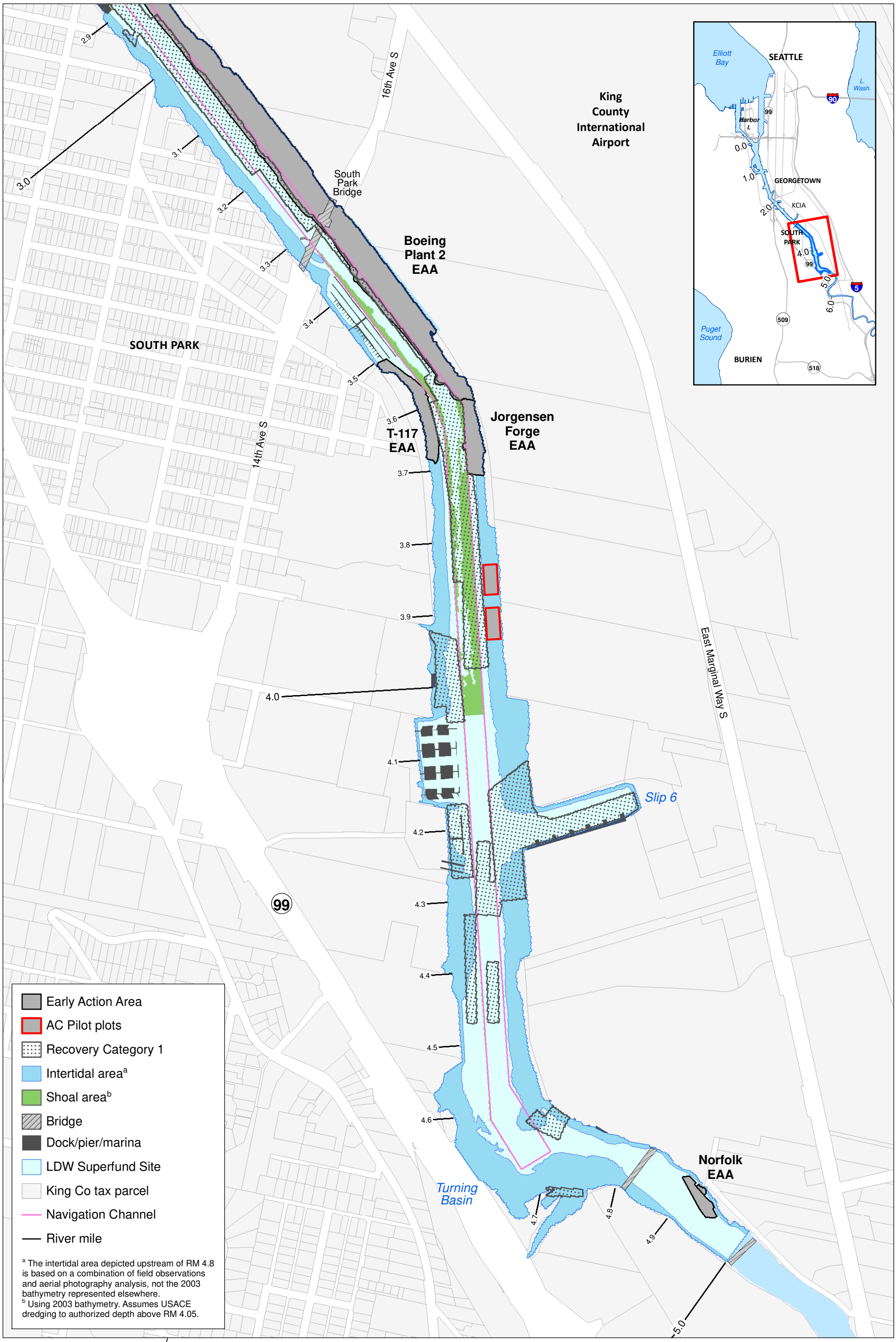


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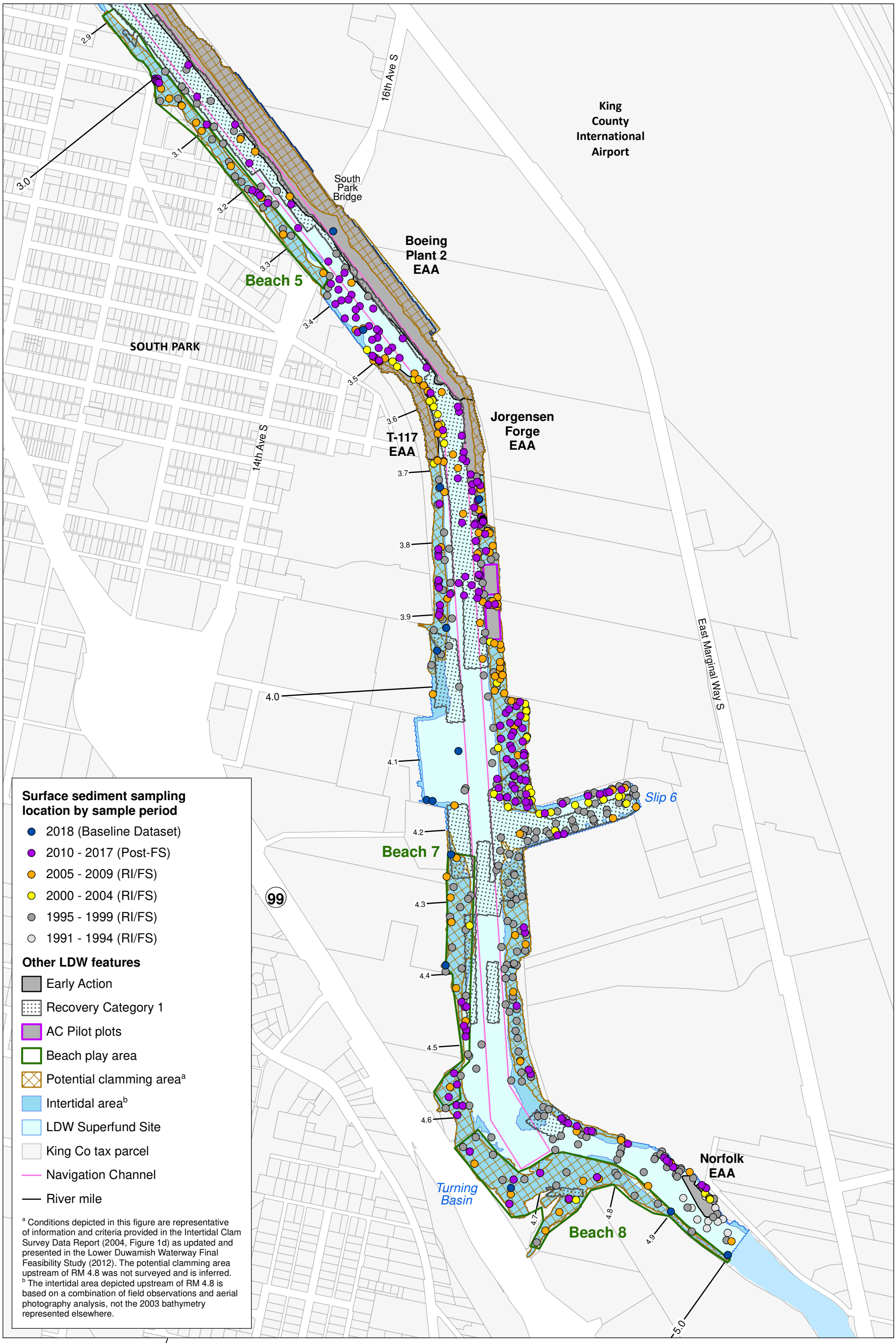
**Map 1. Overview of the LDW upper reach (RM 3.0 to RM 5.0)**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 01 7034 Upper Reach.mxd

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N

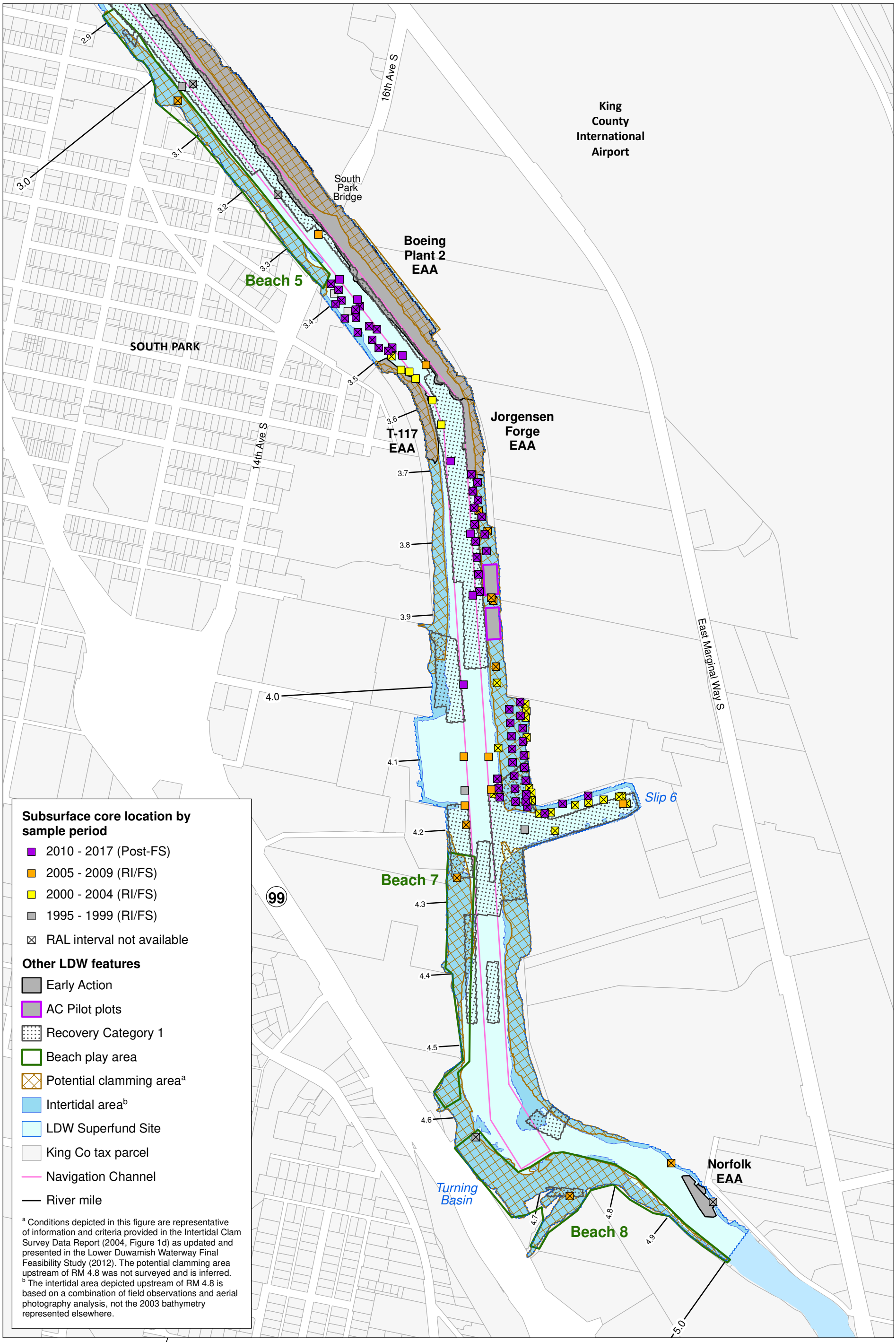
0 500 1,000 Feet

0 200 400 Meters

**Map 2. Existing surface sediment sampling locations in the LDW upper reach by sample period**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by: craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 02 7034 Upper Reach - SAs surfsed.mxd

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N

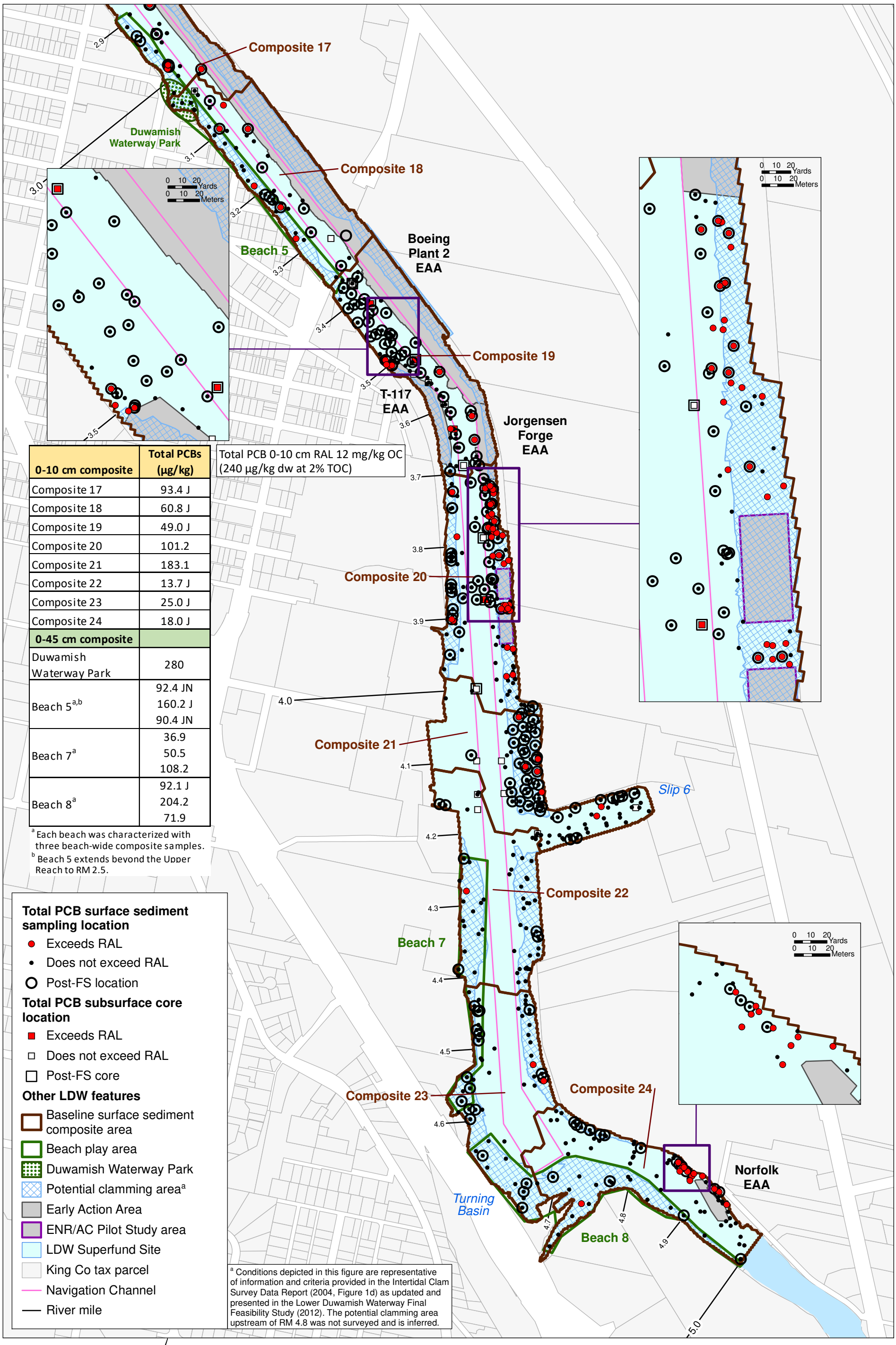
0 500 1,000 Feet

0 200 400 Meters

**Map 3. Existing subsurface sediment sampling locations in the LDW upper reach by sample period**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 03 7034 Upper Reach - SAs subsurf.mxd




| 0-10 cm composite | Total PCBs (µg/kg) |
|---|---|
| Composite 17 | 93.4 J |
| Composite 18 | 60.8 J |
| Composite 19 | 49.0 J |
| Composite 20 | 101.2 |
| Composite 21 | 183.1 |
| Composite 22 | 13.7 J |
| Composite 23 | 25.0 J |
| Composite 24 | 18.0 J |
| **0-45 cm composite** | |
| Duwamish Waterway Park | 280 |
| Beach 5[a,b] | 92.4 JN<br>160.2 J<br>90.4 JN |
| Beach 7[a] | 36.9<br>50.5<br>108.2 |
| Beach 8[a] | 92.1 J<br>204.2<br>71.9 |

[a] Each beach was characterized with three beach-wide composite samples.
[b] Beach 5 extends beyond the Upper Reach to RM 2.5.

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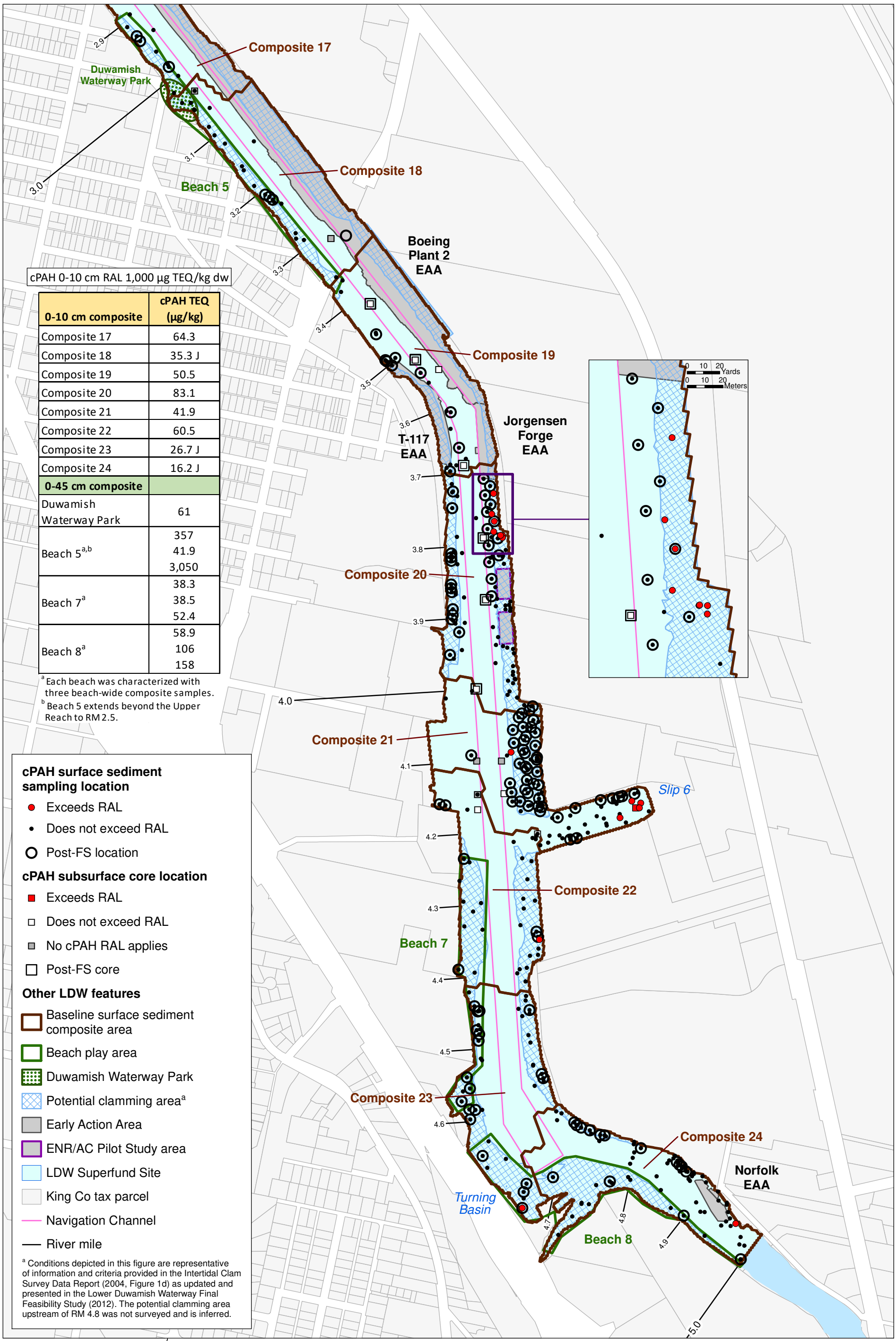
**Map 4. Total PCB results compared to RAL in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by: craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 04 6849 Surface sediment compositing data - wAllSed - tPCBs.mxd




| 0-10 cm composite | cPAH TEQ (µg/kg) |
|---|---|
| Composite 17 | 64.3 |
| Composite 18 | 35.3 J |
| Composite 19 | 50.5 |
| Composite 20 | 83.1 |
| Composite 21 | 41.9 |
| Composite 22 | 60.5 |
| Composite 23 | 26.7 J |
| Composite 24 | 16.2 J |
| **0-45 cm composite** | |
| Duwamish Waterway Park | 61 |
| Beach 5[a,b] | 357<br>41.9<br>3,050 |
| Beach 7[a] | 38.3<br>38.5<br>52.4 |
| Beach 8[a] | 58.9<br>106<br>158 |

[a] Each beach was characterized with three beach-wide composite samples.
[b] Beach 5 extends beyond the Upper Reach to RM 2.5.

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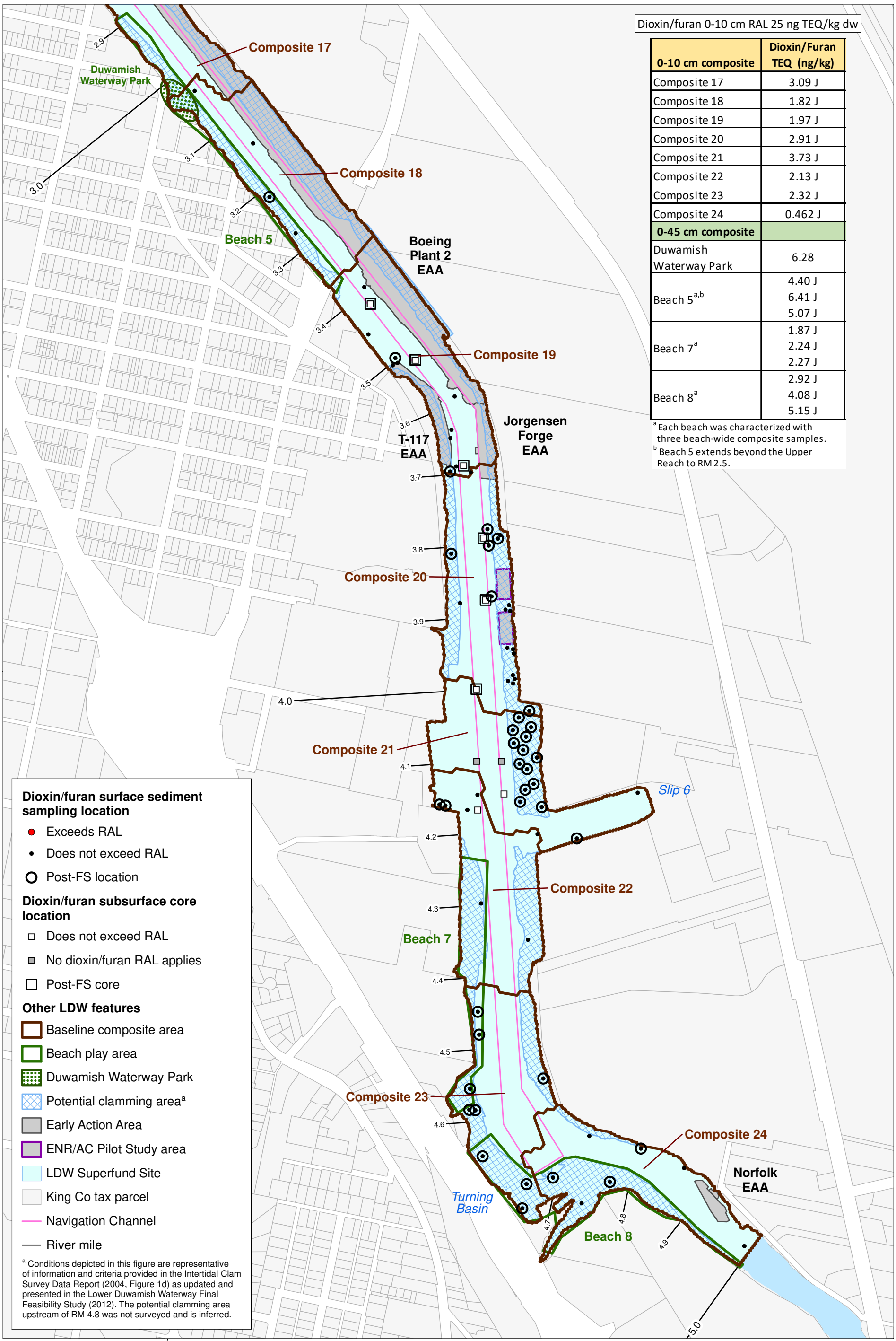
**Map 5. cPAH TEQ results compared to RAL in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 05 6849 Surface sediment compositing data - wAllSed - cPAH.mxd




Dioxin/furan 0-10 cm RAL 25 ng TEQ/kg dw

| 0-10 cm composite | Dioxin/Furan TEQ (ng/kg) |
|---|---|
| Composite 17 | 3.09 J |
| Composite 18 | 1.82 J |
| Composite 19 | 1.97 J |
| Composite 20 | 2.91 J |
| Composite 21 | 3.73 J |
| Composite 22 | 2.13 J |
| Composite 23 | 2.32 J |
| Composite 24 | 0.462 J |
| **0-45 cm composite** | |
| Duwamish Waterway Park | 6.28 |
| Beach 5[a,b] | 4.40 J<br>6.41 J<br>5.07 J |
| Beach 7[a] | 1.87 J<br>2.24 J<br>2.27 J |
| Beach 8[a] | 2.92 J<br>4.08 J<br>5.15 J |

[a] Each beach was characterized with three beach-wide composite samples.
[b] Beach 5 extends beyond the Upper Reach to RM 2.5.

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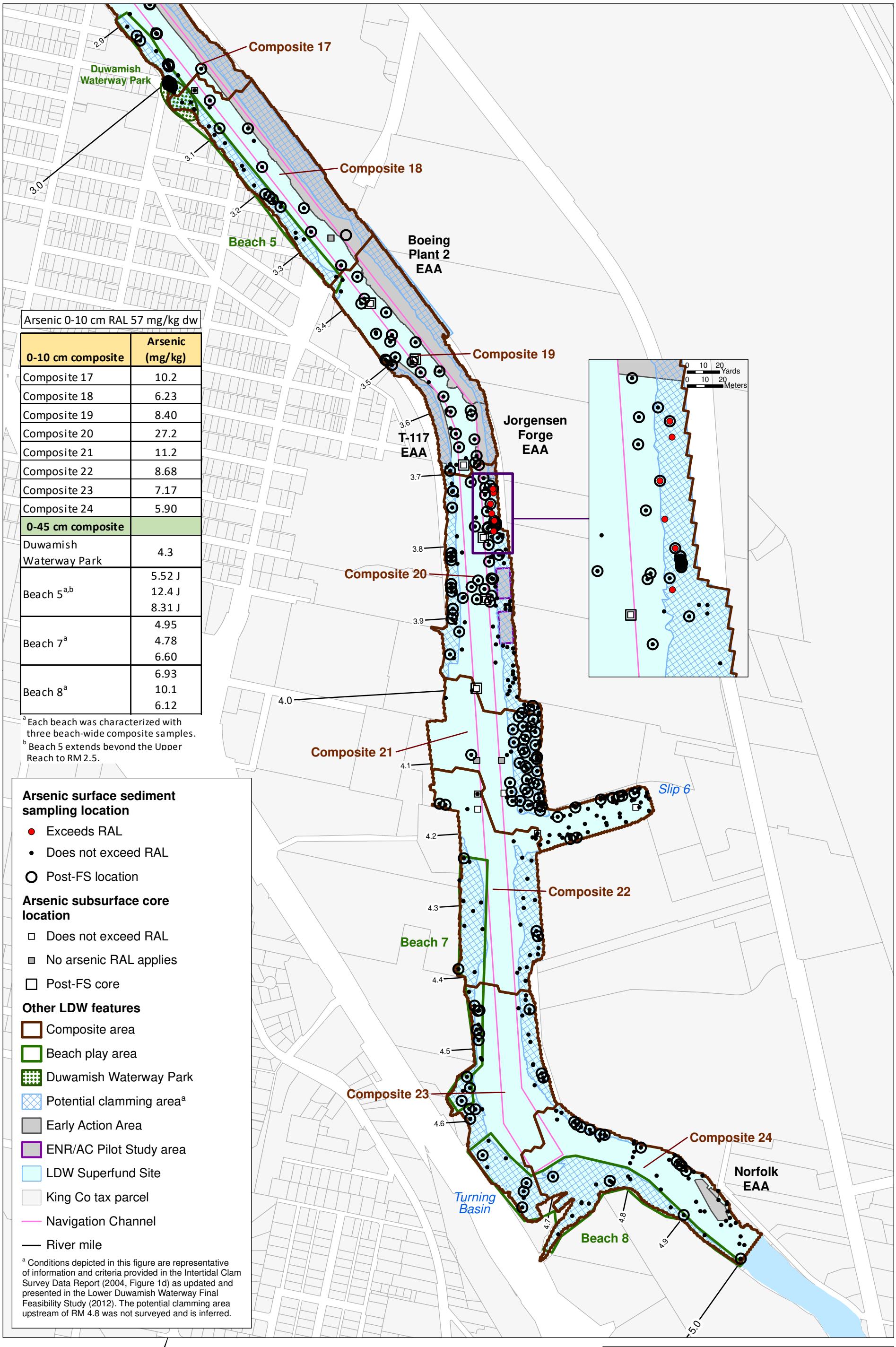
N

0 500 1,000 Feet
0 200 400 Meters

**Map 6. Dioxin/furan TEQ results compared to RAL in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 06 6849 Surface sediment compositing data - wAllSed - DF.mxd




Arsenic 0-10 cm RAL 57 mg/kg dw

| 0-10 cm composite | Arsenic (mg/kg) |
|---|---|
| Composite 17 | 10.2 |
| Composite 18 | 6.23 |
| Composite 19 | 8.40 |
| Composite 20 | 27.2 |
| Composite 21 | 11.2 |
| Composite 22 | 8.68 |
| Composite 23 | 7.17 |
| Composite 24 | 5.90 |
| **0-45 cm composite** | |
| Duwamish Waterway Park | 4.3 |
| Beach 5[a,b] | 5.52 J<br>12.4 J<br>8.31 J |
| Beach 7[a] | 4.95<br>4.78<br>6.60 |
| Beach 8[a] | 6.93<br>10.1<br>6.12 |

[a] Each beach was characterized with three beach-wide composite samples.
[b] Beach 5 extends beyond the Upper Reach to RM 2.5.

**Arsenic surface sediment sampling location**

- Exceeds RAL
- Does not exceed RAL
- Post-FS location

**Arsenic subsurface core location**

- Does not exceed RAL
- No arsenic RAL applies
- Post-FS core

**Other LDW features**

- Composite area
- Beach play area
- Duwamish Waterway Park
- Potential clamming area[a]
- Early Action Area
- ENR/AC Pilot Study area
- LDW Superfund Site
- King Co tax parcel
- Navigation Channel
- River mile

[a] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012). The potential clamming area upstream of RM 4.8 was not surveyed and is inferred.

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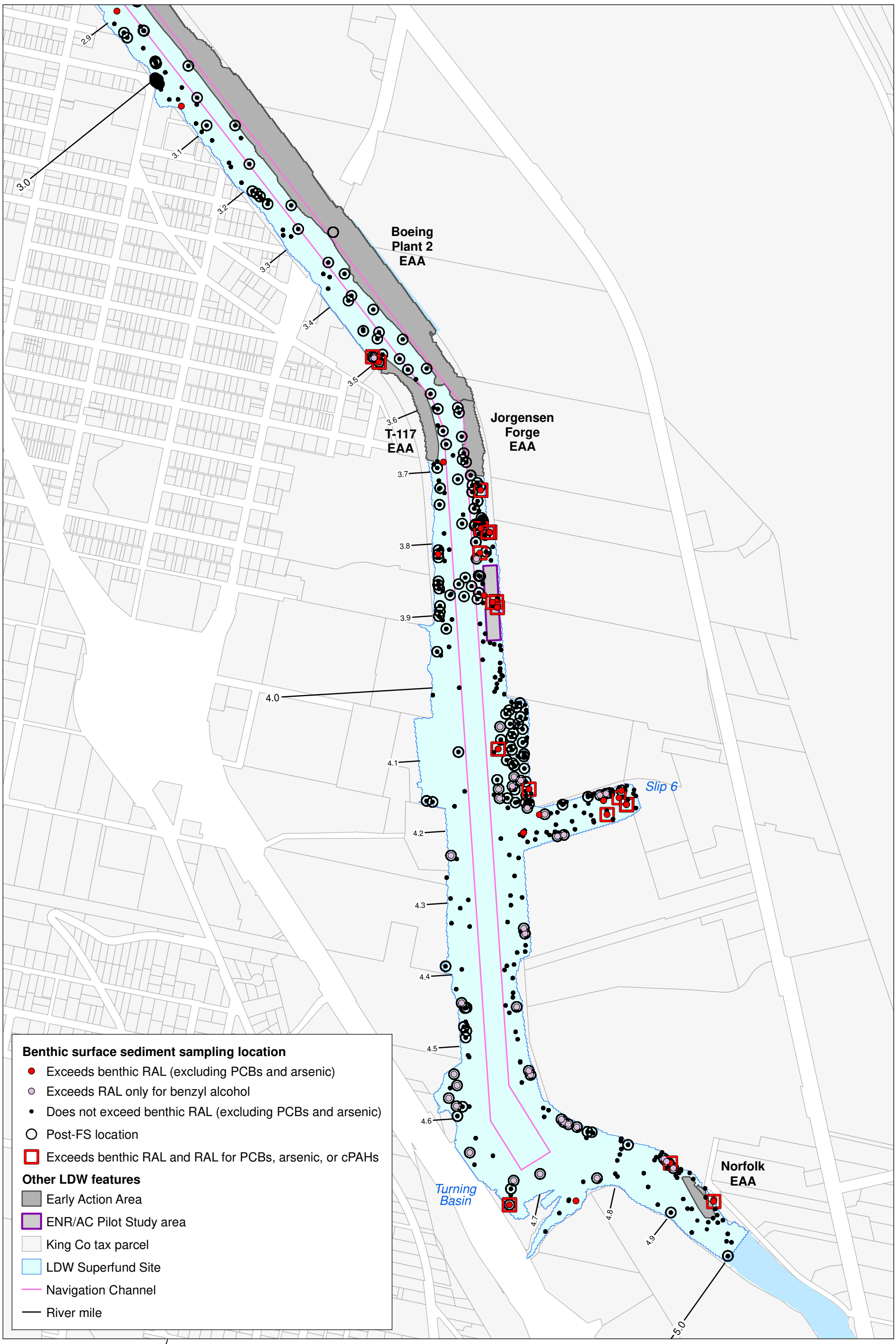
N

0 500 1,000 Feet
0 200 400 Meters

**Map 7. Arsenic results compared to RAL in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 07 6849 Surface sediment compositing data - wAllSed - Arsenic.mxd

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N

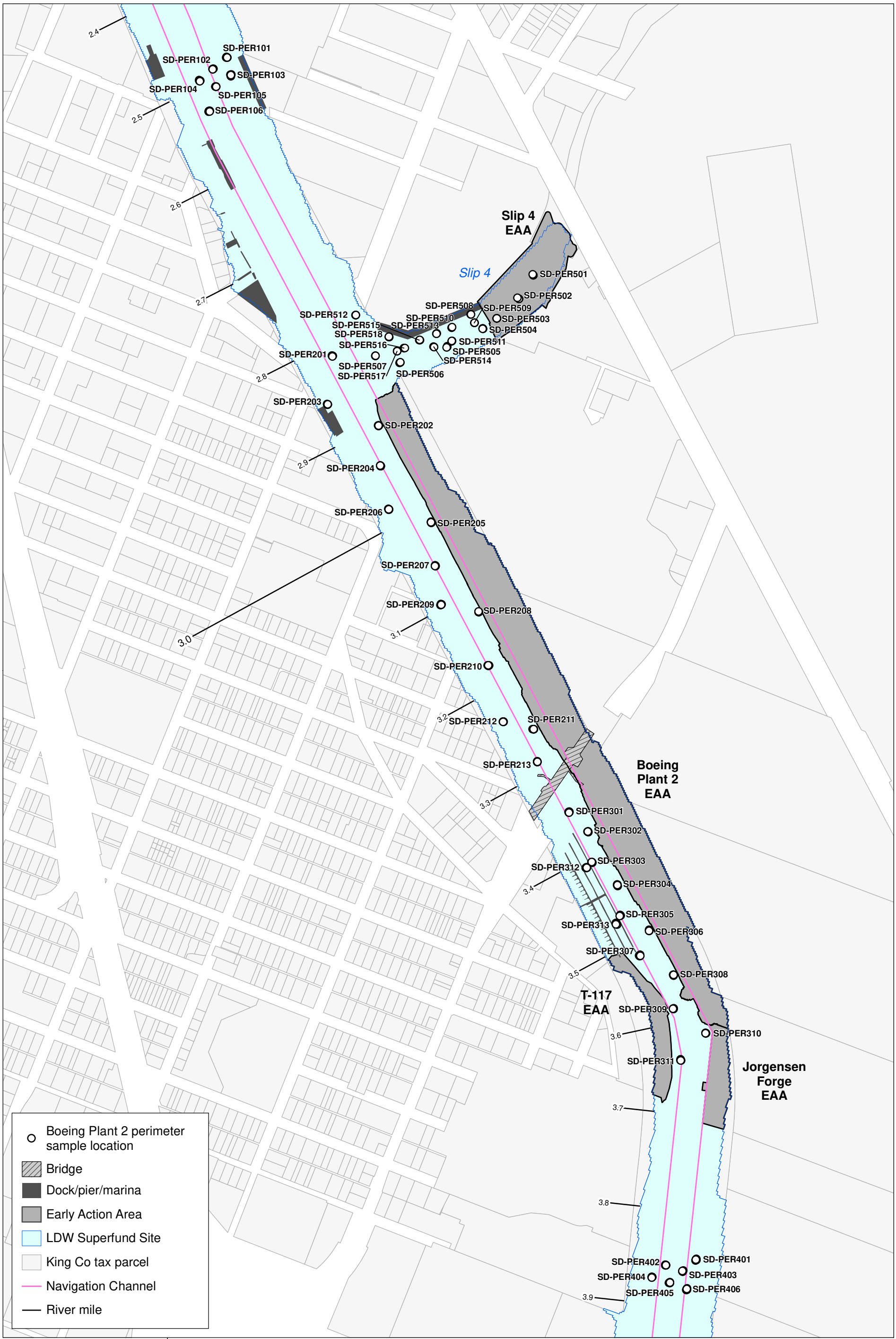
0 500 1,000 Feet

0 200 400 Meters

**Map 8. Benthic RAL exceedances in LDW upper reach surface sediment**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 08 7027 Benthic SMS exc in Upper Reach.mxd

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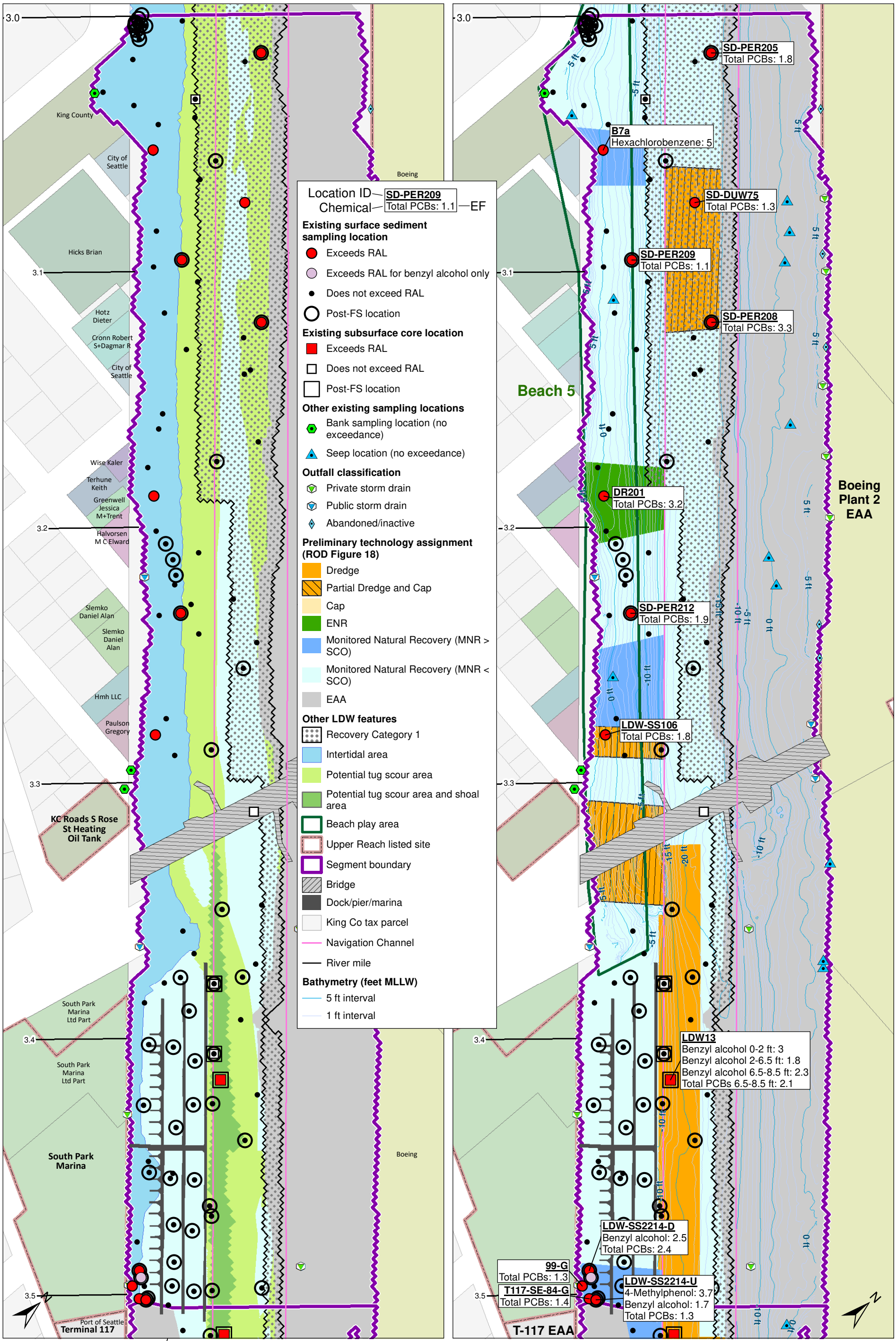
**Map 9. Boeing Plant 2 perimeter sample locations in the LDW**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 09 7053 Boeing Plant 2 Perimeter.mxd

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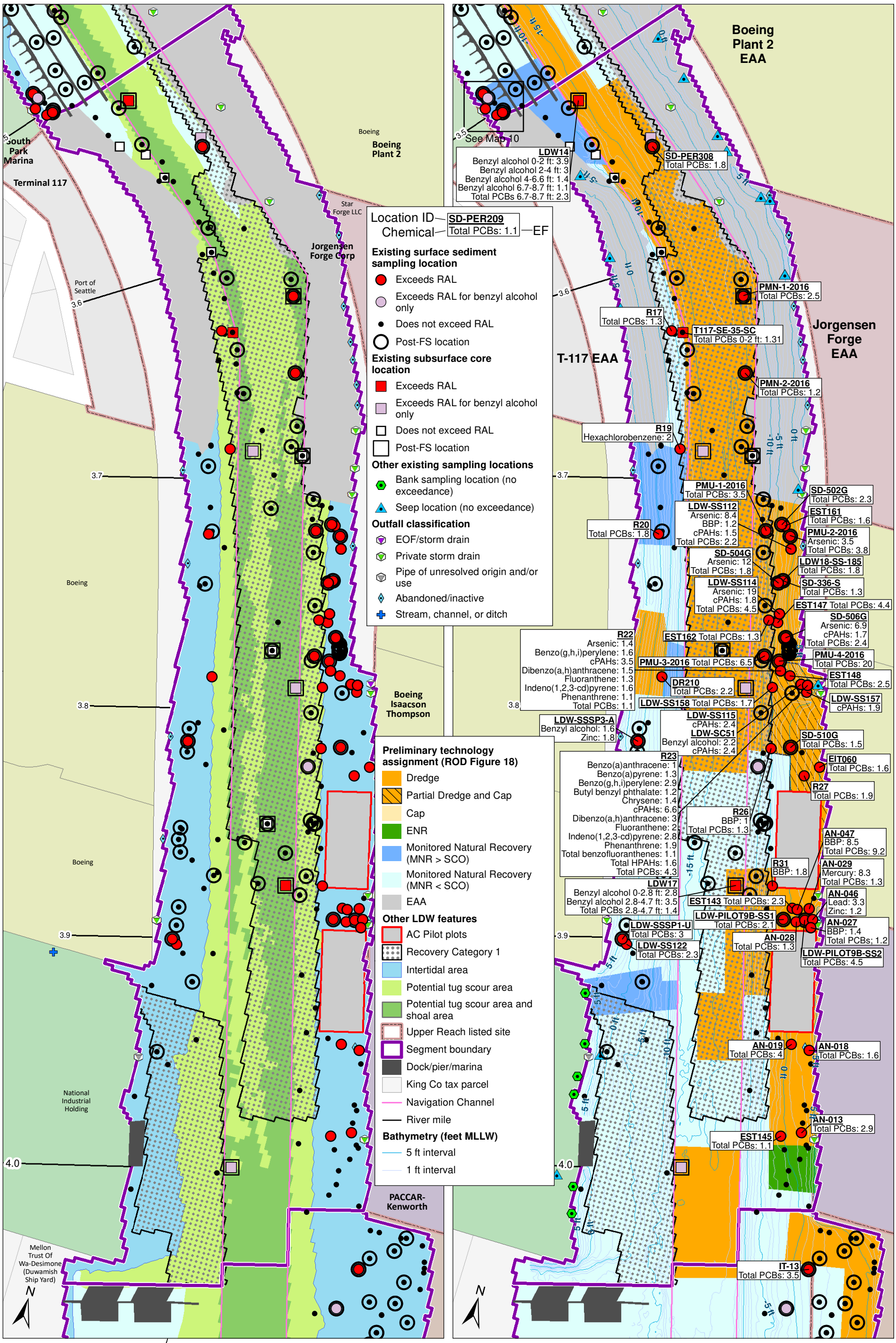
**Map 10. Segment 1 (RM 3.0 to RM 3.5) sediment RAL exceedances, bathymetry, and ROD Figure 18 remedial action areas**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 10 7034 Upper Reach - Segment 1 - dual.mxd

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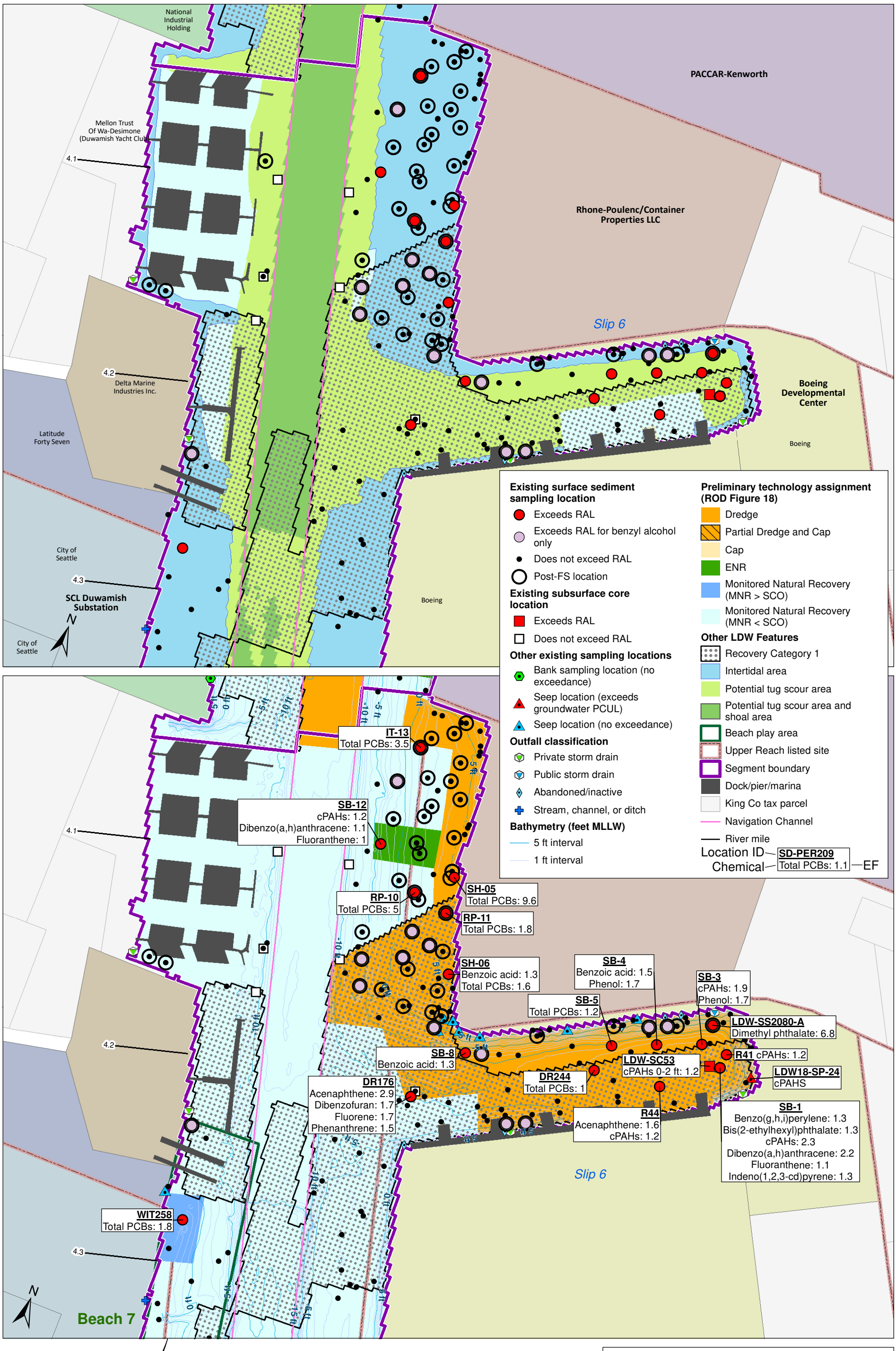
0 200 400 Feet
0 50 100 Meters
Scale is the same for each inset map

**Map 11. Segment 2 (RM 3.5 to RM 4.05) sediment RAL exceedances, bathymetry, and ROD Figure 18 remedial action areas**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 11 7034 Upper Reach - Segment 2 - dual.mxd

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0 200 400 Feet
0 50 100 Meters
Scale is the same for each inset map

**Map 12. Segment 3a (RM 4.05 to RM 4.35) sediment RAL exceedances, bathymetry, and ROD Figure 18 remedial action areas**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 12 7034 Upper Reach - Segment 3a - dual.mxd

Location ID — SD-PER209
Chemical — Total PCBs: 1.1 — EF

**Existing surface sediment sampling location**
- Exceeds RAL
- Exceeds RAL for benzyl alcohol only
- Does not exceed RAL
- Post-FS location

**Other existing sampling locations**
- Bank sampling location (exceeds RAL)
- Bank sampling location (no exceedance)
- Seep location (exceeds groundwater PCUL)
- Seep location (no exceedance)

**Outfall classification**
- CSO/storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned/inactive
- Stream, channel, or ditch

**Preliminary technology assignment (ROD Figure 18)**
- Dredge
- Partial Dredge and Cap
- Cap
- ENR
- Monitored Natural Recovery (MNR > SCO)
- Monitored Natural Recovery (MNR < SCO)
- EAA

**Other LDW features**
- Recovery Category 1
- Intertidal area[a]
- Potential tug scour area
- Potential tug scour area and shoal area
- Beach play area
- Upper Reach listed site
- Segment boundary
- Bridge
- Dock/pier/marina
- King Co tax parcel
- Navigation Channel
- River mile

**Bathymetry (feet MLLW)**
- 5 ft interval
- 1 ft interval

[a] The intertidal area depicted upstream of RM 4.8 is based on a combination of field observations and aerial photography analysis, not the 2003 bathymetry represented elsewhere.

Boeing Developmental Center
Desimone Trust Boeing
City of Seattle
SCL Duwamish Substation
Boeing
Muckleshoot Tribe USA in Trust
Turning Basin
Port of Seattle
Desimone Trust Oxbow 2601
Mellon
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
N

R63
cPAHs: 1.4
B9a
Total PCBs: 1.1
R75
Total PCBs: 1.2
LDW18-SP-33
BEHP
cPAHS
See Map 14
Norfolk EAA
LDW18-BNK6-1
Total PCBs: 11
LDW-SS148
Total PCBs: 1.7
B10a
Phenol: 1.3
BKG-2
Acenaphthene: 1.3
cPAHs: 2.4
Phenanthrene: 1.2
Beach 7
Beach 8
0 ft
-5 ft
-10 ft
-15 ft

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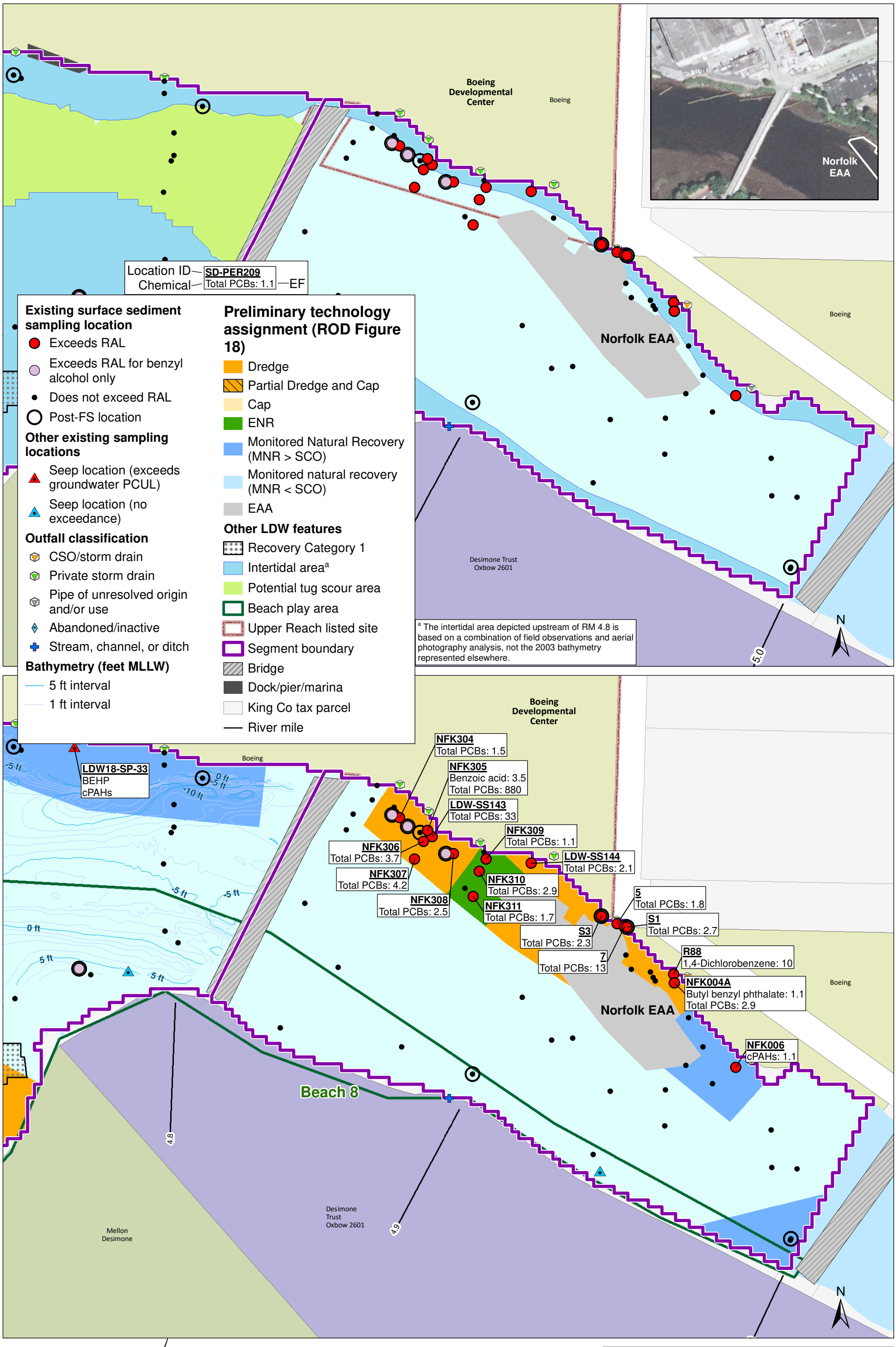
0 300 600 Feet
0 100 200 Meters
Scale is the same for each inset map

**Map 13. Segment 3b (RM 4.35 to RM 4.8) sediment RAL exceedances, bathymetry, and ROD Figure 18 remedial action areas**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 13 7034 Upper Reach - Segment 3b - dual.mxd

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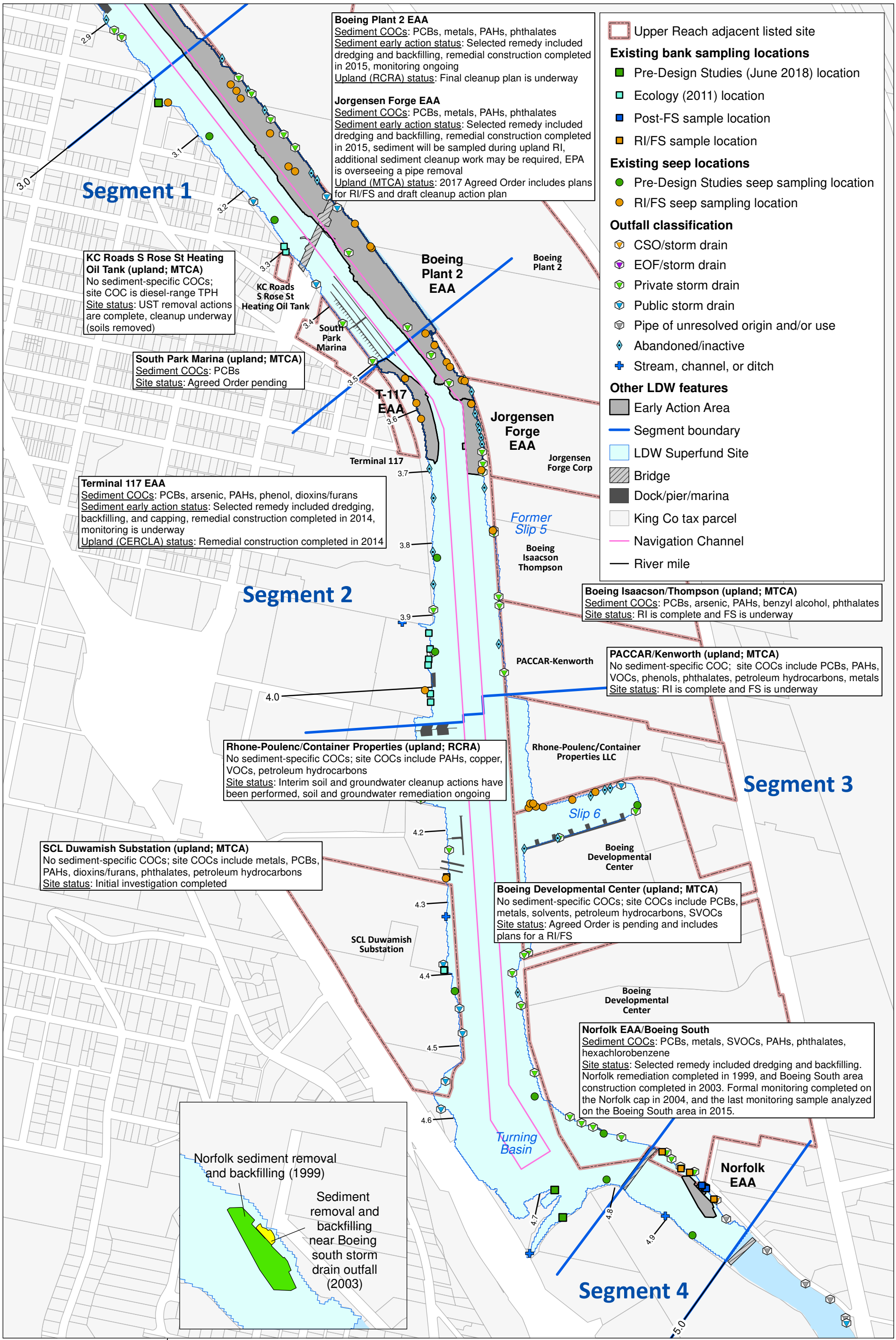
0 100 200 Feet
0 40 80 Meters
Scale is the same for each inset map

**Map 14. Segment 4 (RM 4.8 to RM 5.0) sediment RAL exceedances, bathymetry, and ROD Figure 18 remedial action areas**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 14 7034 Upper Reach - Segment 4 - dual.mxd

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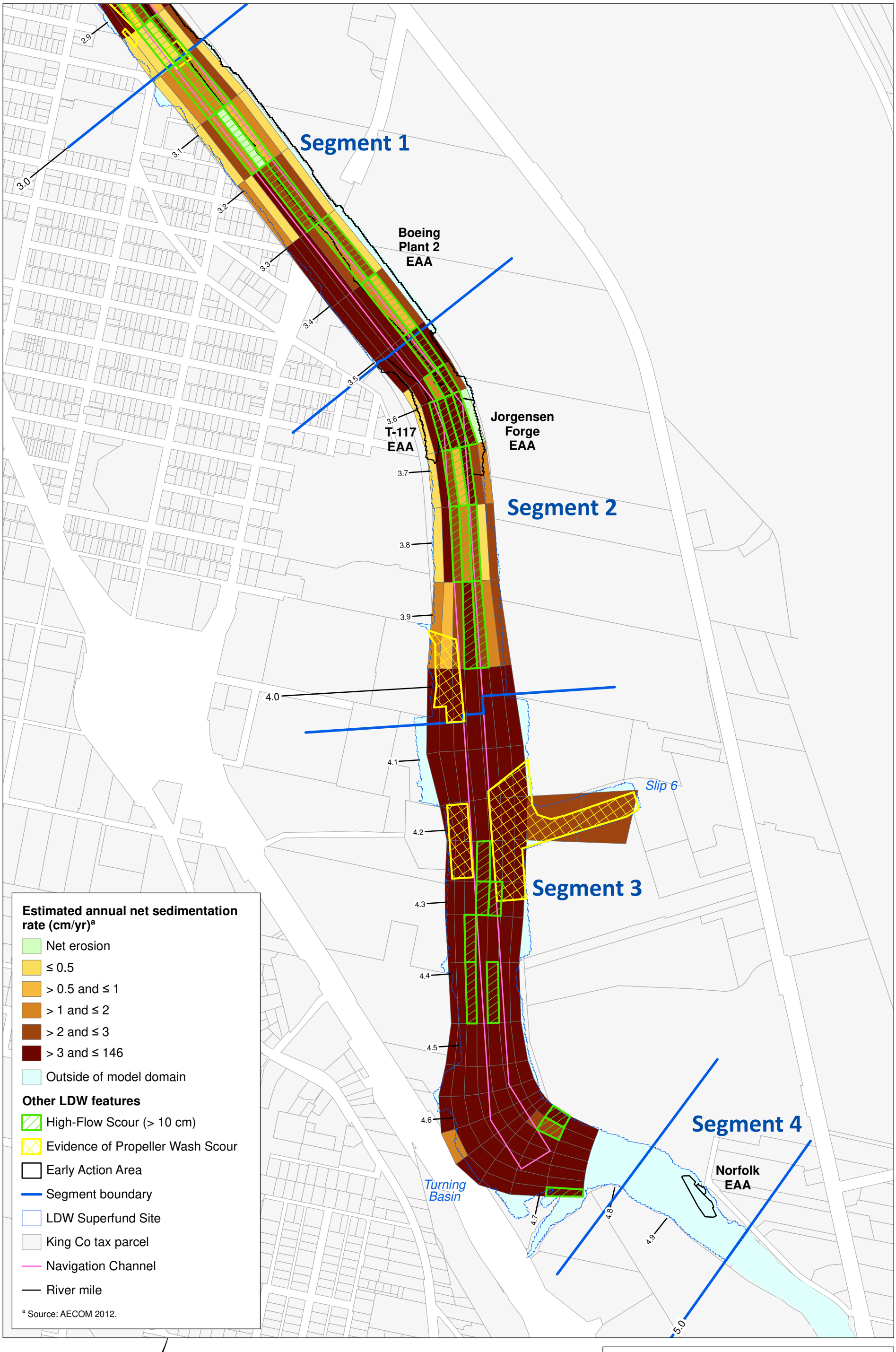
**Map 15. EAAs and adjacent listed sites in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 15 7054 EAAs and listed sites.mxd

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N

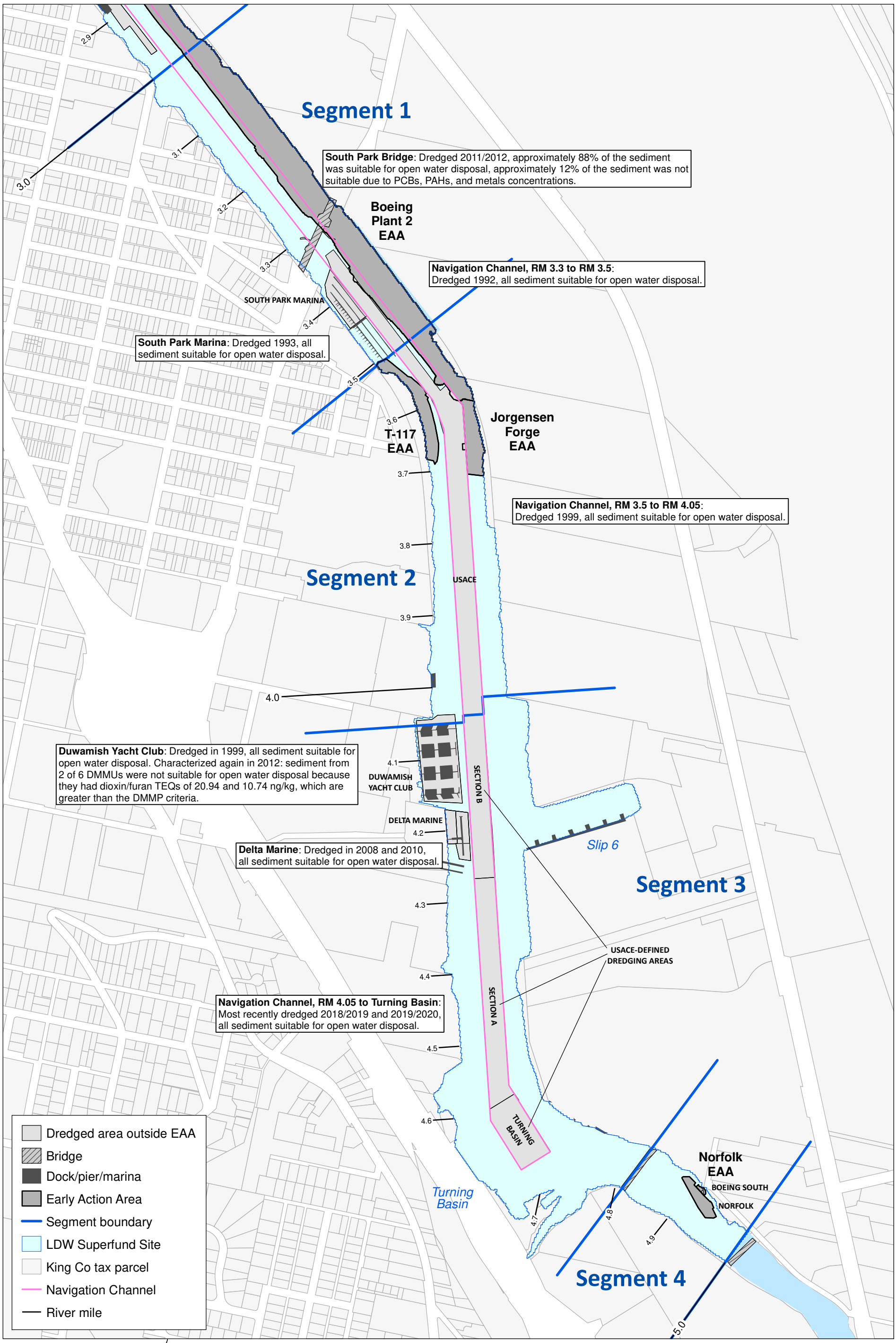
0 500 1,000 Feet

0 200 400 Meters

**Map 16. Estimated annual net sedimentation rates and scour areas in the LDW**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 16 7051 Estimated annual net sedimentation rates.mxd

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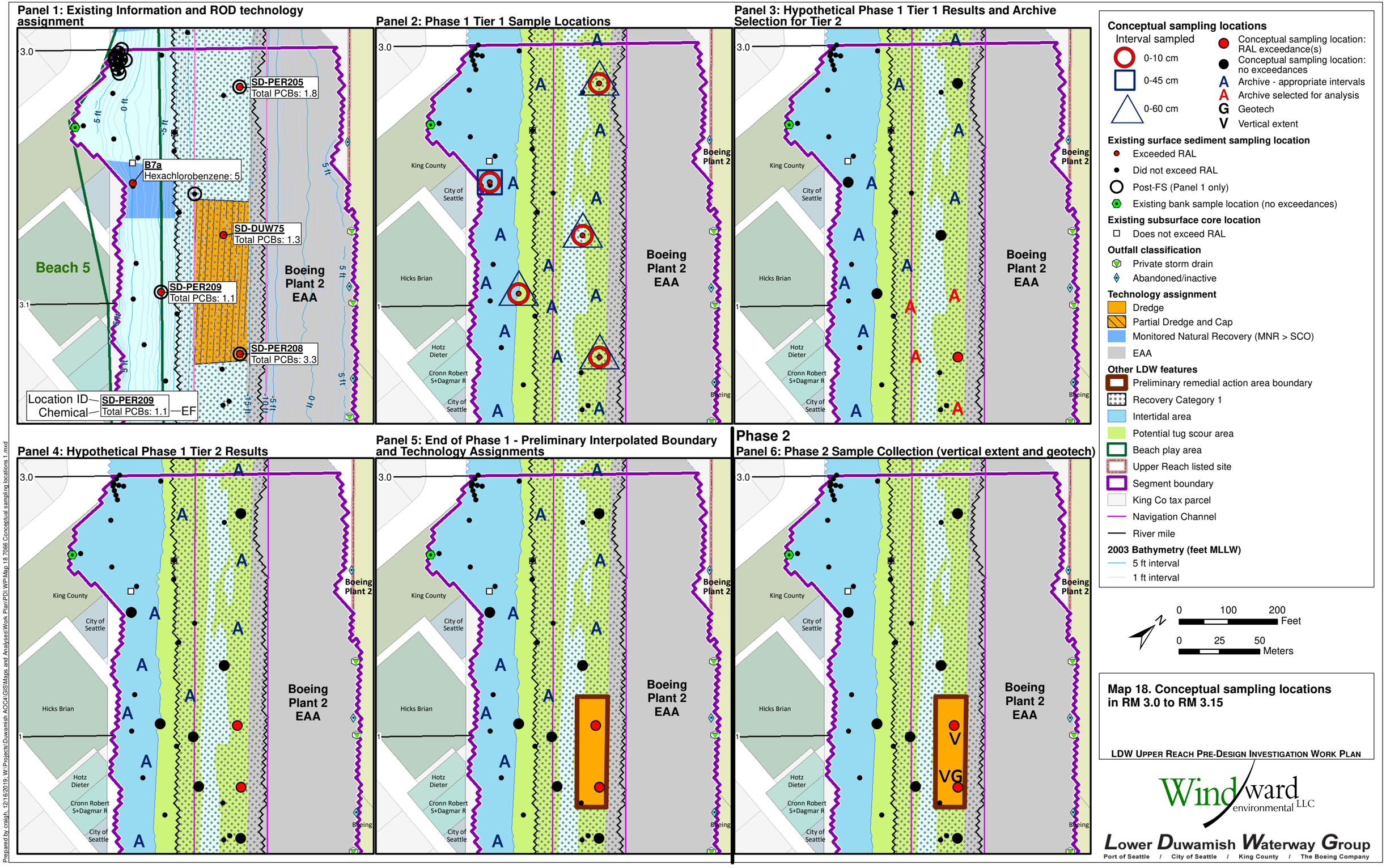
**Map 17. Areas in the LDW upper reach dredged since 1992**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 17 7055 Dredge areas.mxd




**Map 18. Conceptual sampling locations in RM 3.0 to RM 3.15**

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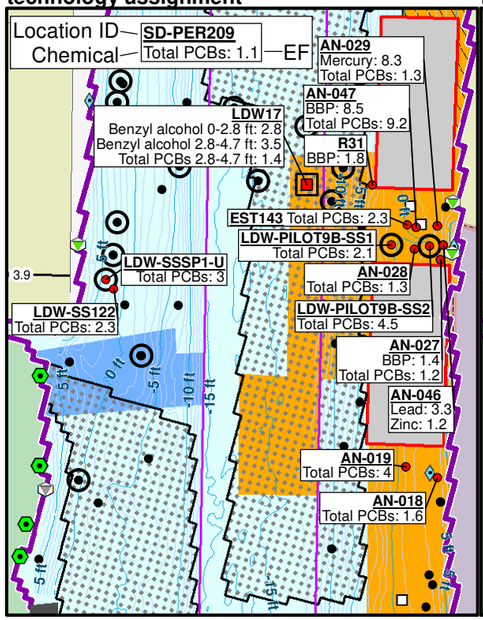
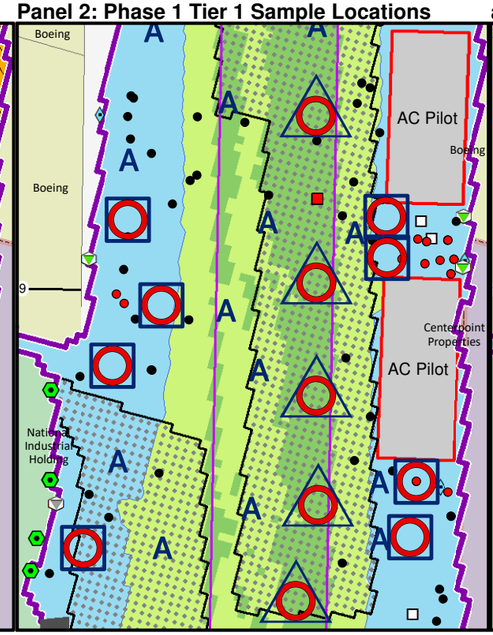
Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 18 7066 Conceptual sampling locations 1.mxd

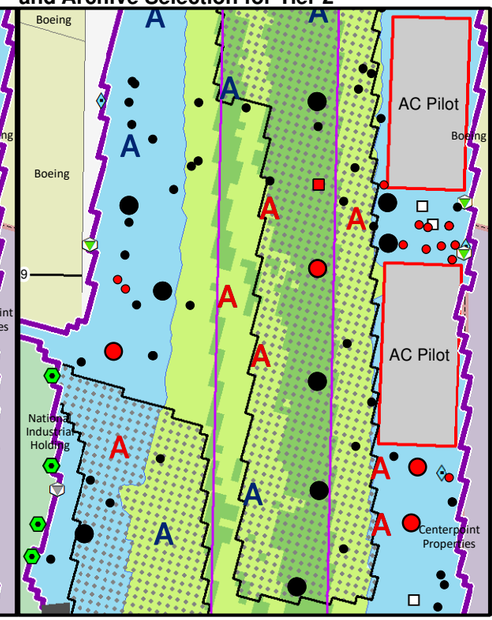
## Panel 1: Existing Information and ROD technology assignment



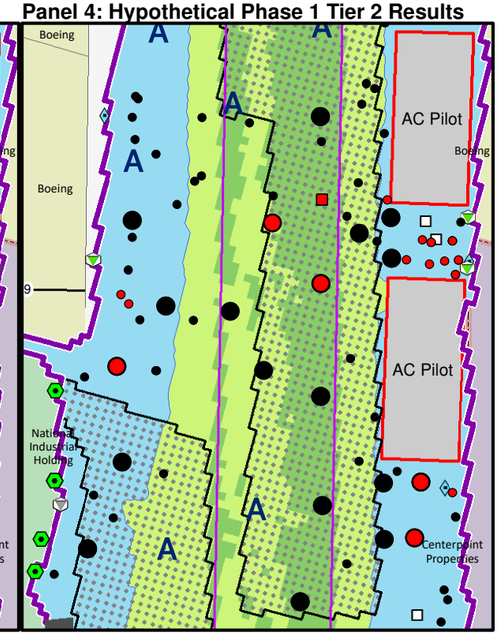

## Panel 2: Phase 1 Tier 1 Sample Locations




## Panel 3: Hypothetical Phase 1 Tier 1 Results and Archive Selection for Tier 2

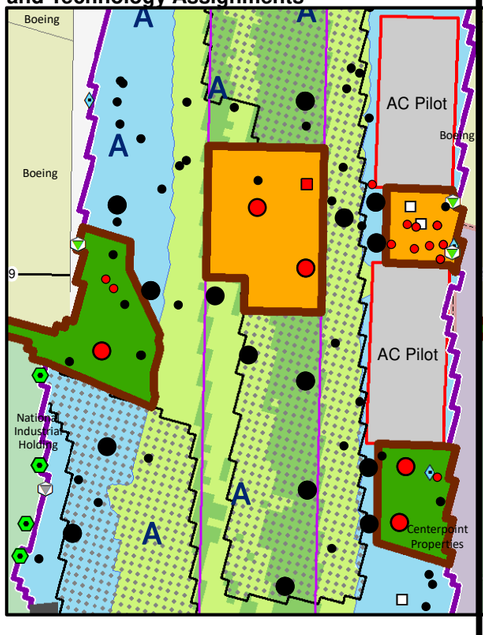



## Panel 4: Hypothetical Phase 1 Tier 2 Results



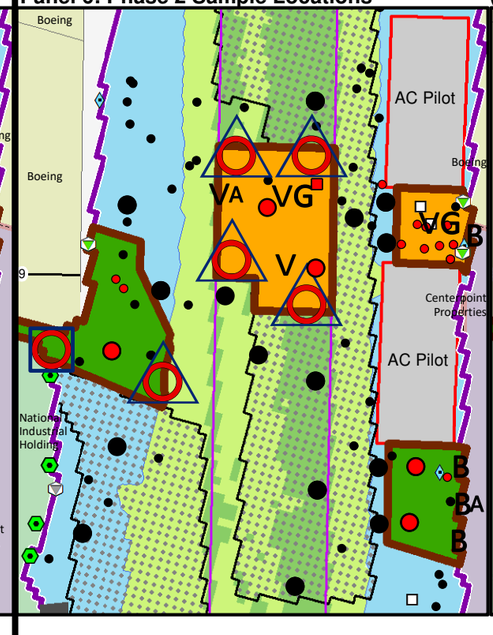

## End of Phase 1

### Panel 5: Preliminary Interpolated Boundaries and Technology Assignments



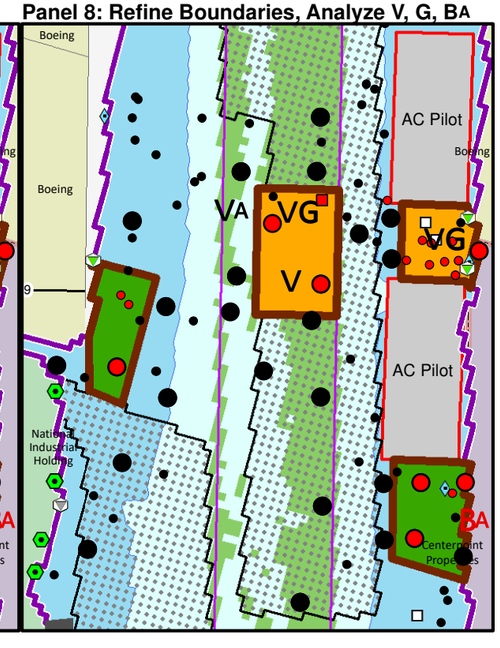

## Phase 2

### Panel 6: Phase 2 Sample Locations




### Panel 7: Hypothetical Phase 2 Results (Sediment and Bank)

### Panel 8: Refine Boundaries, Analyze V, G, BA




**Conceptual sampling locations**

Interval sampled
- 0-10 cm
- 0-45 cm
- 0-60 cm

- Conceptual sampling location: RAL exceedance(s)
- Conceptual sampling location: no exceedances
- A Archive - appropriate intervals
- A Archive selected for analysis
- B Bank
- BA Bank archive selected for analysis
- G Geotech
- V Vertical extent

**Existing surface sediment sampling location**
- Exceeded RAL
- Did not exceed RAL
- Post-FS (Panel 1 only)
- Existing bank sample location (no exceedances)

**Existing subsurface core location**
- Exceeded RAL
- Did not exceed RAL
- Post-FS (Panel 1 only)

**Outfall classification**
- Private storm drain
- Pipe of unresolved origin and/or use
- Abandoned/inactive

**Technology assignment**
- Dredge
- Partial Dredge and Cap
- ENR
- Monitored Natural Recovery (Surface Sediment >SCO)

**Other LDW features**
- Preliminary remedial action area boundary
- AC Pilot plots
- Recovery Category 1
- Intertidal area
- Potential tug scour area
- Potential tug scour area and shoal area
- Segment boundary
- King Co tax parcel
- Navigation Channel
- River mile

**2003 Bathymetry (feet MLLW)**
- 5 ft interval
- 1 ft interval

N

0 100 200 Feet

0 25 50 Meters

**Map 19. Conceptual sampling locations in RM 3.8 to RM 4.0**

LDW Upper Reach Pre-Design Investigation Work Plan

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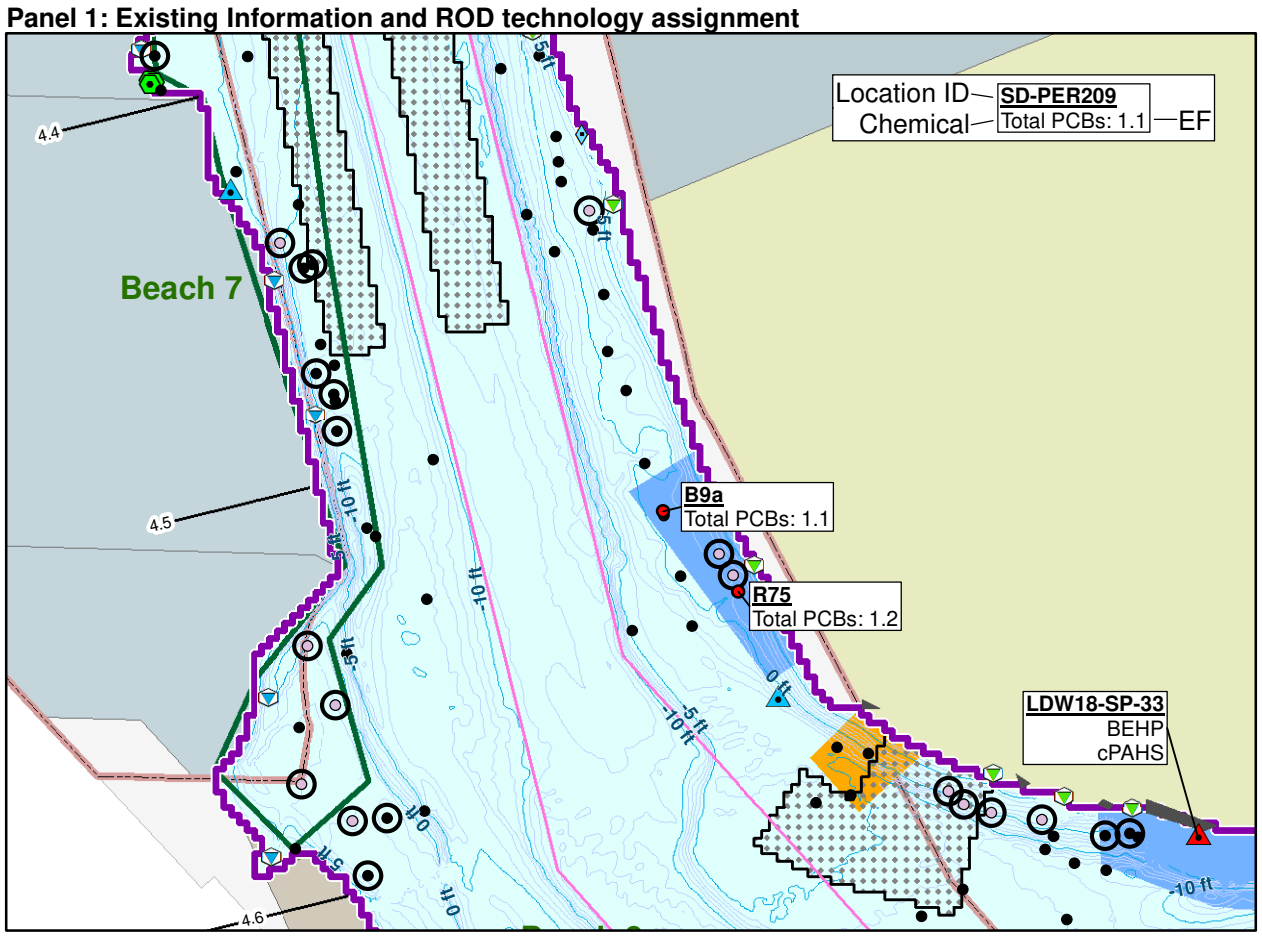
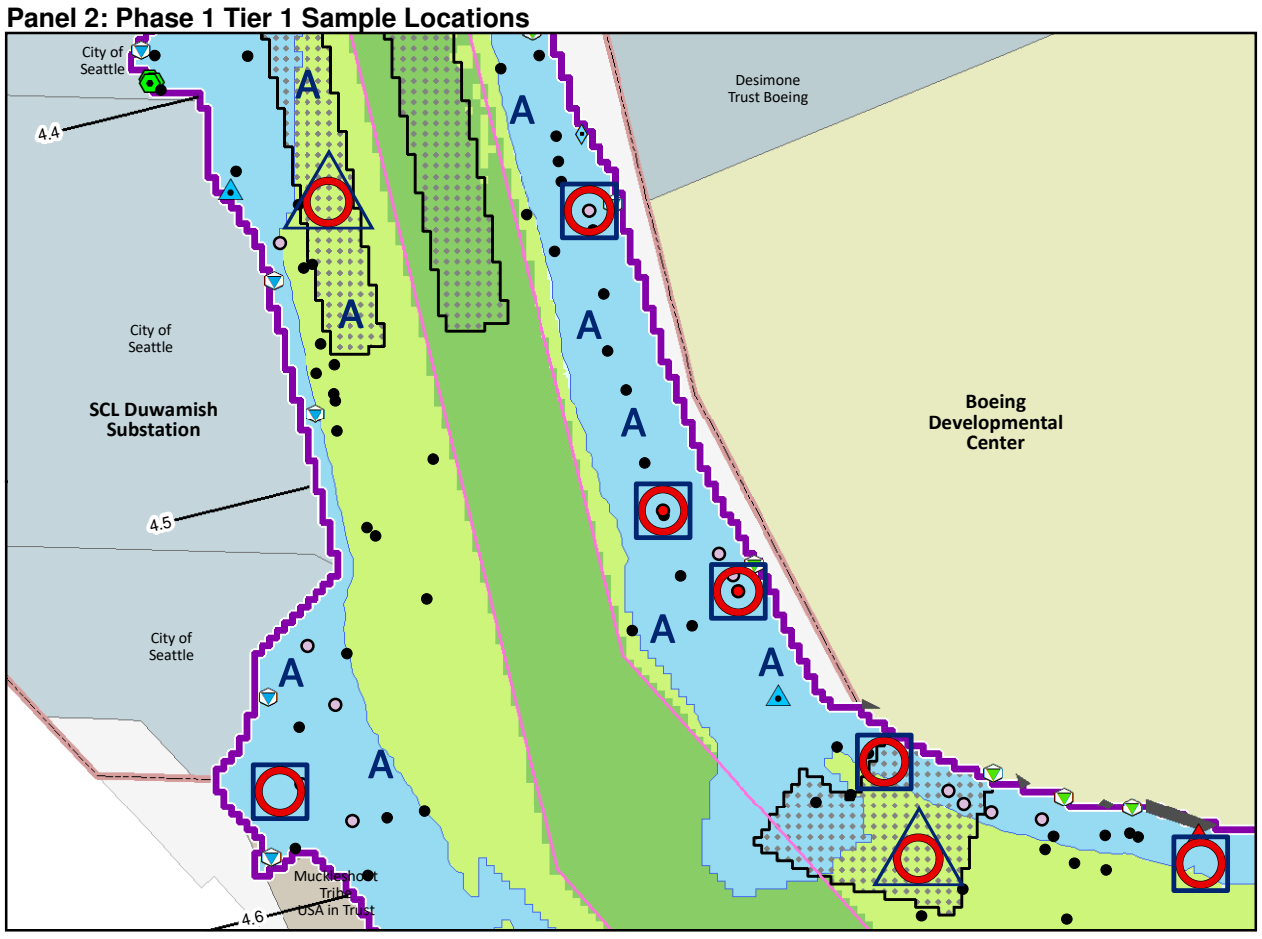
Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map 19 7066 Conceptual sampling locations 2.mxd

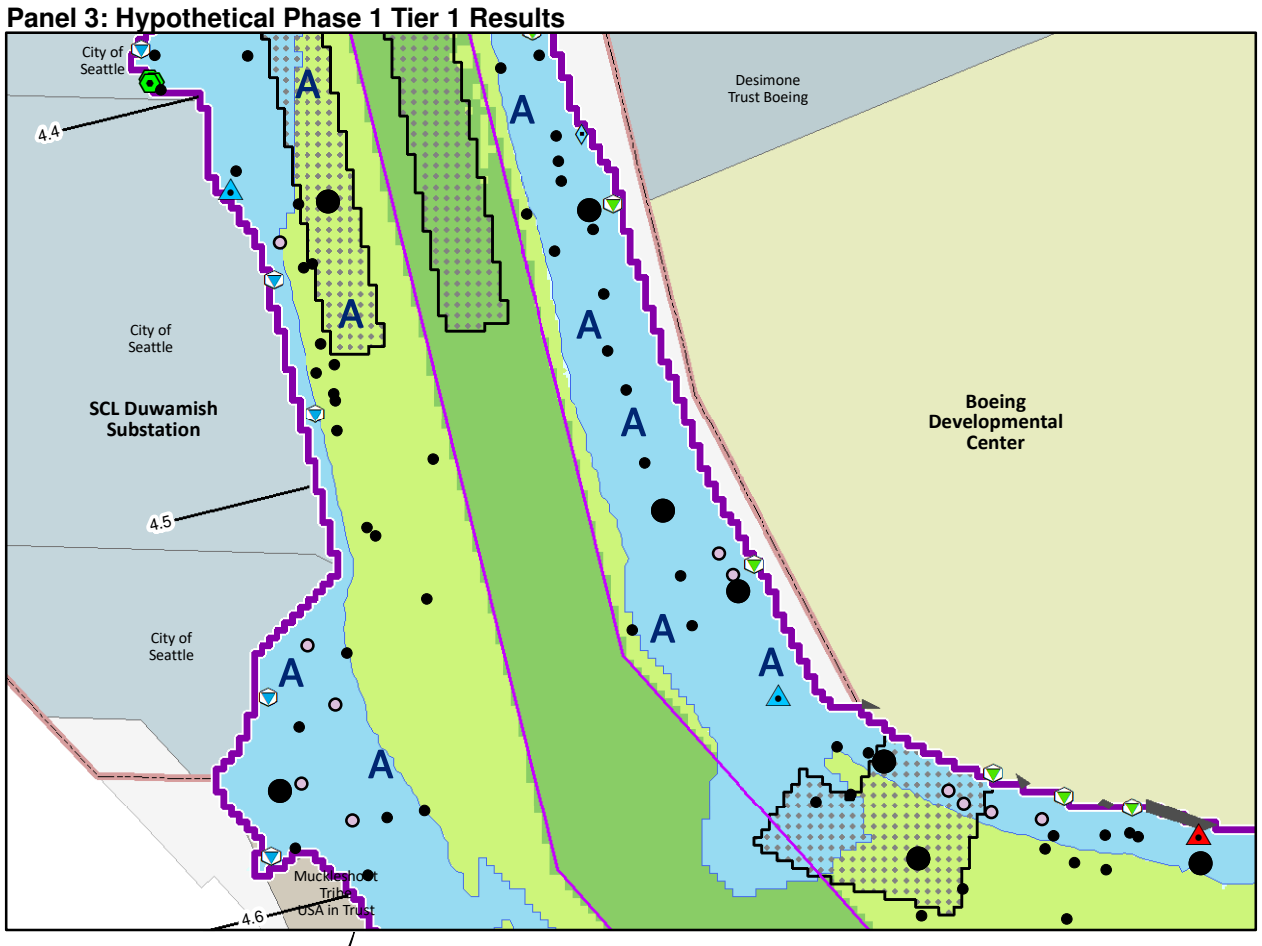
**Panel 1: Existing Information and ROD technology assignment**




**Panel 2: Phase 1 Tier 1 Sample Locations**




**Panel 3: Hypothetical Phase 1 Tier 1 Results**




**Conceptual sampling locations**

Interval sampled
- 0-10 cm
- 0-45 cm
- 0-60 cm

- Conceptual sampling location: RAL exceedance(s)
- Conceptual sampling location: no exceedances
- A Archive - appropriate intervals

**Existing surface sediment sampling location**
- Exceeds RAL
- Exceeds RAL for benzyl alcohol only
- Does not exceed RAL

**Other existing sampling locations**
- Bank sampling location (no exceedance)
- Seep location (exceeds groundwater PCUL)
- Seep location (no exceedance)

**Outfall classification**
- Private storm drain
- Public storm drain
- Abandoned/inactive

**Technology assignment**
- Dredge
- Monitored Natural Recovery (MNR > SCO)

**Other LDW features**
- Recovery Category 1
- Intertidal area
- Potential tug scour area
- Potential tug scour area and shoal area
- Beach play area
- Dock/pier/marina
- Upper Reach listed site
- Segment boundary
- King Co tax parcel
- Navigation Channel
- River mile

**Bathymetry (feet MLLW)**
- 5 ft interval
- 1 ft interval

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N

0 200 400 Feet

0 50 100 Meters

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**Map 20. Conceptual sampling locations in RM 4.4 to RM 4.6**

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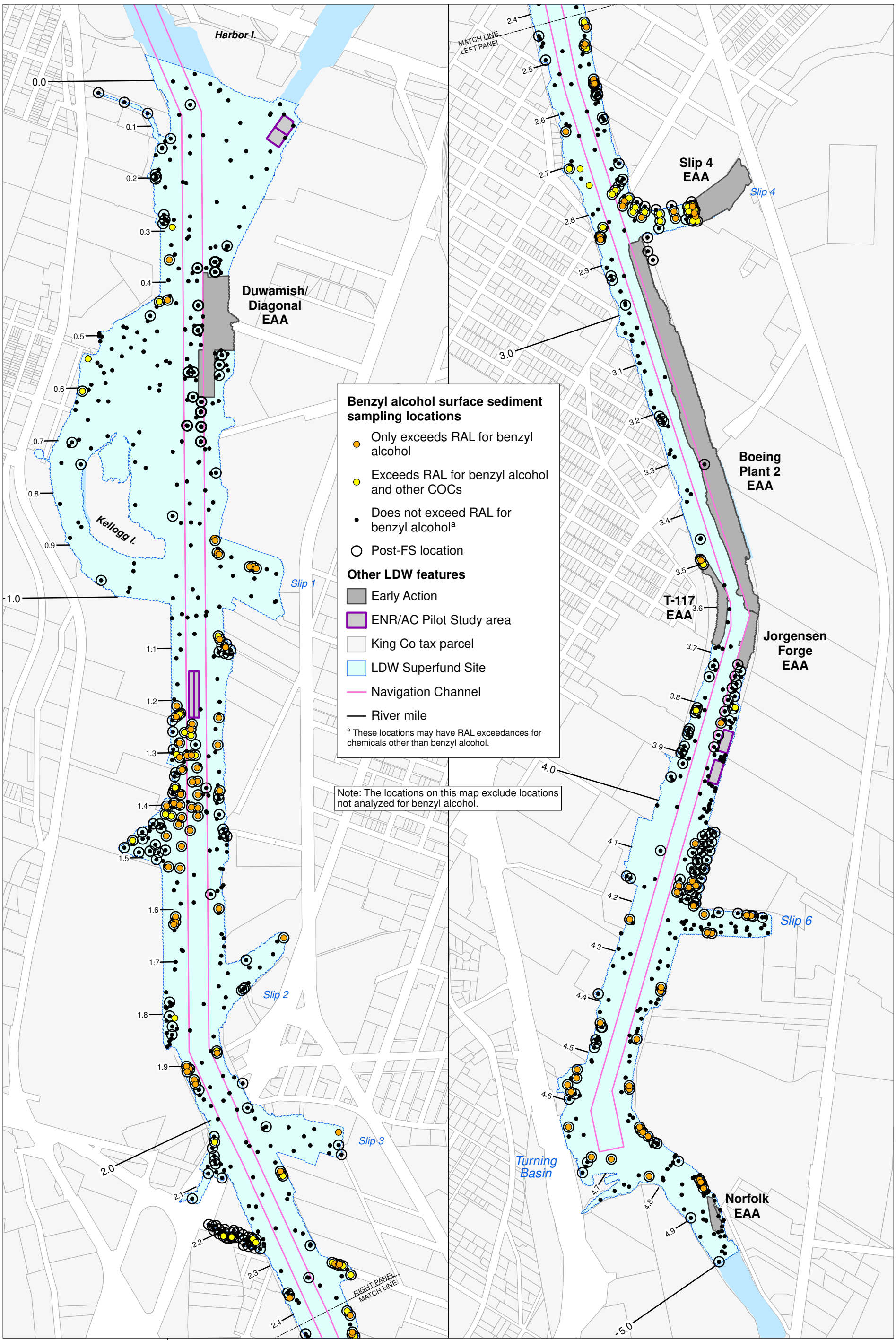


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N

0 600 1,200 Feet

0 200 400 Meters

**Map A-1. Benthic RAL exceedances in LDW surface sediment**

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Segment 1

Boeing Plant 2 EAA

LDW-SS2214-A: 280 J µg/kg

LDW-SC49a: 200 µg/kg

T-117 EAA

Jorgensen Forge EAA

LDW15: 170 µg/kg

LDW16: 130 µg/kg

SD-511G: 120 J µg/kg

Segment 2

LDW18: 290 µg/kg

IT-12: 220 µg/kg

RP-12: 66 µg/kg

IT-2: 120 µg/kg

IT-4: 260 µg/kg

RP-24: 200 J µg/kg

RP-25: 130 J µg/kg

RP-17: 110 µg/kg

RP-20: 150 J µg/kg

0 25 50 Yards

0 20 40 Meters

LDW-SS2078-D: 120 J µg/kg

LDW-SS2078-A: 120 J µg/kg

Slip 6

LDW-SS2082-U: 280 µg/kg

LDW-SS2083-A: 290 µg/kg

LDW18-DeltaMarine: 600 µg/kg

LDW-SS2089-D: 300 µg/kg

LDW-SS2089-A: 360 µg/kg

Segment 3

LDW-SS2099-D: 120 J µg/kg

LDW-SS2085-A: 360 µg/kg

LDW-SS2090-D: 150 µg/kg

LDW-SS2090-A: 130 µg/kg

LDW-SS2200-D: 150 µg/kg

LDW-SS2200-A: 140 µg/kg

LDW-SS2201-D: 130 µg/kg

LDW-SS2201-A: 140 µg/kg

LDW-SSBDC2-D: 200 µg/kg

LDW-SSBDC2-U: 230 µg/kg

LDW-SSBDC3-D: 120 µg/kg

LDW-SSBDC2-A: 140 µg/kg

LDW-SS2092-A: 250 µg/kg

LDW-SS2097-D: 220 µg/kg

LDW-SS2094-D: 220 µg/kg

BKG-5: 180 µg/kg

BKG-1: 120 µg/kg

BKG-4: 260 µg/kg

Turning Basin

BKG-3: 170 µg/kg

Norfolk EAA

Segment 4

2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0

**Benzyl alcohol surface sediment sampling locations**

- Only exceeds RAL for benzyl alcohol
- Exceeds RAL for benzyl alcohol and other COCs
- Does not exceed RAL for benzyl alcohol[a]
- Post-FS location

**Benzyl alcohol subsurface core locations**

- Only exceeds RAL for benzyl alcohol
- Exceeds RAL for benzyl alcohol and other COCs
- Does not exceed RAL for benzyl alcohol[a]
- No benzyl alcohol RAL applies (Recovery Category 2/3)
- Post-FS core
- Bioassay sample
- Segment boundary
- Recovery Category 1
- Early Action Area
- ENR/AC Pilot Study area
- USACE 2018-2020 dredge prism[b]
- King Co tax parcel
- LDW Superfund Site
- Navigation Channel
- River mile

[a] These locations may have RAL exceedances for chemicals other than benzyl alcohol.
[b] DMMU composites are within the USACE dredge prism.

Note: The locations on this map exclude locations not analyzed for benzyl alcohol.

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N

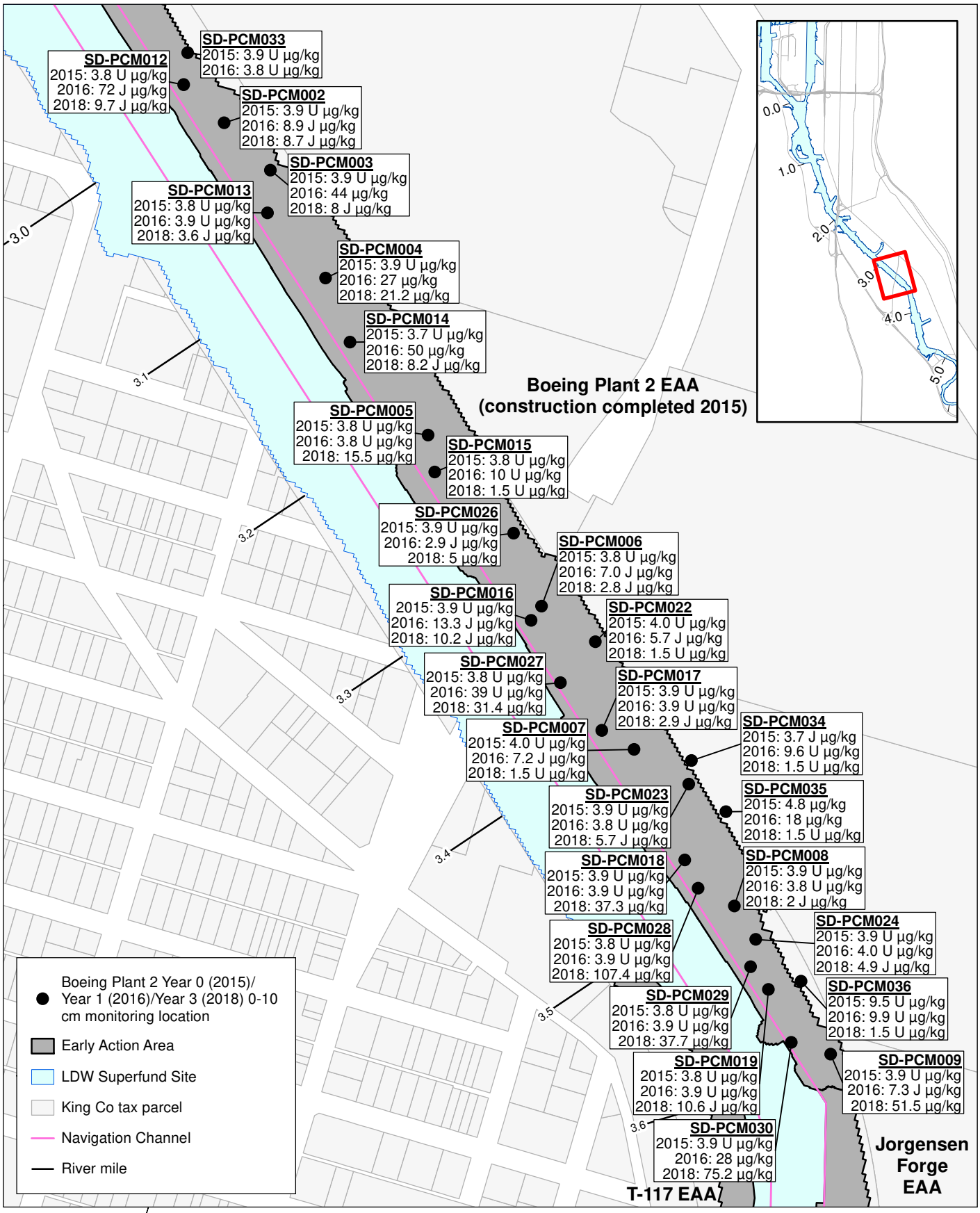
0 500 1,000 Feet

0 200 400 Meters

**Map A-2. Benzyl alcohol RAL exceedances and toxicity test results in the LDW upper reach**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map A-2 7027 Benzyl alcohol exc in Upper Reach.mxd

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N

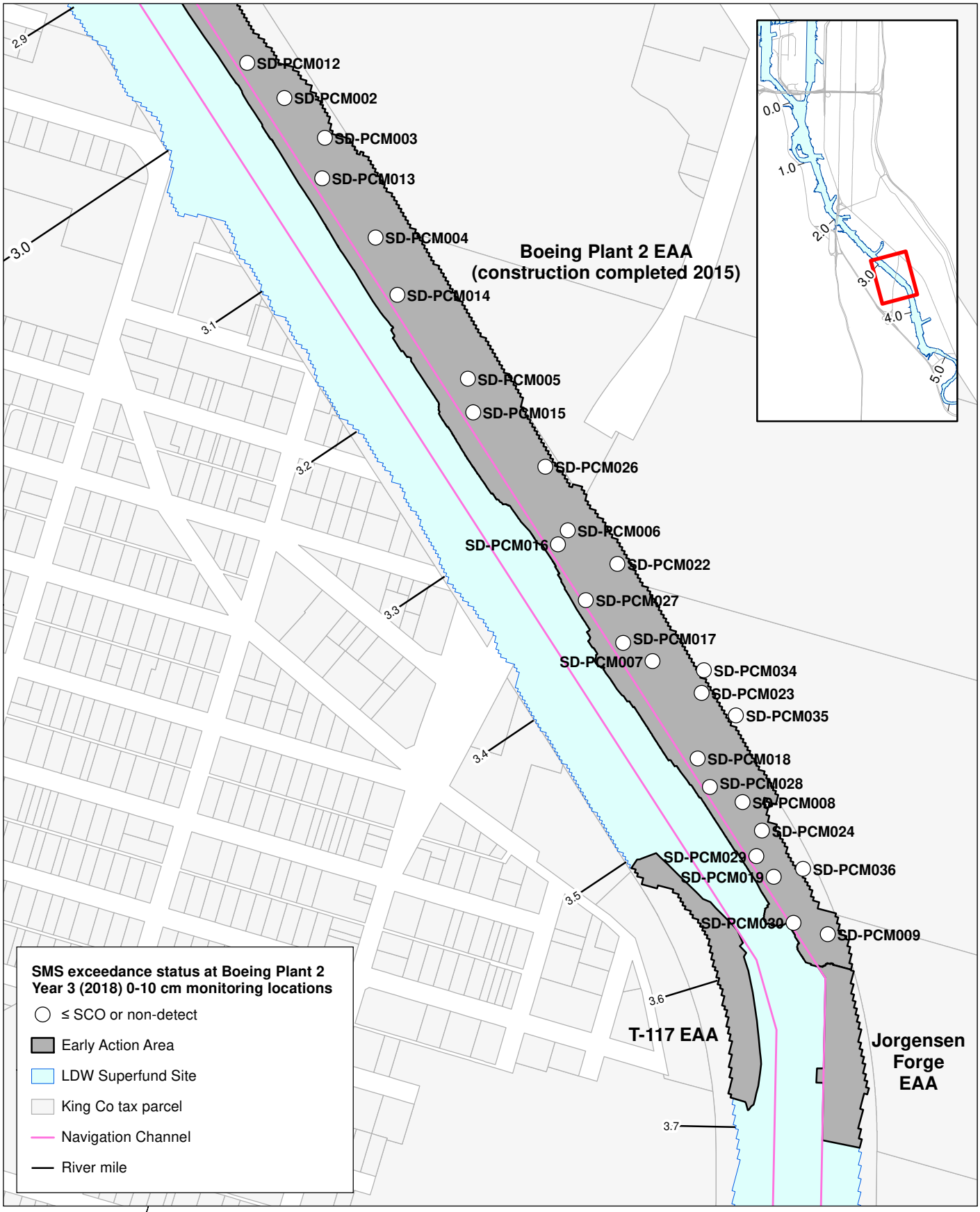
0 200 400 Feet

0 40 80 Meters

**Map B-1. Total PCB concentrations at monitoring locations in the Boeing Plant 2 Early Action Area**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-1 7056 BP2 PCBs.mxd

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N

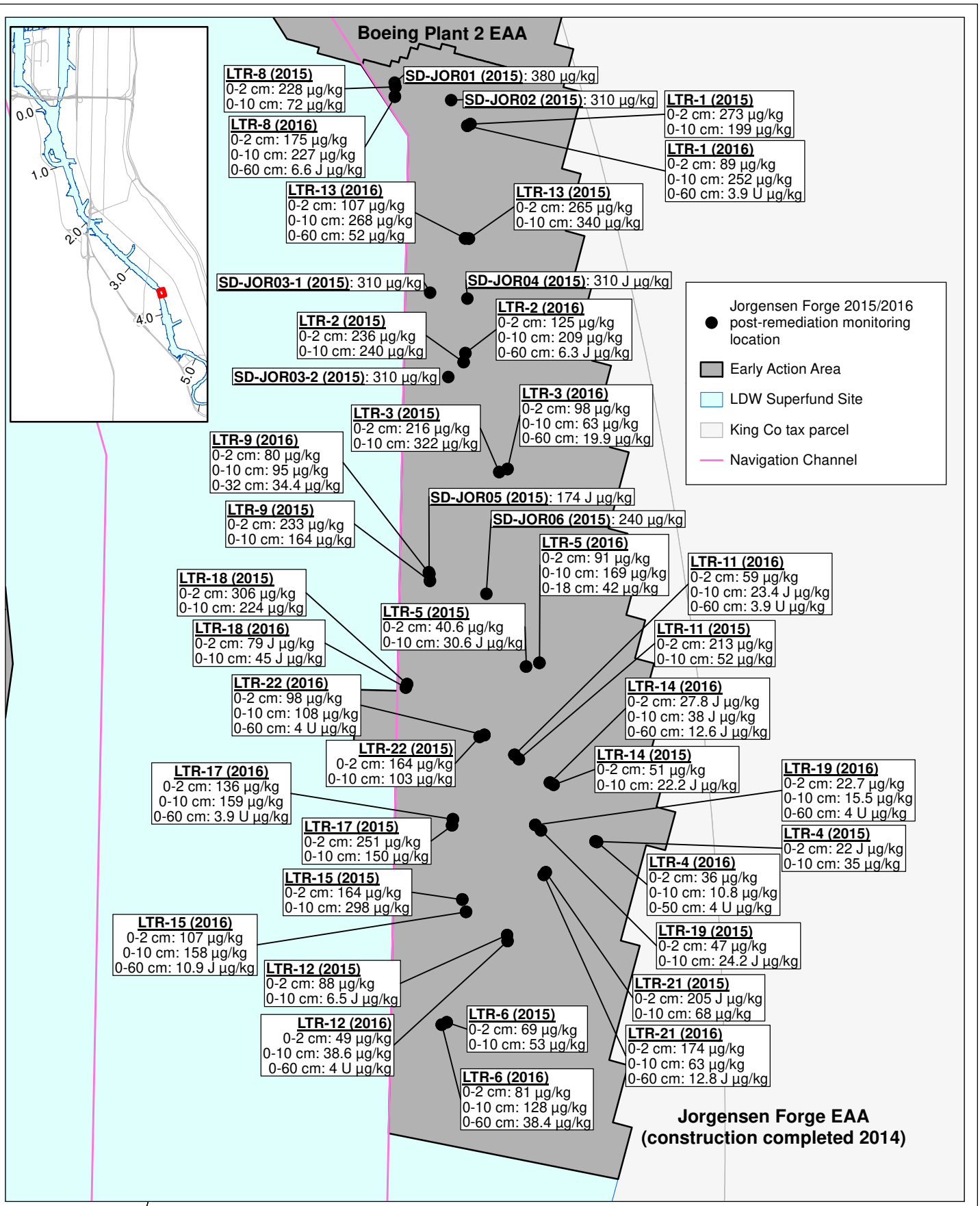
0 200 400 Feet

0 50 100 Meters

**Map B-2. Comparison of Boeing Plant 2 monitoring data with benthic SCO from Washington SMS**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-2 7057 BP2 SMS.mxd

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N

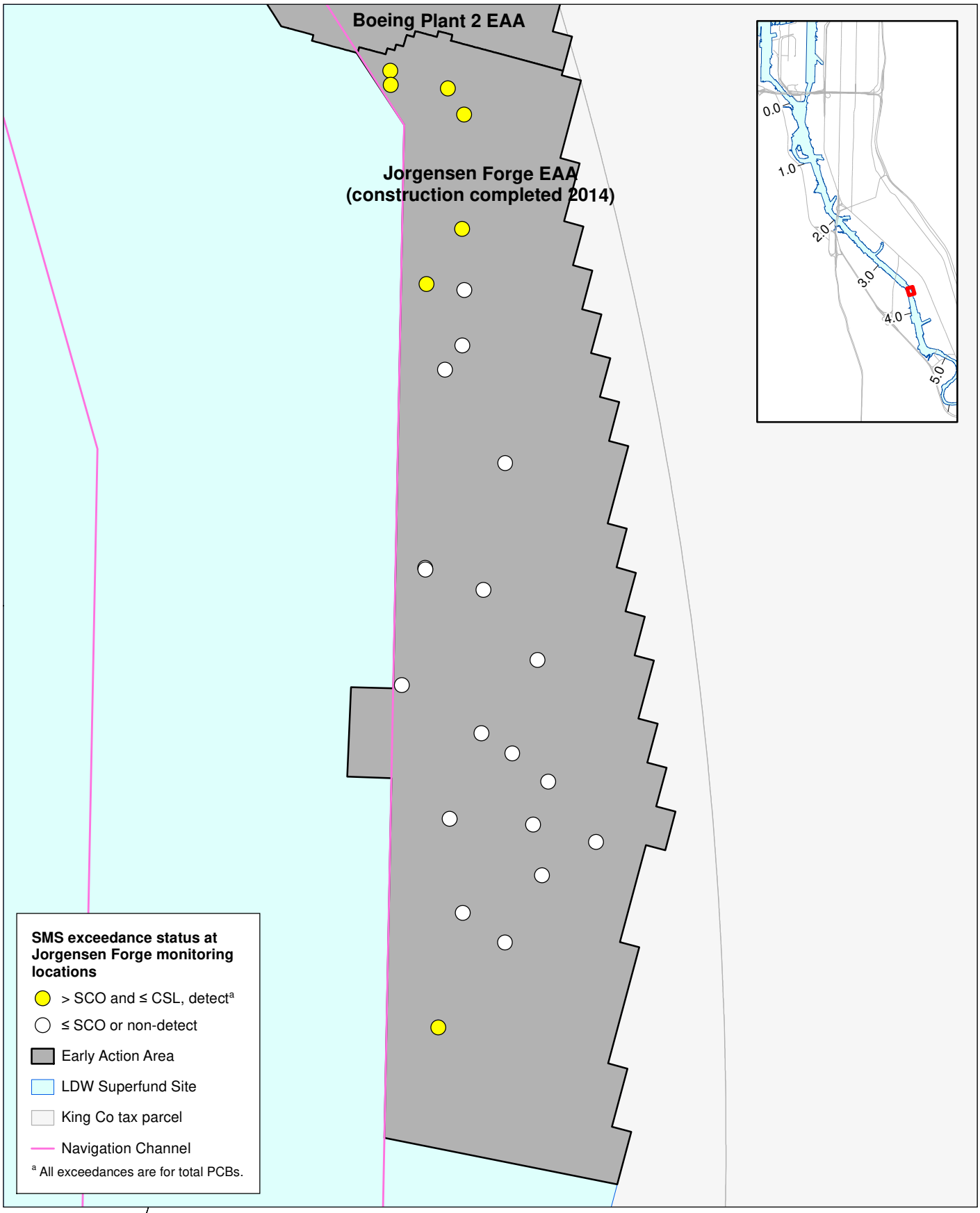
0 30 60 Feet

0 10 20 Meters

**Map B-3. Total PCB concentrations at monitoring locations in the Jorgensen Forge Early Action Area**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-3 7056 JF PCBs.mxd

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N

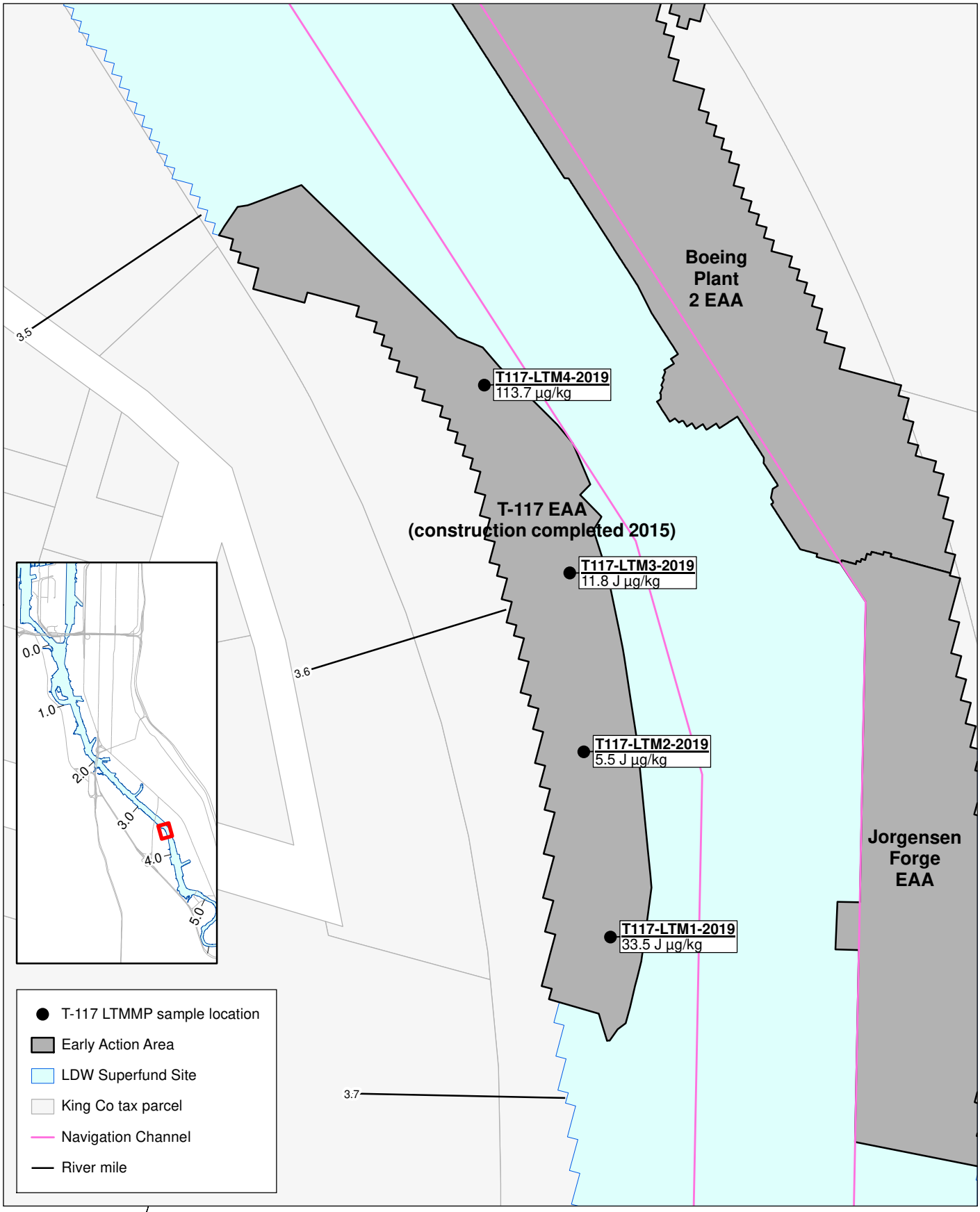
0 30 60 Feet

0 10 20 Meters

**Map B-4. Comparison of Jorgensen Forge monitoring data with benthic SCO from Washington SMS**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-4 7057 JF SMS.mxd

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N

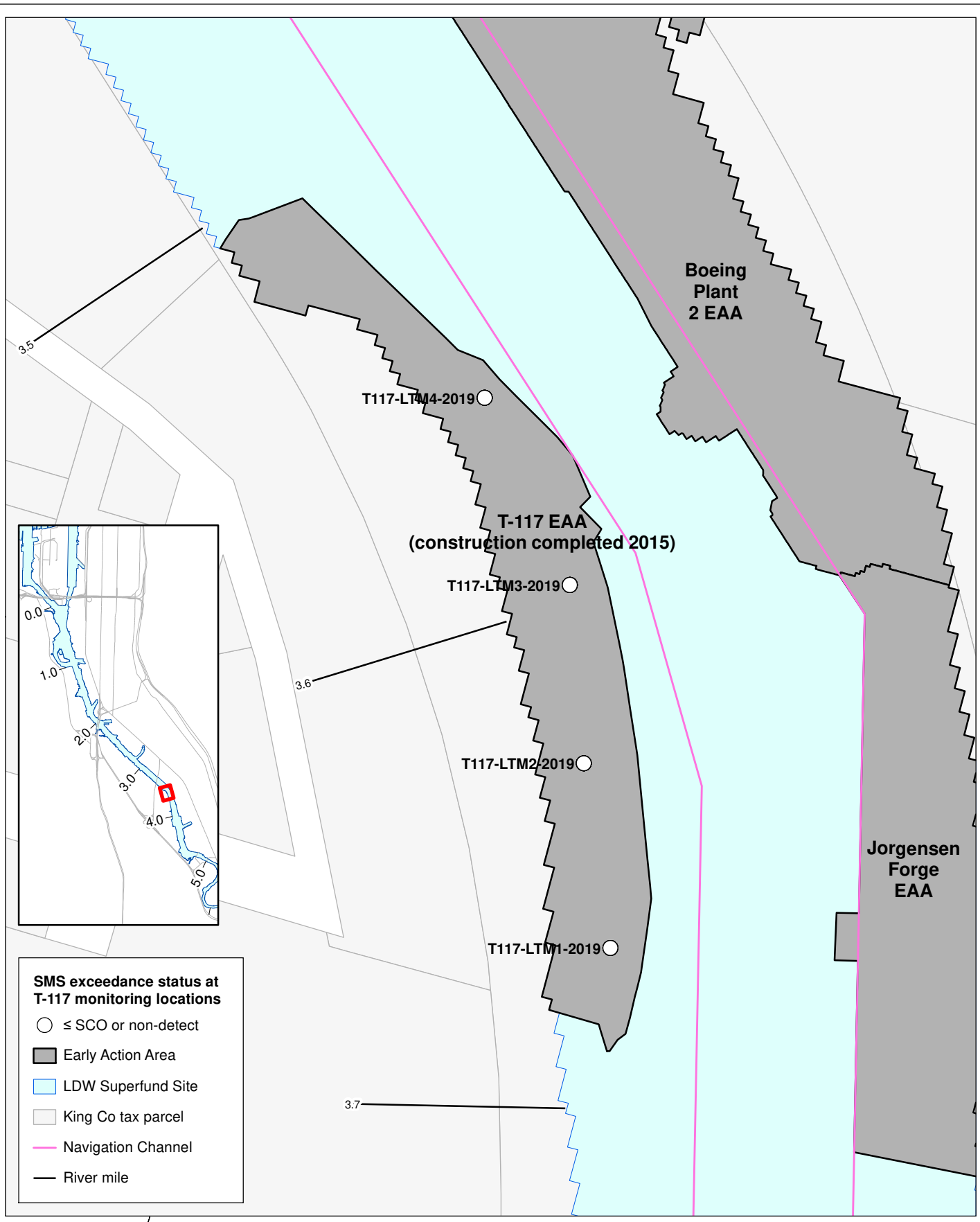
0 50 100 Feet

0 20 40 Meters

**Map B-5. Total PCB concentrations at monitoring locations in the T-117 Early Action Area**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-5 7056 T-117 PCBs.mxd

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N

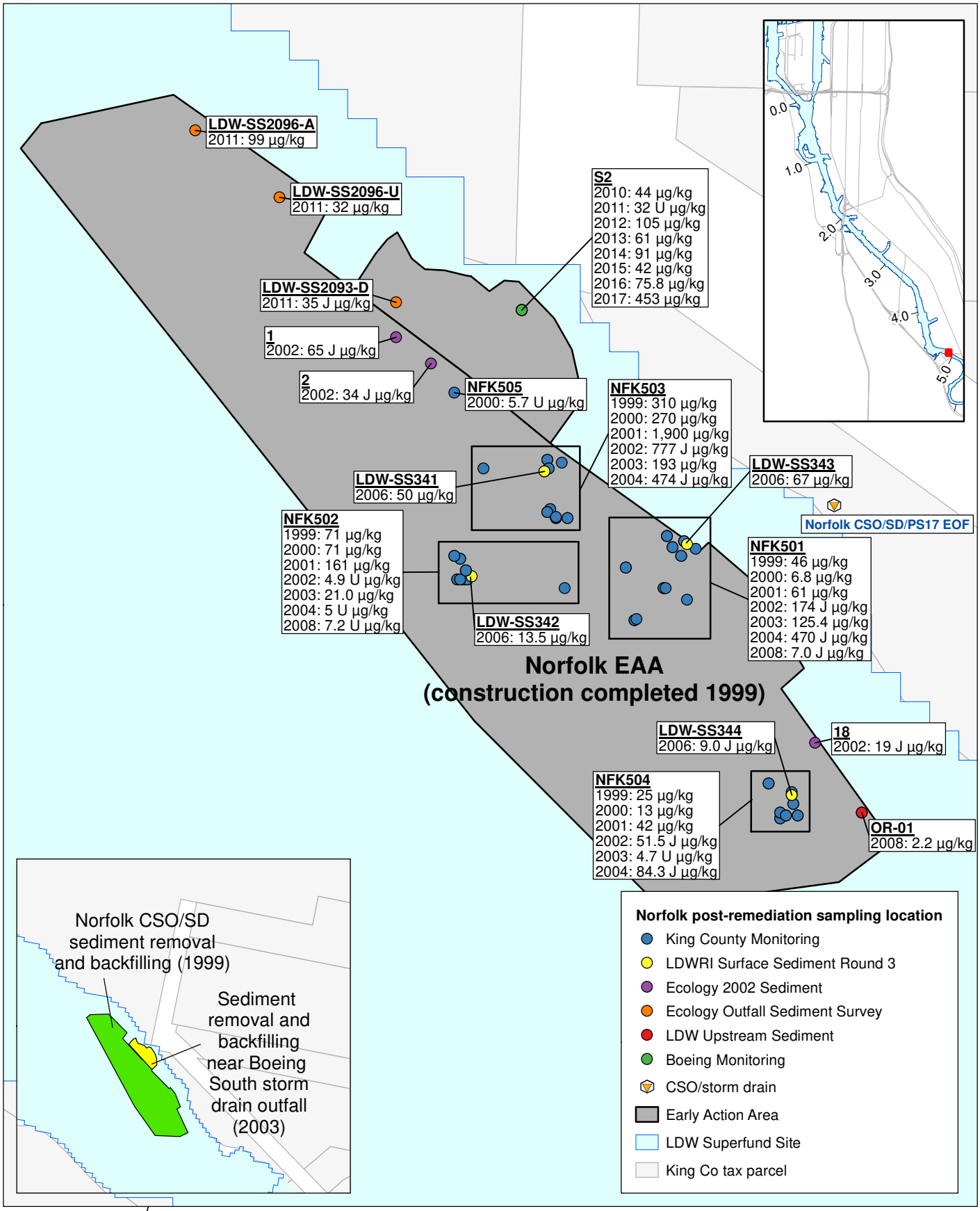
0 50 100 Feet

0 20 40 Meters

**Map B-6. Comparison of T-117 monitoring data with benthic SCO from Washington SMS**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-6 7057 T-117 SMS.mxd

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N

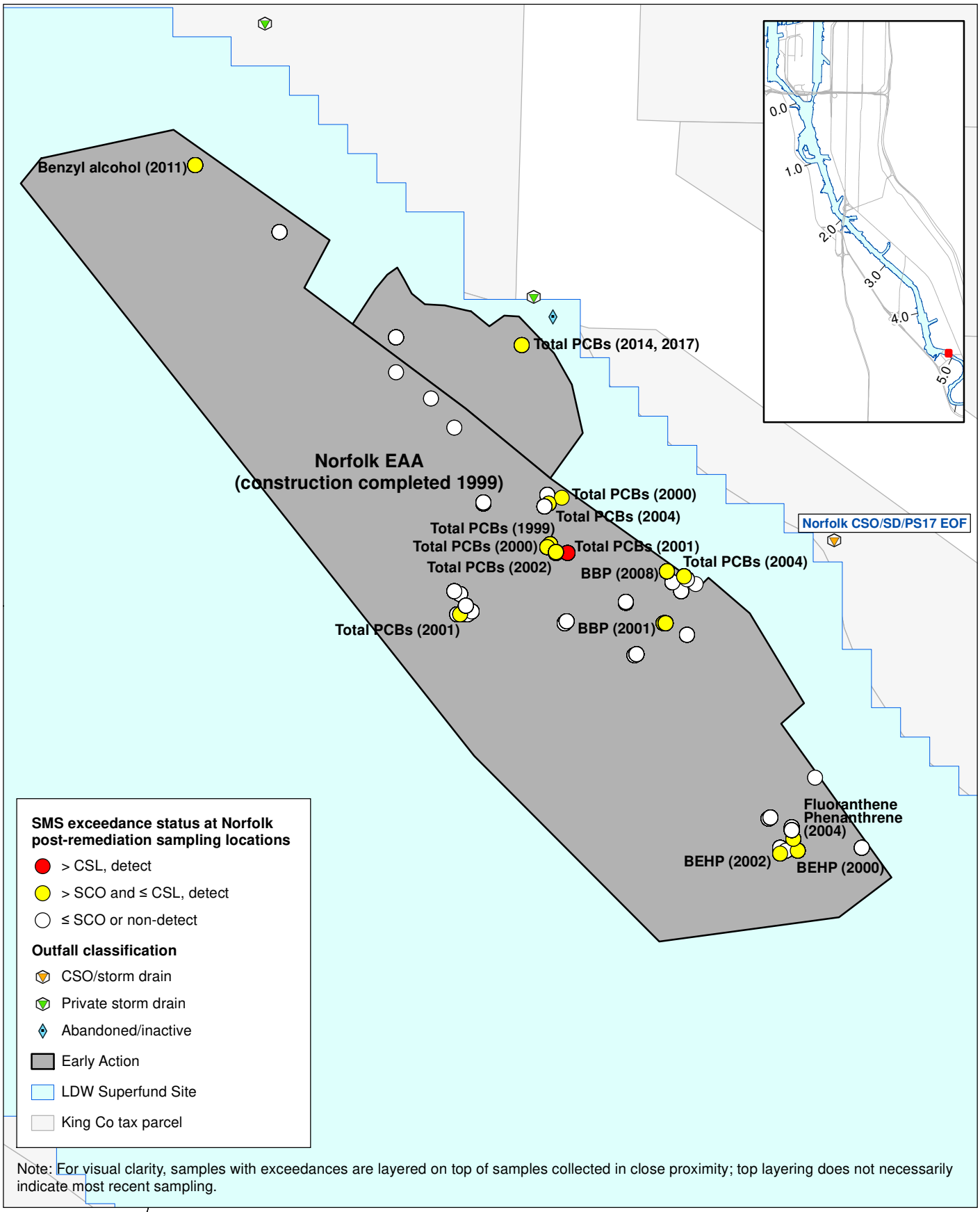
0 20 40 Feet

0 5 10 Meters

**Map B-7. Total PCB concentrations at monitoring locations in the Norfolk Early Action Area and Boeing South storm drain area**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-7 7056 Norfolk PCBs.mxd




Note: For visual clarity, samples with exceedances are layered on top of samples collected in close proximity; top layering does not necessarily indicate most recent sampling.

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N

0 20 40 Feet

0 7.5 15 Meters

**Map B-8. Comparison of Norfolk monitoring data with benthic SCO and CSL from Washington SMS**

LDW Upper Reach Pre-Design Investigation Work Plan

Prepared by craigh, 12/16/2019; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Work Plan\PDI WP\Map B-8 7057 Norfolk SMS.mxd