# Portland Harbor Feasibility Study

Presentation to the
CSTAG/NRRB
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# Portland Harbor

Identification and Screening of Technologies

# ARARs – Chemical Specific

- Protection of surface water
  - National and State WQS criteria
  - WA freshwater sediment criteria (TBC)
- Protection of potential drinking water
  - MCLs & non-zero MCLGs
- State measure of protectiveness
  - $1 \times 10^{-6}$ individual contaminant
  - $1 \times 10^{-5}$ cumulative contaminant
  - HI = 1

# ARARs – Location Specific

- Presence of archaeologically or historically sensitive area
  - Indian Graves & Archeological Objects
- Floodplain management and wetland protection
  - FEMA
- Protection of ESA species & EFH
  - 5 listed species - Willamette
  - Critical habitat - Willamette
  - 9 listed species - Columbia

# ARARs – Action Specific

- Compliance with WQS - CWA Section 401
- Discharge pollutants - CWA Section 402
- Discharge dredge or fill material - CWA Section 404
- DSL Mitigation - ORS 196.825(5)
- Federal navigation channel – Rivers & Harbors Act
- In-water work window – ODFW Management Plan (TBC)
- Disposal
  - Oregon Pesticide Rule
  - Oregon Solid Waste Rule
  - RCRA – OR delegated state
  - TSCA
- Air emissions from sediment/soil removal
  - CAA

# RAOs – Human Health

- **RAO 1 – Sediments:** Direct contact
- **RAO 2 – Biota**: Consumption of fish and shellfish.
- **RAO 3 – Surface Water:** Direct contact (ingestion, inhalation, and dermal contact)
- **RAO 4 – Groundwater:** Reduce migration of contaminated groundwater to sediment and surface water

# RAOs - Ecological

- **RAO 5 – Sediments:** Benthic risk
- **RAO 6 – Biota (Predators):** Consumption of prey
- **RAO 7 – Surface Water:** Ingestion and direct contact
- **RAO 8 – Groundwater:** Reduce migration of contaminated groundwater to sediment and surface water

# RAOs – Both HH and Eco

- **RAO 9 – River Banks:** Reduce migration of contaminated river banks to sediment and surface water

# COCs

- Further screened COCs from BRAs
- Risk-based and ARAR-based
- 69 COCs total
- Multi-media
  - Sediment
  - Surface water
  - Pore water

# COCs

- RAO 1: HH Direct contact
  - Beach - 2 COCs
  - Sediment - 9 COCs
- RAO 2: HH consumption - 17 COCs
- RAO 3: HH Surface Water - 21 COCs
- RAO 4: HH Groundwater migration – 30 COCs
- RAO 5: Eco Benthic risk – 18 COCs
- RAO 6: Eco Biota (Predator) Ingestion – 8 COCs
- RAO 7: Eco Surface water – 10 COCs
- RAO 8: Eco Direct Contact Pore Water – 38 COCs
- RAO 9: Riverbank Recontamination – 22 COCs

# PRGs – RAO 1 Human Health

**Media - Beach**

- Receptor – Tribal Fisher
- Apply only to beach
- 1 risk-based (cPAHs) @ $10^{-6}$
- 1 background (As)

**Media - Sediment**

- Receptor – Tribal Fisher
- Apply only nearshore
- 8 risk-based (PCBs, cPAHs, dioxin/furans) @ $10^{-6}$
- 1 background (As)

# PRGs – RAO 2 Human Health

**Media – Fish Tissue**

- Receptor – Subsistence Fisher
- Apply site-wide
- 9 risk-based @ $10^{-6}$
- 7 risk-based @ HQ=1
- 1 ARAR-based (mercury)

**Media - Sediment**

- Receptor – Subsistence Fisher
- Apply site-wide
- 5 risk-based @ $10^{-6}$
- 1 risk-based @ HQ=1
- 5 background

# PRGs – RAO 3 Human Health

- Media – Surface Water
- Apply site-wide
- 1 risk-based (MCPP) @ $10^{-6}$
- 19 ARAR-based (AWQC)

# PRGs – RAO 4 Human Health

- Media – Pore water
- Apply site-wide
- 5 ARAR-based (MCLs)
- 25 ARAR-based (AWQC)

# PRGs – RAO 5 Eco

- Media – Sediment
- Receptor – Benthic organism
- Apply site-wide
- 18 ARAR-based (WA Freshwater)

# PRGs – RAO 6 Eco

- Media – Sediment
- Apply site-wide
- Receptor – Spotted Sandpiper
  - 1 risk-based (DDx)
- Receptor – Osprey (egg)
  - 5 risk-based (4,4'-DDE, dioxin/furans)
- Receptor – River Otter
  - 1 risk-based (HxCDF)
- Receptor – Mink
  - 1 risk-based (PCBs)

# PRGs – RAO 7 Eco

- Media – Surface Water
- Receptor – Aquatic life
- Apply site-wide
- 9 risk-based (BERA TRV)
- 1 ARAR-based (AWQC) TBT

# PRGs – RAO 8 Eco

- Media – Pore water
- Receptor – Aquatic life
- Apply site-wide
- 34 risk-based (BERA TRV)
- 4 ARAR-based (AWQC)

# PRGs – RAO 9 Eco

- Media – river banks
- Receptors – Humans and Eco
- Apply to riverbanks
- Combined PRGs from RAOs 1, 2, 5, & 6
- 22 PRGs

# Target Areas

- Human Health – 2,190 acres (entire site)
- Ecological – 1,520 acres (60% of site)

# Representative Technologies

- No Action
- ICs
  - Fish consumption advisory
  - Waterway & land use restriction
- MNR
  - Deposition & dispersion
- EMNR
- Containment
  - Engineered, armored, & reactive
- Removal
  - Mechanical
- In-situ treatment
  - GAC & organophilic mats
- Ex-situ treatment
  - Sequestration & thermal desorption
- Disposal
  - CDF (Terminal 4)
  - Subtitle D
  - Subtitle C

# Portland Harbor

Development and Screening of Alternatives

# Development of Alternatives

- Combination of technologies
  - Used for all alternatives, except Alternative A
- Technologies include:
  - Dredging
  - Capping
  - In-situ treatment
  - Ex-situ treatment
  - EMNR
  - MNR
  - ICs

# SMA Technologies Considered

- Caps
- Dredging & Excavation
- Dredge/Cap
- Institutional Controls

# RALs vs. PRGs

- Entire site (2,190 acres) exceeds PRGs
- RALs are not PRGs
- RALs define dredge/cap areas
- RALs = "high concentration" areas
  - MNR in these areas inconsistent with CSM
- Allows for range of alternatives in FS
  - Less action to more action
  - Identify sediment management areas
- Levels of Active Risk Reduction
  - Maximum incremental reduction
  - Point of minimum concentration change
- MNR/EMNR to achieve RG
- Background considered

# Focused COCs

- Subset of COCs with most widespread footprint
  - PCBs
  - PAHs
  - Dioxins/furans
    - PeCDD
    - PeCDF
    - TCDD
  - DDx

# Example RAL Curve

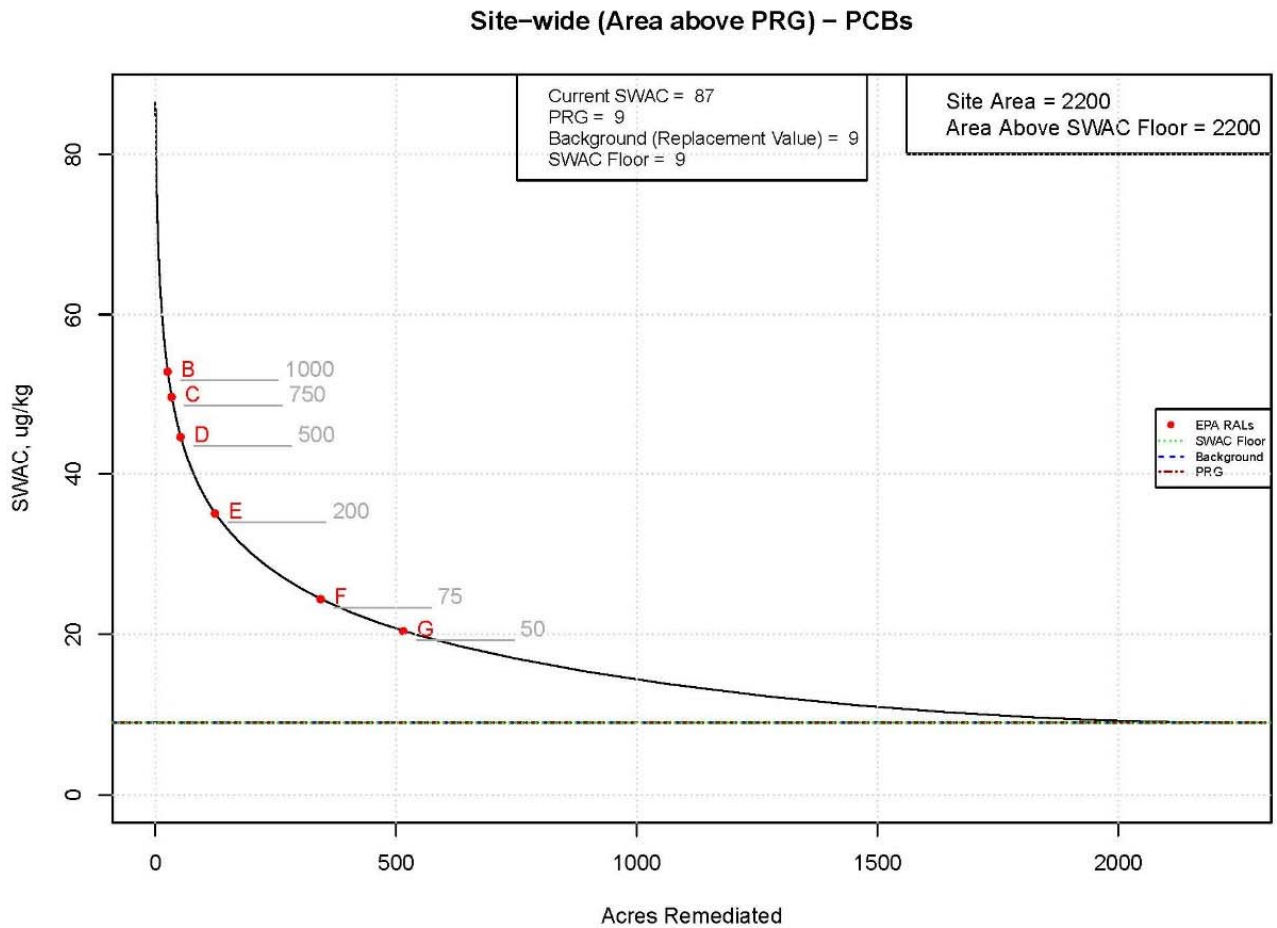



**Figure 3.3-1**
**PCBs Site-wide RAL Curves**

# Issues with Dioxins/Furan RALs

- PRGs below MDL
- Data density
  - False positive RAL footprints
- Consistent method used by PRPs
  - Considered other methods

# Remedial Action Levels

| Contaminant | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| PCBs | 1,000 | 750 | 500 | 200 | 75 | 50 |
| Total PAHs* | 170,000 | 130,000 | 69,000 | 35,000 | 13,000 | 5,400 |
| 1,2,3,7,8-PeCDD | 1 | 1 | 1 | 0.2 | 0.2 | 0.009 |
| 2,3,4,7,8-PeCDF | 0.003 | 0.002 | 0.0008 | 0.0008 | 0.0008 | 0.0008 |
| 2,3,7,8-TCDD | 0.002 | 0.002 | 0.002 | 0.0006 | 0.0006 | 0.0006 |
| DDx | 650 | 550 | 450 | 300 | 160 | 40 |

*Equivalent to cPAH RALs in draft FS.
All units µg/kg.

# Technology Assignment

**Objective**: Develop a process that identified technologies

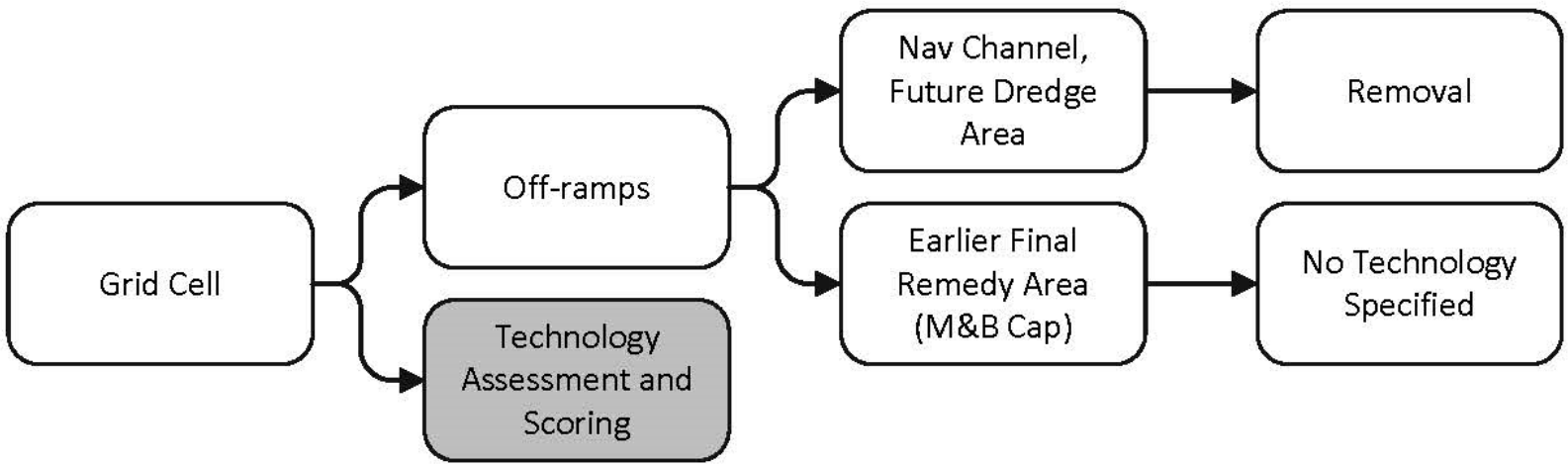
- Based on environmental conditions
  - Hydrodynamics
  - Sediment bed characteristics
  - Anthropogenic conditions
- Uses a decision-based approach:
  - Engineered Cap
  - Armored Cap
  - Dredging

**Outcome**: Indicates appropriate technology based on analysis… **<u>It does not select a remedy</u>**.

# Multi-Criteria Decision Matrix

- Unbiased and reproducible method
- Based on multiple site characteristics
- Uses 10' x 10' grid cells
  - Technology assigned to grid cell
  - Predominant technology
- Scored based on multiple criteria

# Overview of Technology Assignment Process



# Technology Assignment Matrix

## Criteria Scoring

- +1 = technology favorable
- 0 = technology neutral
- -1 = technology unfavorable
- NC = not applicable

| **Technology Assessment Scoring** | | Dredge | Armor Cap | Cap |
|---|---|---|---|---|
| Hydrodynamics | Wind/Wave Zone? | 1 | 0 | NC |
| | Erosive? | | | -1 |
| | Depositional? (<2.5cm/year or Subsurface:Surface Ratio>2)? | -1 | 1 | 1 |
| | Shallow? | 1 | -1 | 0 |
| Sediment Bed Characteristics | Slope 15-30%? | 1 | 1 | NC |
| | Slope >30% | | 0 | |
| | Rock, Cobble, Bedrock Present? | -1 | 1 | 1 |
| Anthropogenic Influences | Structures/Pilings? | -1 | 1 | 1 |
| | Prop Wash Zone? | 1 | 0 | NC |
| | Moderate or Heavy Debris? | -1 | 0 | 1 |
| | Technology Score | Sum Scores for Each Technology | | |

# Hydrodynamics Criteria

**Erosive OR Wind/Wave Zone**

- Erosive = critical shear stress for 2 year recurrence (flood)
- Wind/wave zone – near shore areas

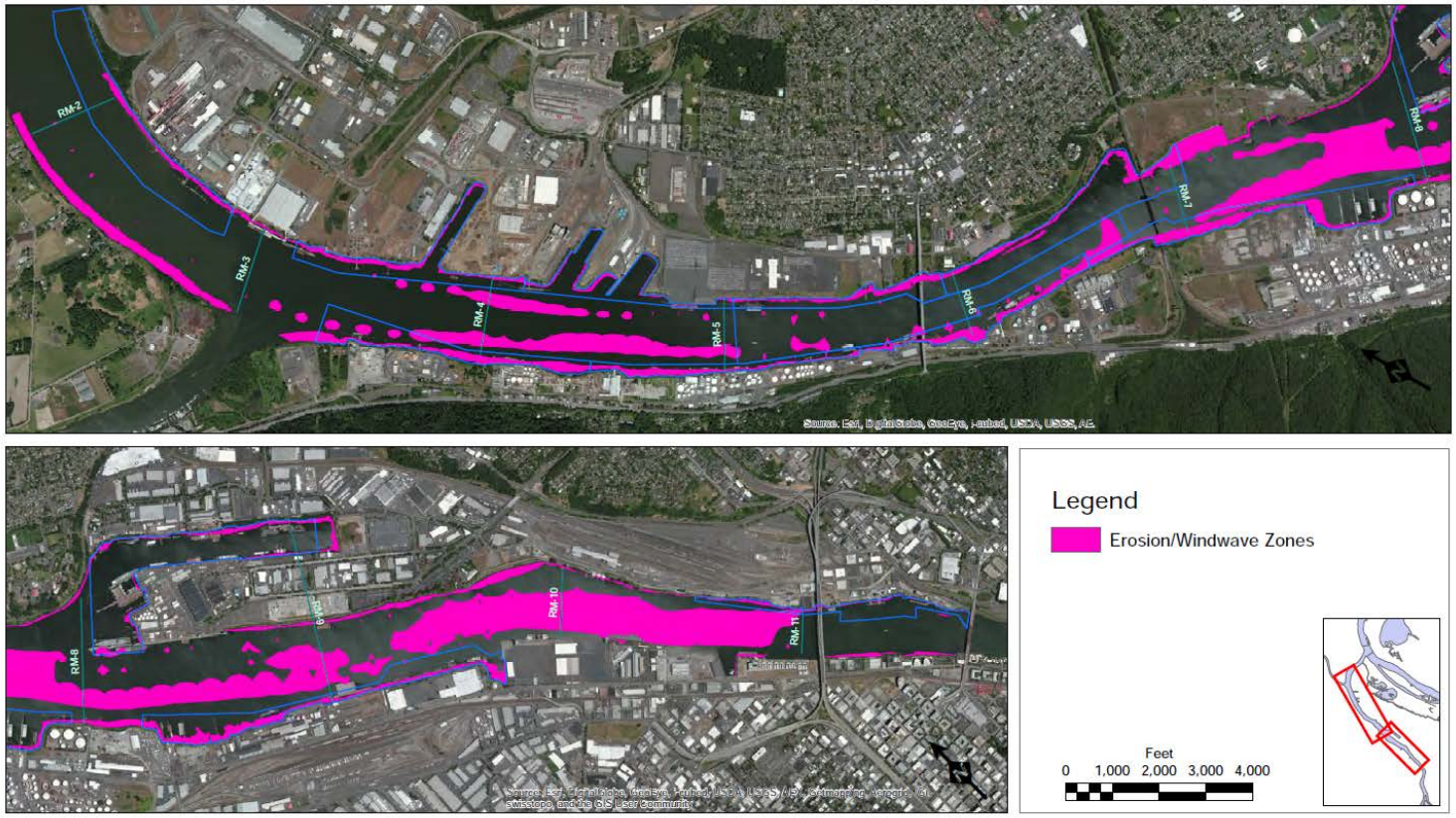
**Depositional**

- Either depositional (> 2.5cm/yr) May 2003 to 2009 surveys
  OR
- Average Subsurface/Surface RAL concentrations > 2

**Shallow**

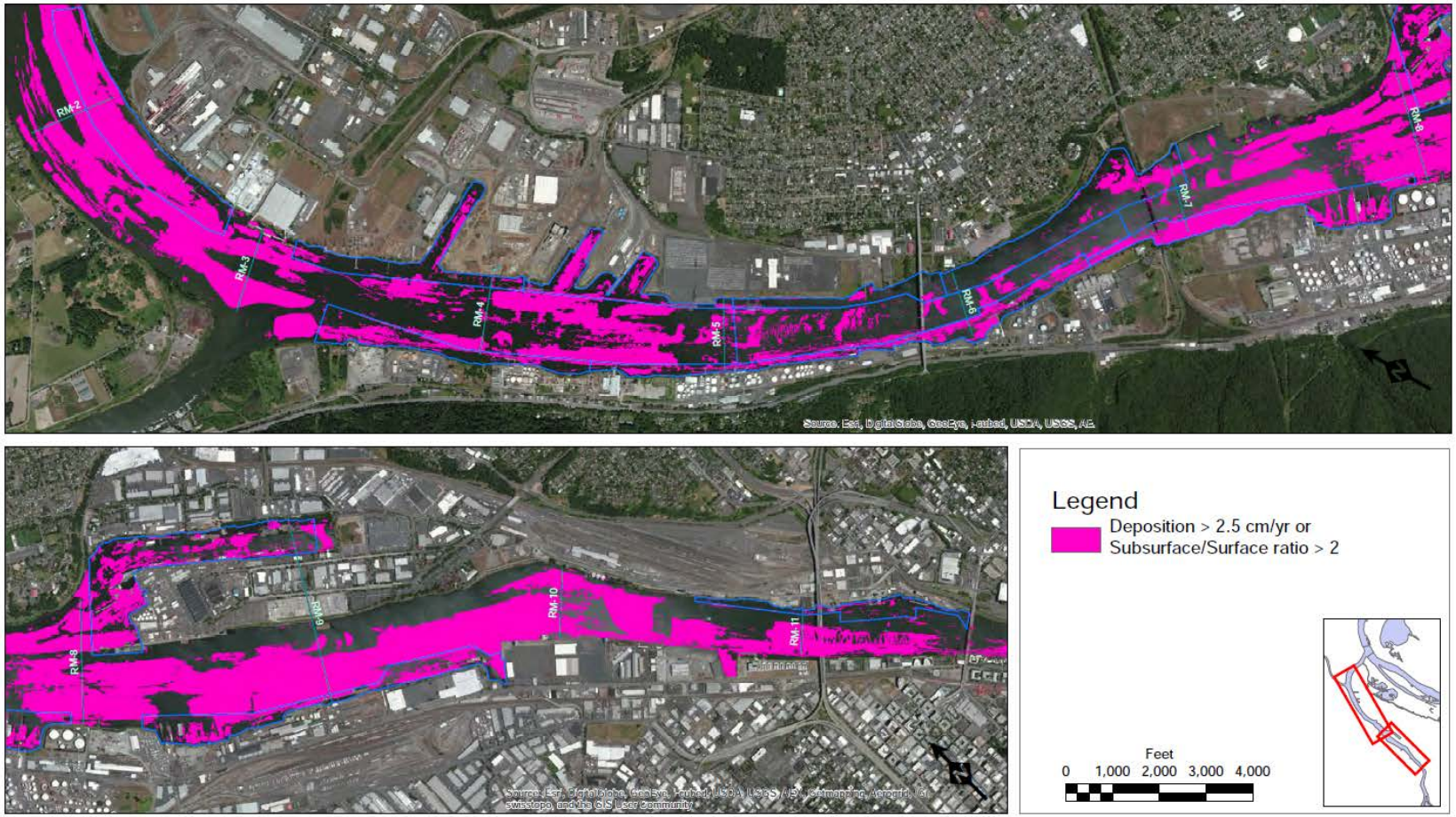
- Shallow - <1 m at low water level, >2 feet NAVD 88

# Wind/Wave Zone



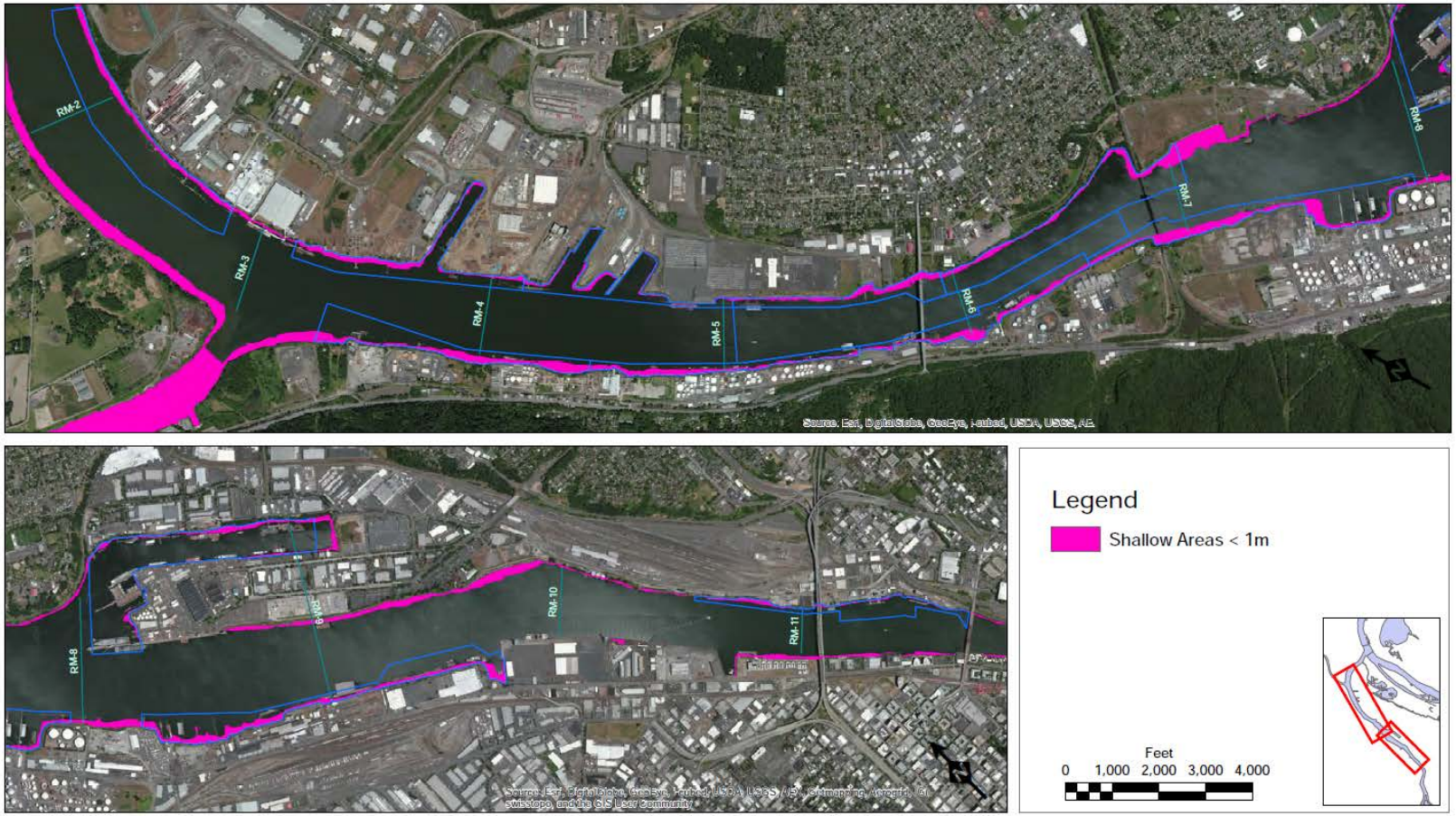

Erosion/Windwave Zones

# Depositional




Depositional Areas

# Shallow Areas

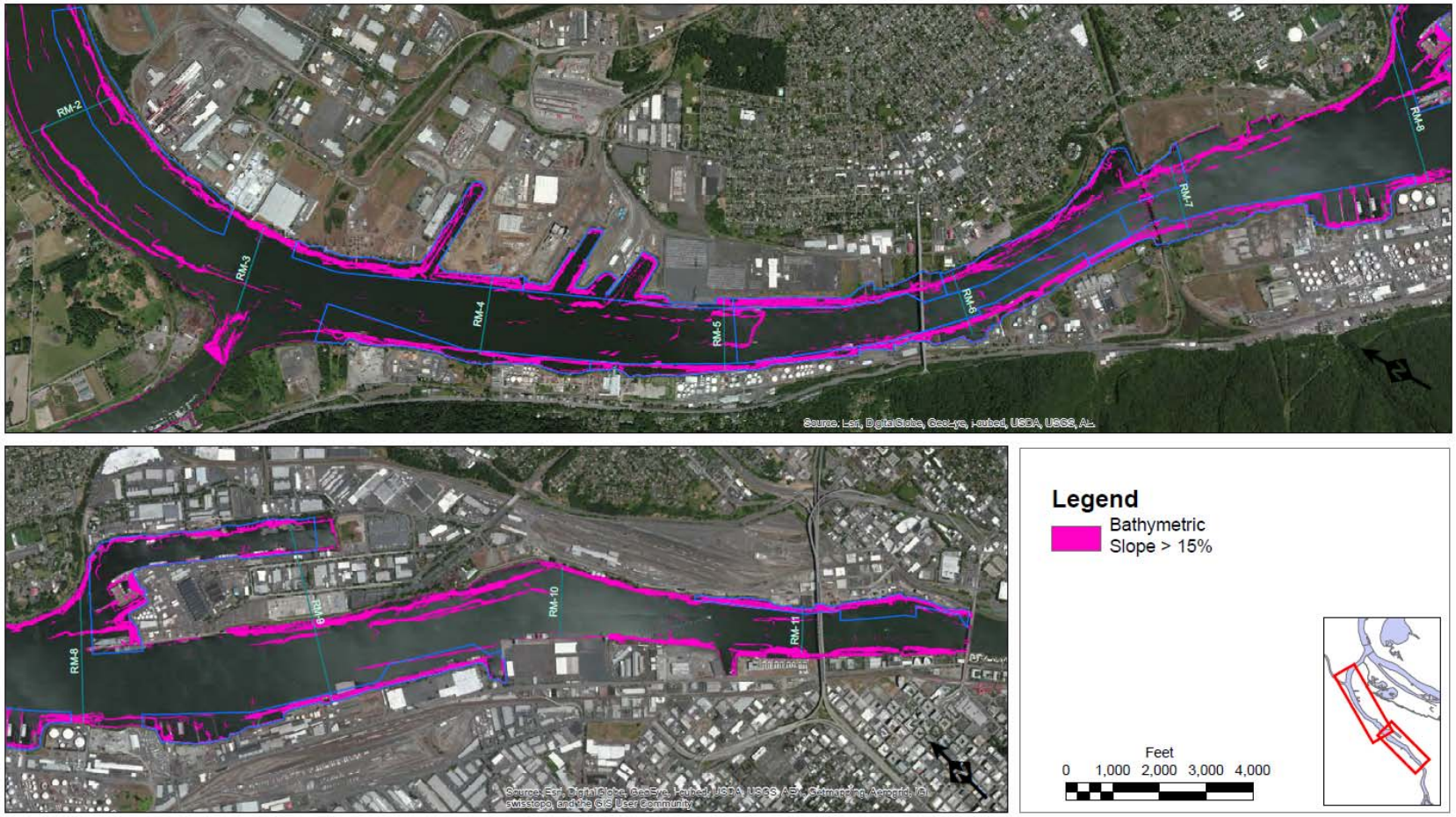



Shallow Areas

# Sediment Bed Characteristics Criteria

- Slope > 15 % (Based on 2009 Bathymetry)
- Rock, Cobble, Bedrock within potential dredge prism
  - none identified

# Bathymetry/Slope

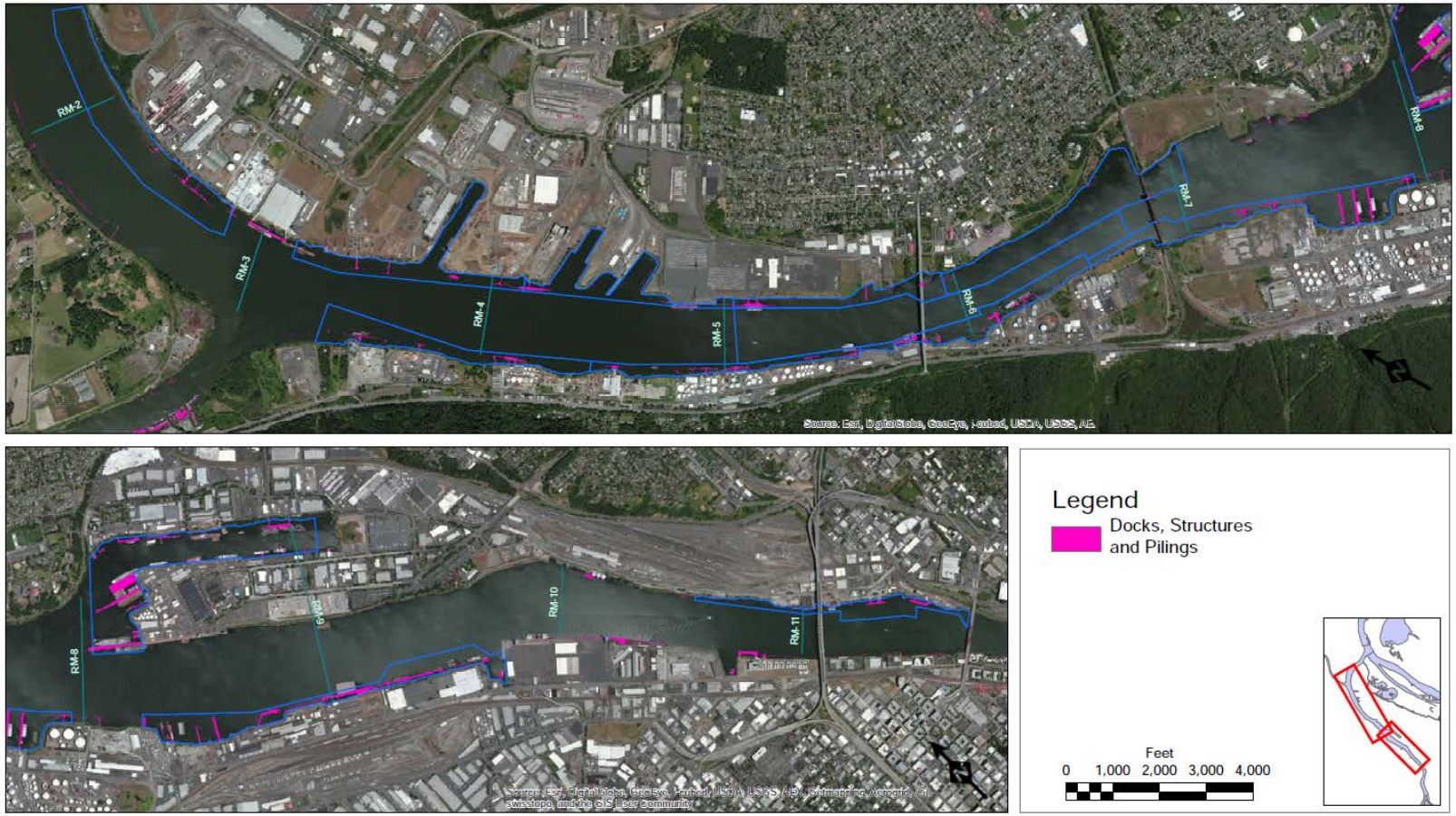



**Bathymetric Slope**

# Anthropogenic Influences Criteria

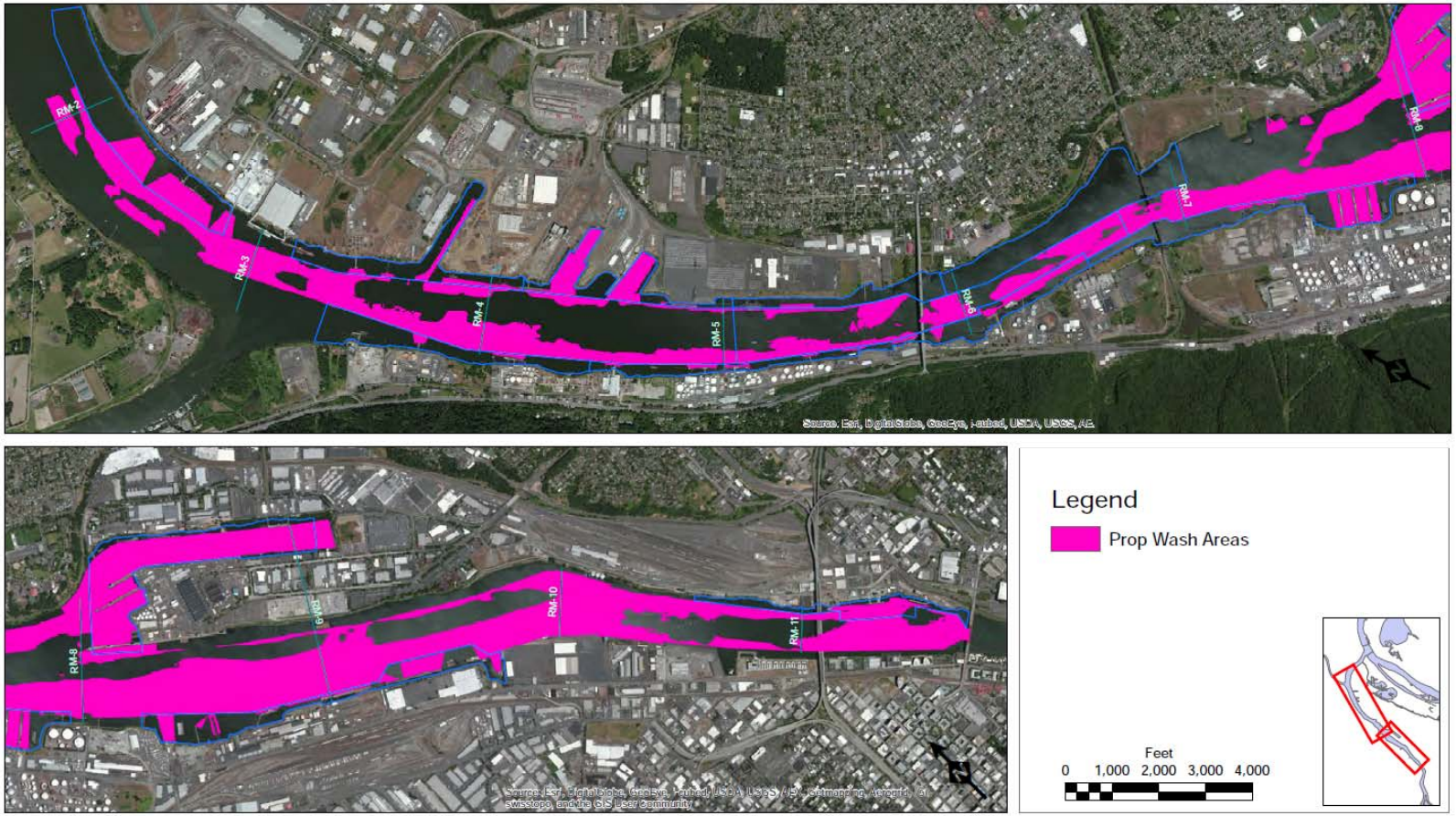
- Structures and Pilings
- Prop Wash Zone
- Debris as indicated by side/scan sonar

# Structures and Pilings



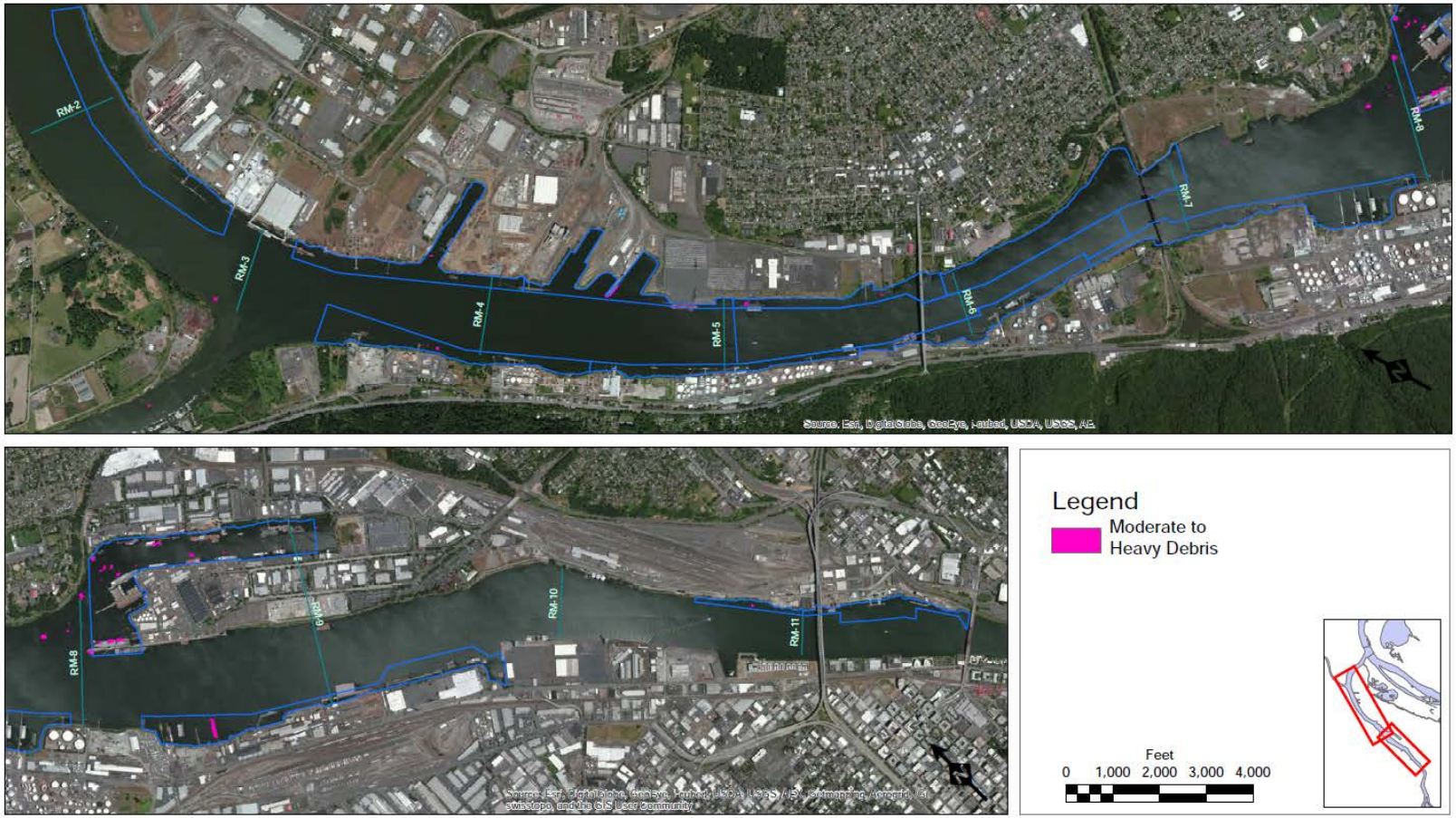

Docks, Structures and Pilings

# Prop Wash Areas




Prop Wash Areas

# Debris

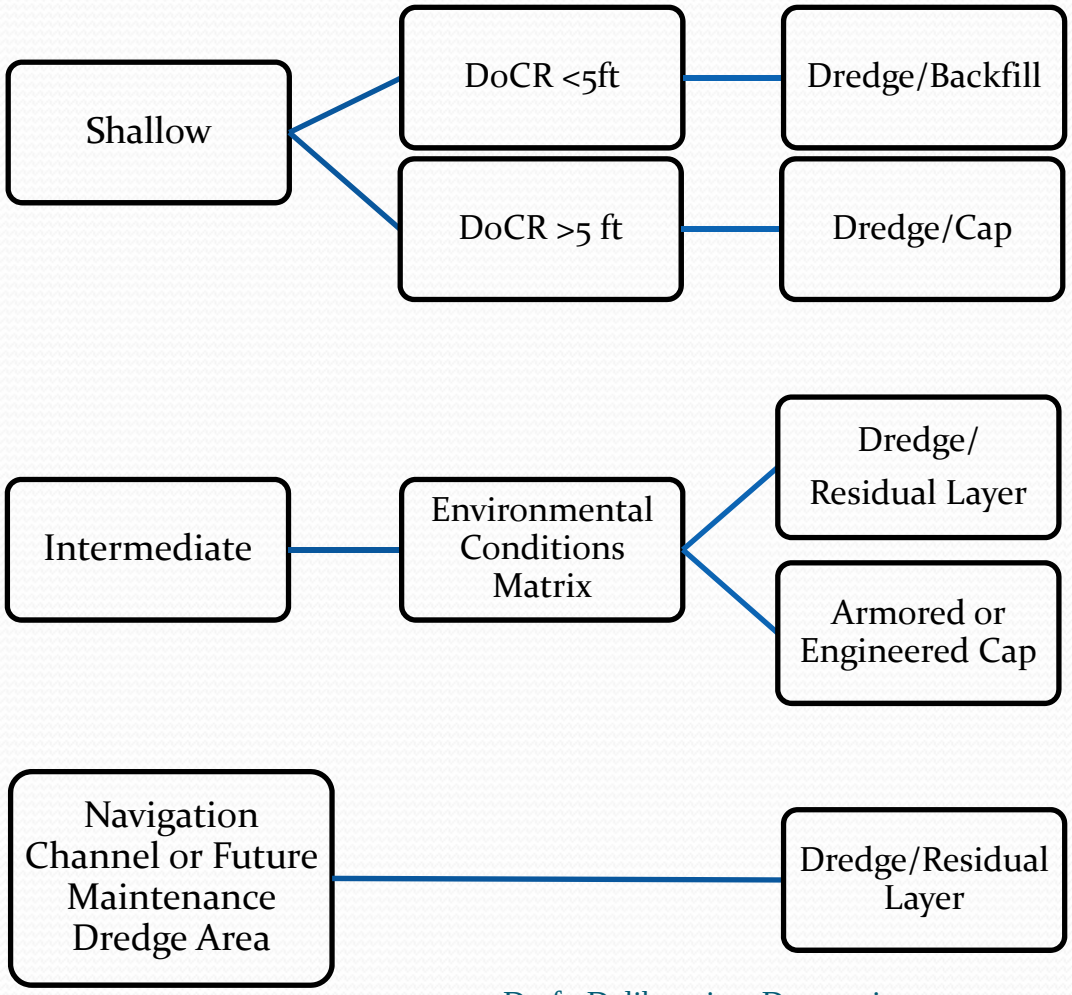



Debris

# Areas for Technology Assignment

- **Navigation Channel & FMD**
  - Dredging
- **Shallow (>4 feet NAVD88)**
  - Dredge/cap
  - Armor with beach mix
- **Intermediate (between Nav Channel and Shallow)**
  - Dredge
  - Cap

# Application of Technologies




**Notes**

Capping:

-Capping under structures

-Armoring based on hydrodynamics

Active Materials:

-Active materials added to caps, backfill, or residual layers in PTW or contaminated groundwater areas.

NAPL and not-reliably-contained:

-Max dredge depth is 15'; then place "significantly augmented" cap; then backfill.

# Cap Assumptions

- 3' thick
- Physical isolation
  - Sand
- Armoring
  - 6 " beach mix in shallow
  - 12" armor stone
- Chemical isolation
  - 12-in. sand w/ 5% AC or organophilic clay
- Institutional Controls

# Special Cap Considerations

- Significantly Augmented Reactive Cap
  - Chemical Isolation Layer: 12-in. sand w/ 20% AC
  - Low Permeability Layer: clay (e.g., AquaBlok)
  - Physical Isolation Layer: 18 in. sand
  - Stabilization Layer: 6 in. armor stone

# Dredging Assumptions

- Equipment
  - Environmental/closed bucket
  - Articulated fixed-arm dredge w/50 feet arm
  - 2 cu yd bucket around and under structures
  - 4 cu yd bucket
- Productivity
  - 123 days/year (July 1 through October 31)
  - 24 hours/6 days per week

# Dredging Assumptions (cont.)

- Accuracy
  - Natural Neighbors Geostatistical Interpolation
  - Depth based on RALs
  - Maximum dredge depth 15-19 feet
- Residuals
  - 12 in. sand
- Resuspension
  - Silt curtains
  - Rigid containment – NAPL (<50 ft water)

# Treatment Assumptions

- PTW and groundwater plumes
- In-situ Treatment
  - Activated carbon
  - Organophilic clay
  - Solidification/stabilization (under structures)
- Ex-situ Treatment
  - Based on disposal decision tree
  - Thermal desorption

# Principal Threat Waste

- Source Material - NAPL
  - Chlorobenzene - Arkema
  - PAHs - Gasco

- Highly Toxic – exceeds $10^{-3}$

| | |
|---|---|
| PCBs | > 200 µg/kg |
| cPAHs | > 100,000 µg/kg |
| DDx | > 7000 µg/kg |
| 2,3,7,8-TCDD | > 0.02 µg/kg |
| 2,3,7,8-TCDF | > 4 µg/kg |
| 1,2,3,7,8-PeCDD | > 0.01 µg/kg |
| 2,3,4,7,8-PeCDF | > 0.4 µg/kg |
| 1,2,3,4,6,7,8-HxCDF | >0.3 µg/kg |

# PTW – Reliably Contained

| Contaminant | PTW Contaminants Reliably Contained |
|---|---|
| **Dioxins/Furans** | Can be reliably contained |
| **PAHs** | Can be reliably contained |
| **Chlorobenzene** | <320 µg/kg |
| **DDx** | Can be reliably contained |
| **Naphthalene** | <140,000 µg/kg |
| **PCBs** | Can be reliably contained |

# PTW Footprint

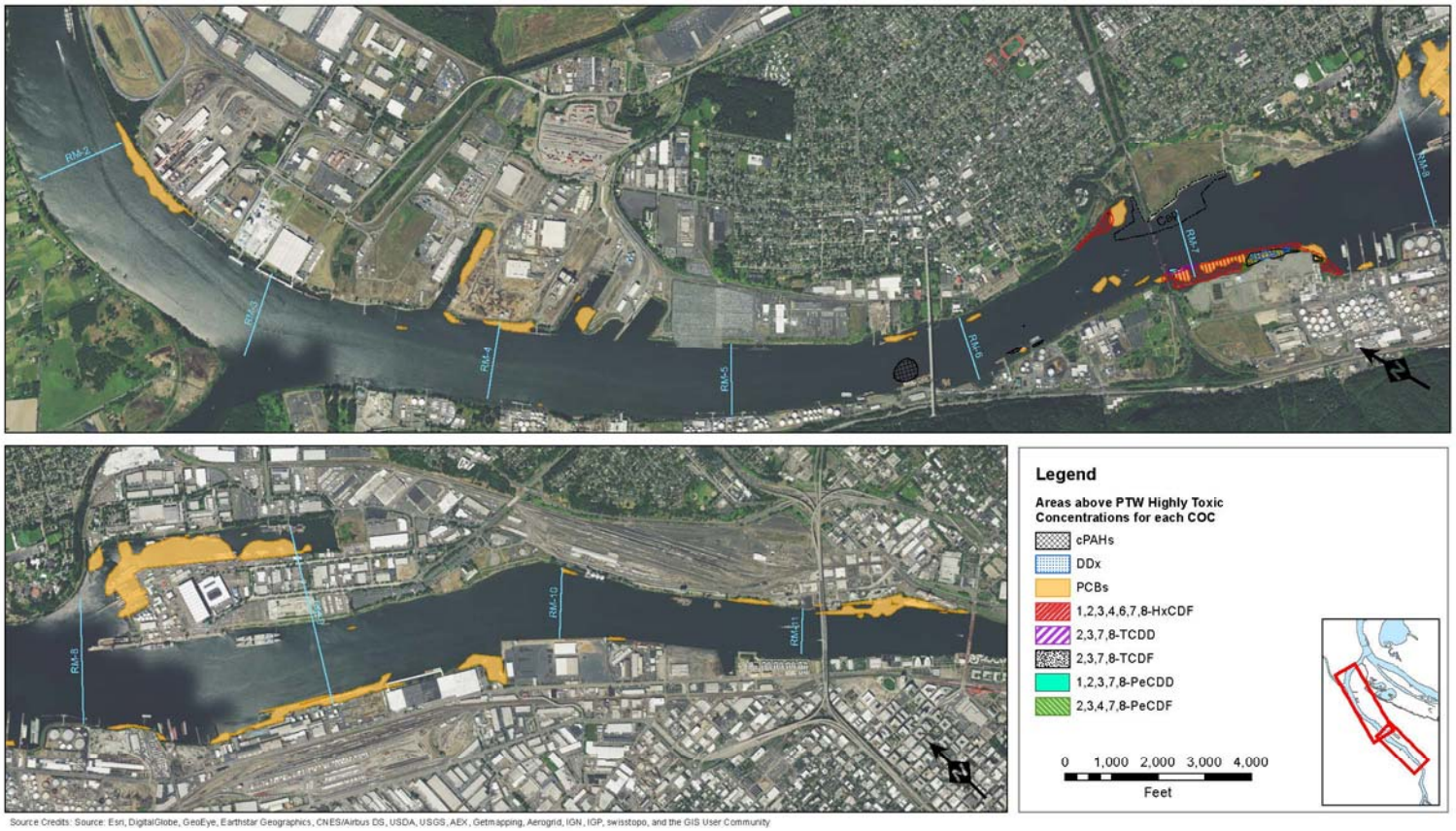



Figure 3.2-3. Highly Toxic PTW Contours (Surface Sediment)

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Date: 9/3/2015

# Ex-situ Treatment Assumptions

- NAPL & PTW Not Reliably Contained
  - Chlorobenzene
  - Napthalene
  - PAHs
  - DDx mixed with chlorobenzene
- Treatment Method
  - Thermal Desorption

# EMNR Assumptions

- Swan Island Lagoon
  - Outside SMAs
  - 12 in. sand
- Institutional Controls

# Remaining Areas

- In-situ treatment for PTW
  - Only if depositional area
  - Activated carbon
- MNR
  - Deposition
  - Dispersion
- Institutional Controls

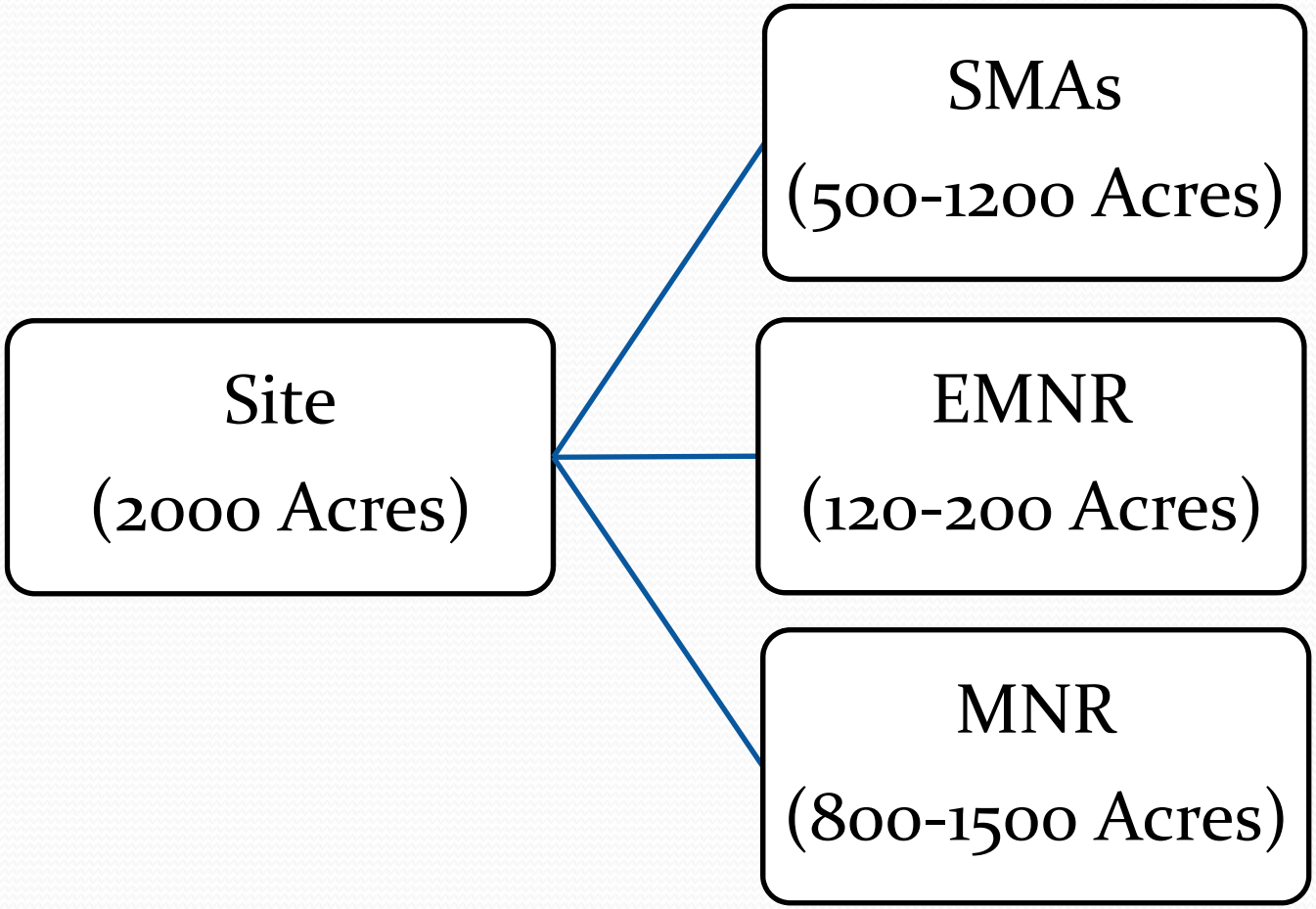
# Institutional Control Assumptions

- Whole River
  - Fish consumption advisories
- Capped Areas
  - Waterway Use Restrictions or Regulated Navigation Areas (RNAs)
  - Land Use/Access Restrictions
- EMNR Areas
  - Land Use/Access Restrictions

# Summary of Technology Assignments

| Alt | Dredge Volume (Cu Yd) | Dredge Areas (Acres) | Dredge/Cap Areas (Acres) | Cap Areas (Acres) | In-Situ Areas (Acres) | Ex-Situ Volume (Cu Yd) | EMNR (Acres) | MNR[3] (Acres) | Disposal | Years to Const. |
|---|---|---|---|---|---|---|---|---|---|---|
| B | 782,620 | 67 | 17 | 23 | 7 | 464,883 | 96 | 1,962 | DMM 2 | 4 |
| C | 950,324 | 83 | 19 | 30 | 5 | 464,883 | 94 | 1,945 | DMM 2 | 4 |
| D | 1,285,223 | 129 | 23 | 45 | 3 | 464,883 | 82 | 1,899 | DMM 2 | 5 |
| E | 2,147,429 | 191 | 38 | 66 | 0 | 464,883 | 54 | 1,838 | DMM 1<br>DMM 2 | 7 |
| F | 4,643,695 | 362 | 61 | 118 | 0 | 464,883 | 22 | 1,638 | DMM 1<br>DMM 2 | 12 |
| G | 7,435,061 | 477 | 78 | 185 | 0 | 464,883 | 13 | 1,396 | DMM 1<br>DMM 2 | 18 |

# Summary of Technology Assignments



# Alternative B

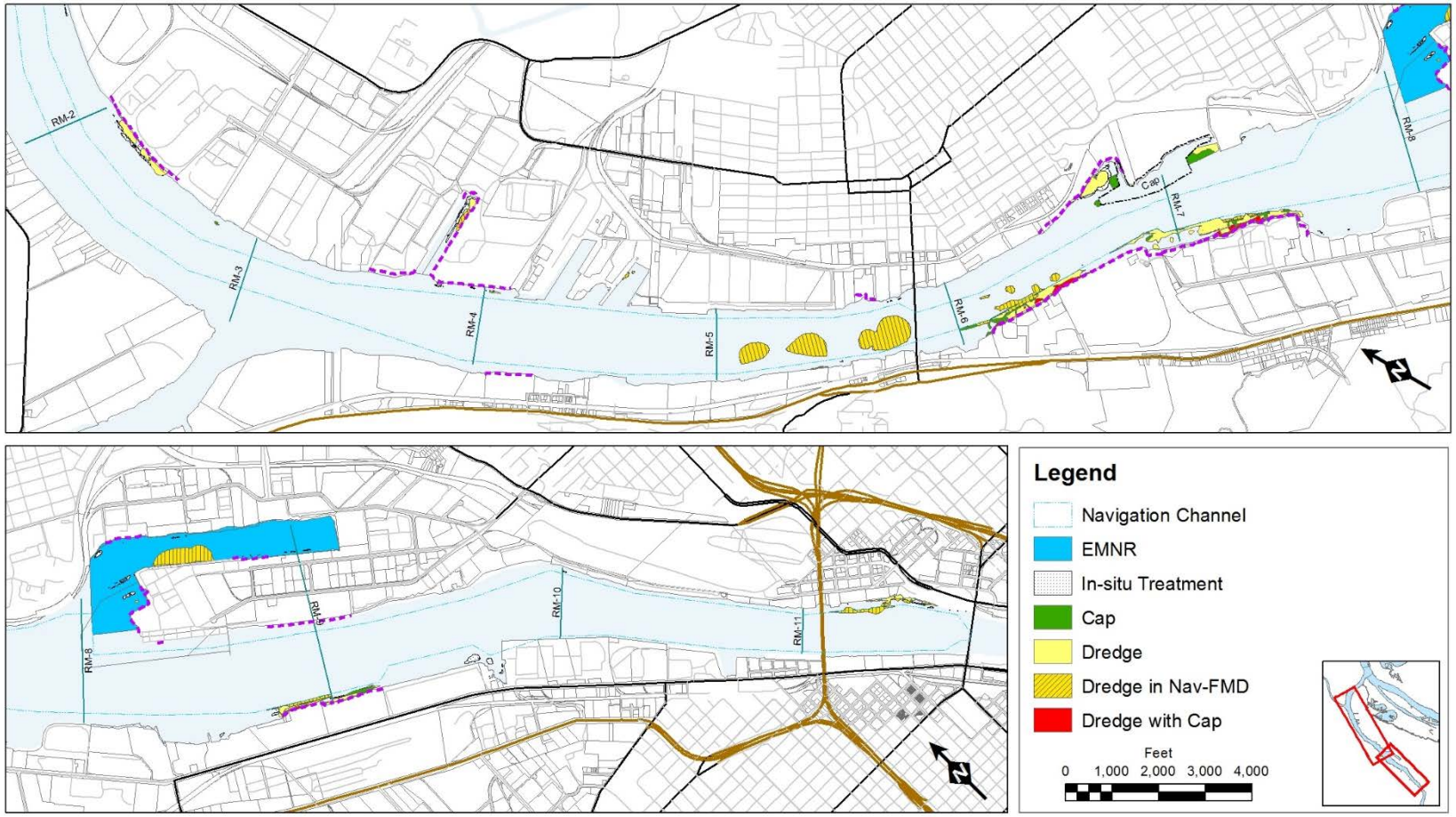



**Figure 3.6-2a. Technology Assignments, Alternative B, Site-Wide**

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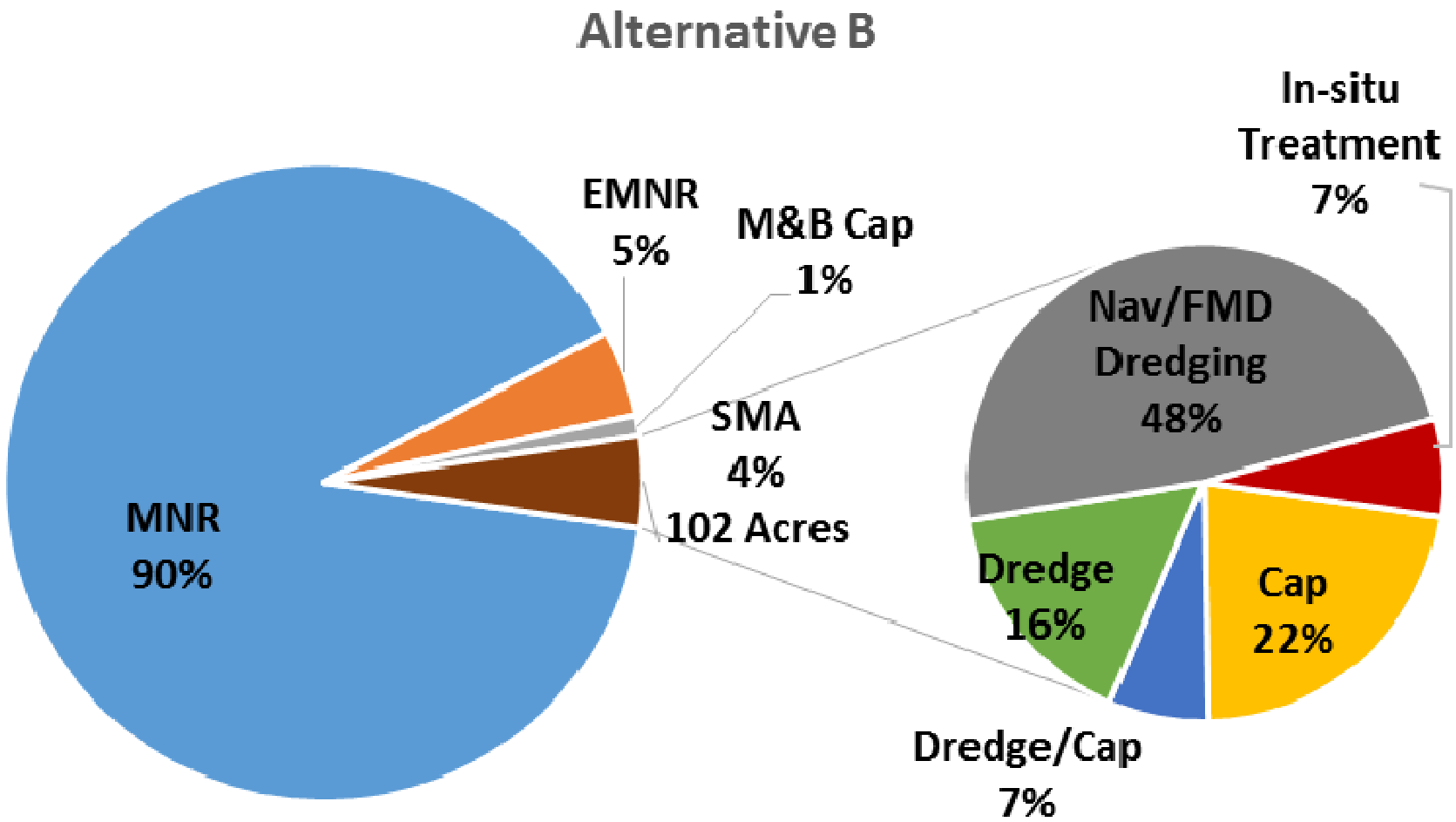
# Alternative B Technologies



# Alternative C

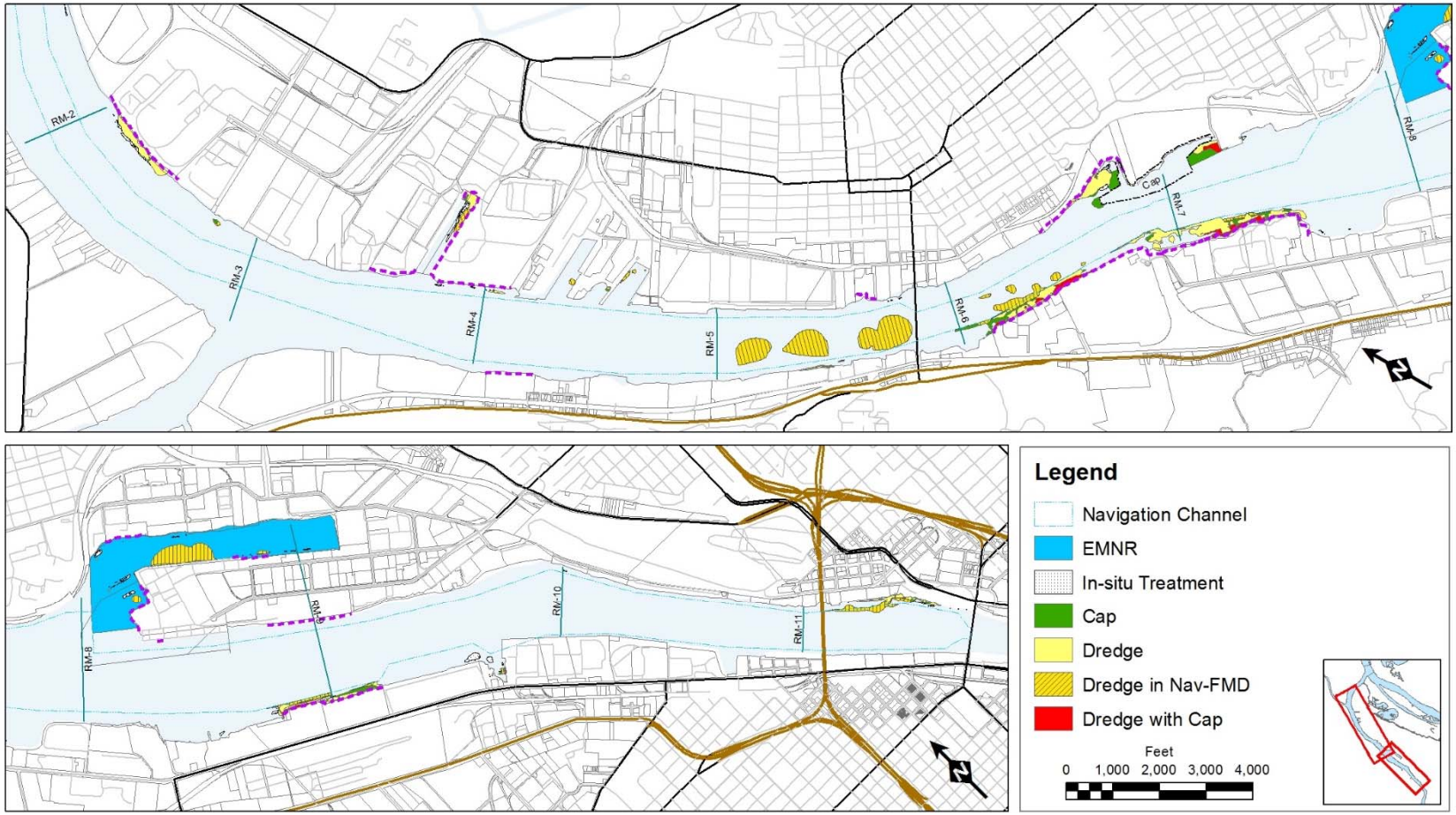



**Figure 3.6-3a. Technology Assignments, Alternative C, Site-Wide**

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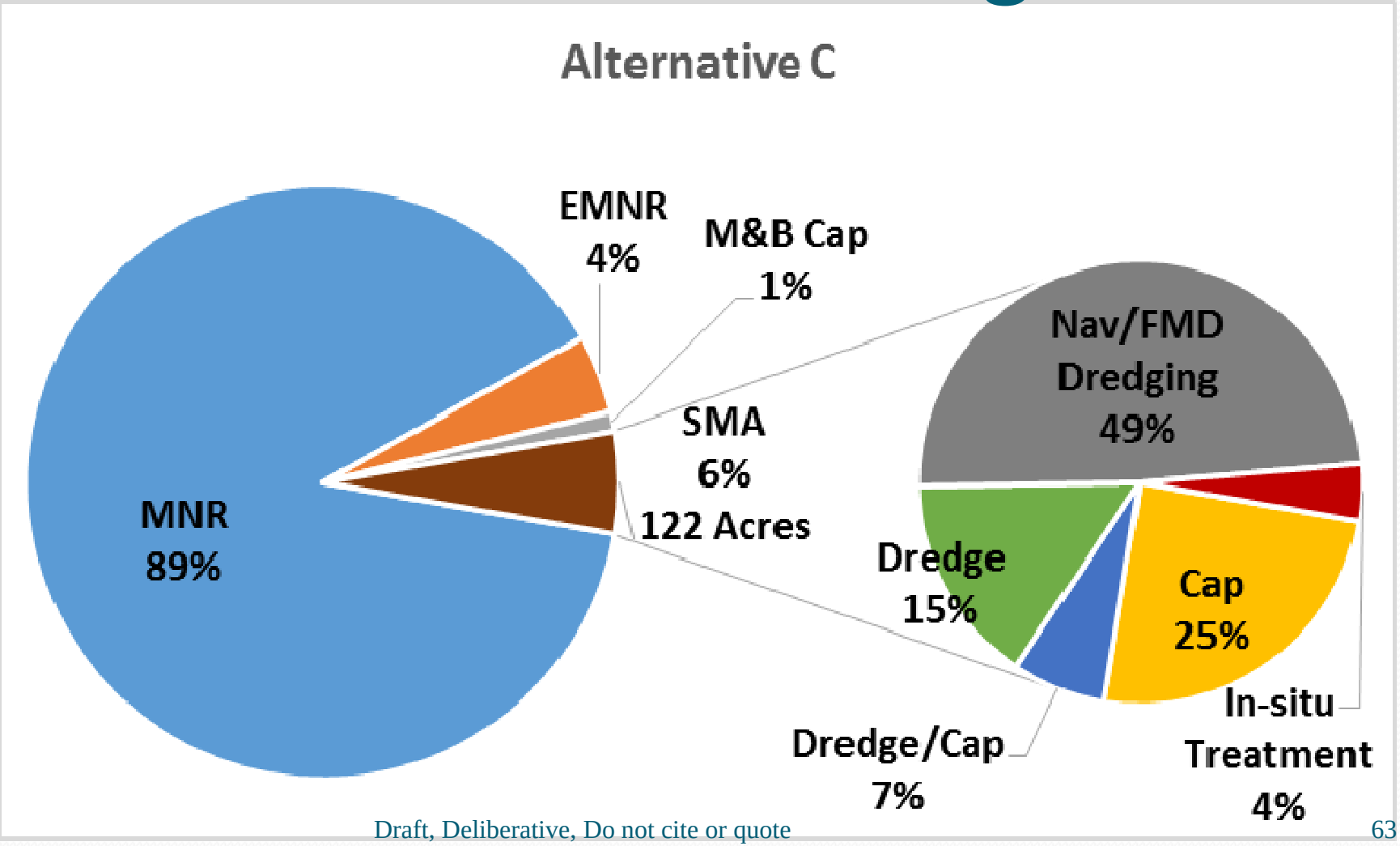
Date: 7/27/2015

# Alternative C Technologies



# Alternative D

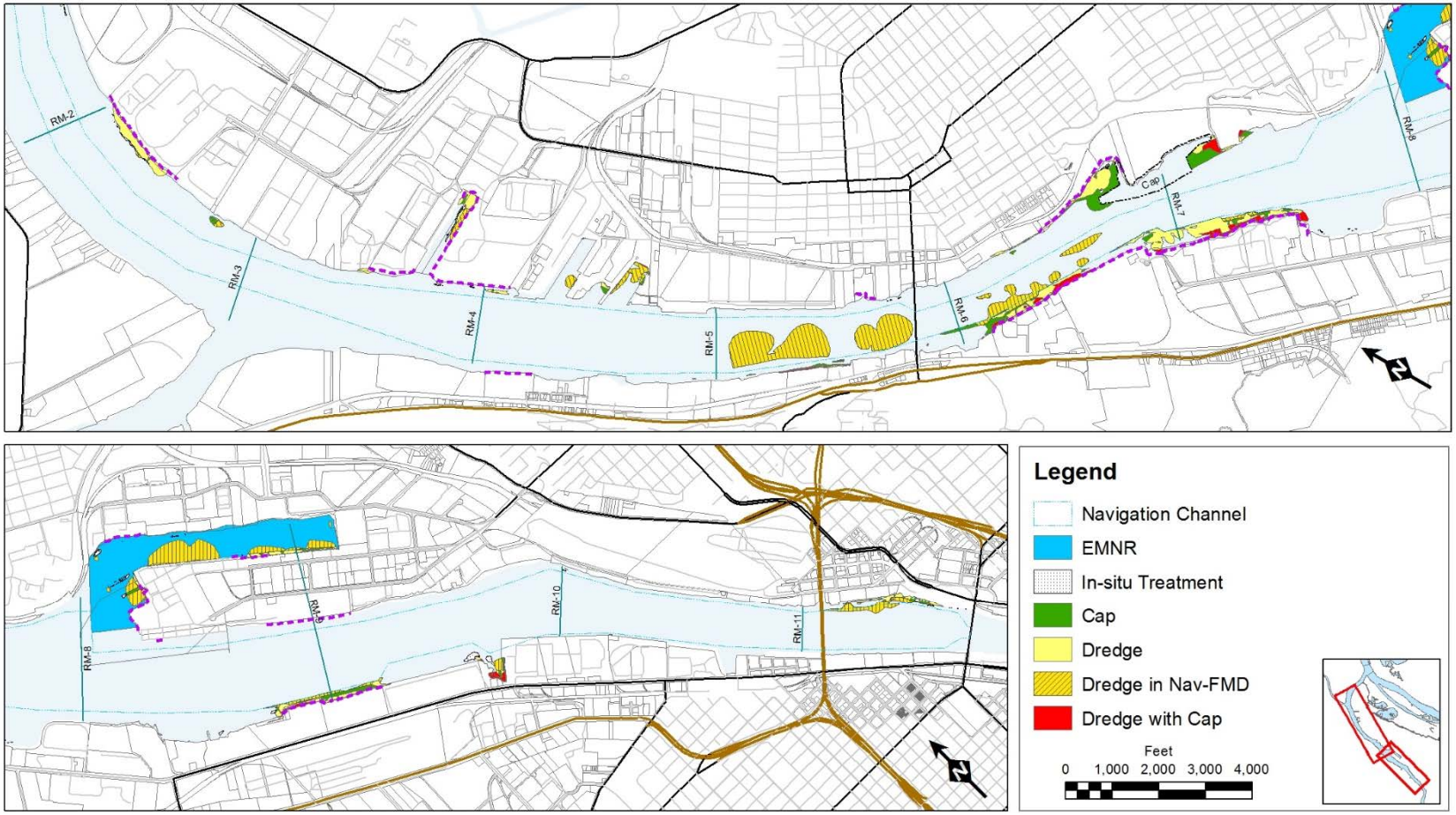



Figure 3.6-4a. Technology Assignments, Alternative D, Site-Wide

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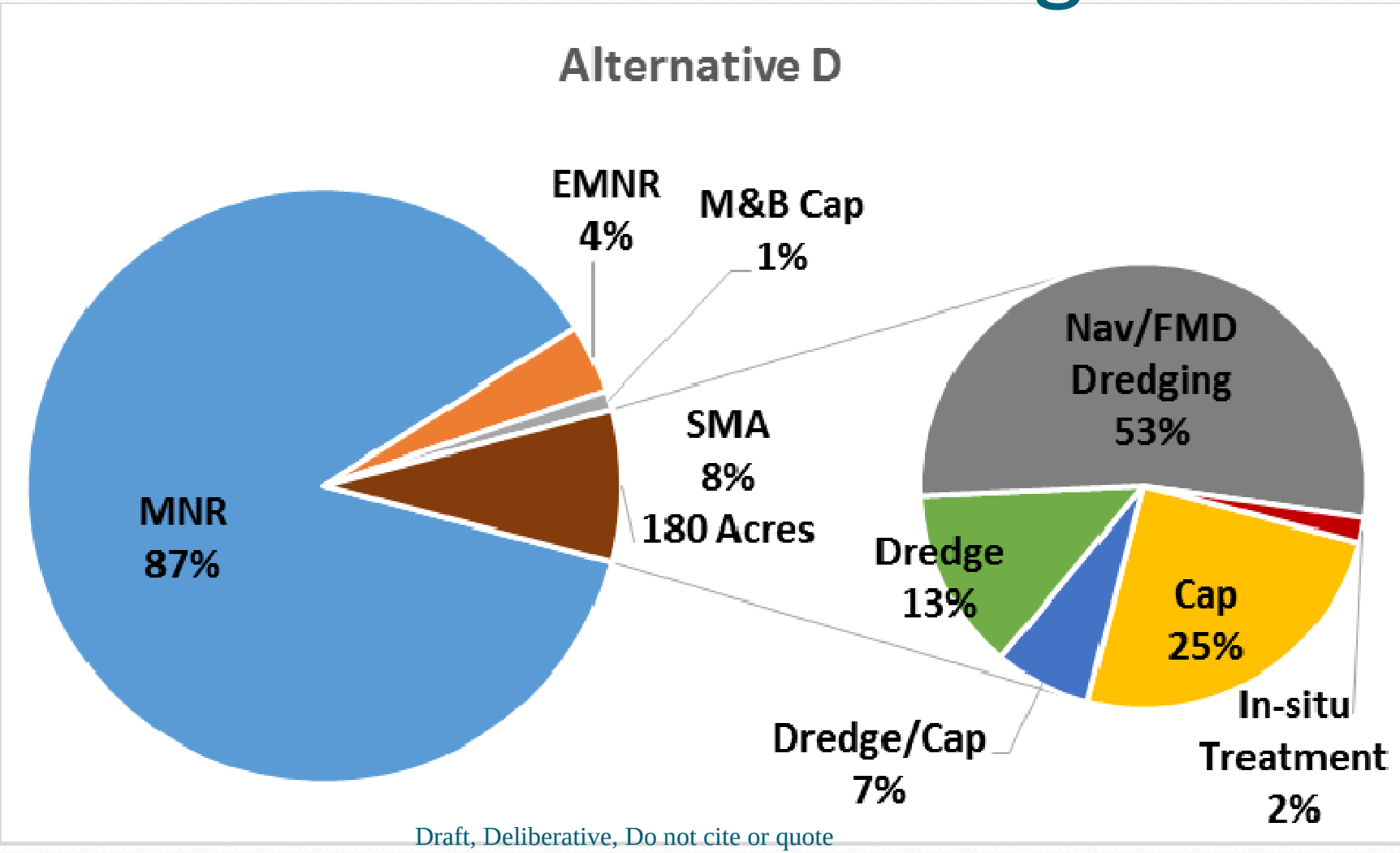
# Alternative D Technologies



# Alternative E

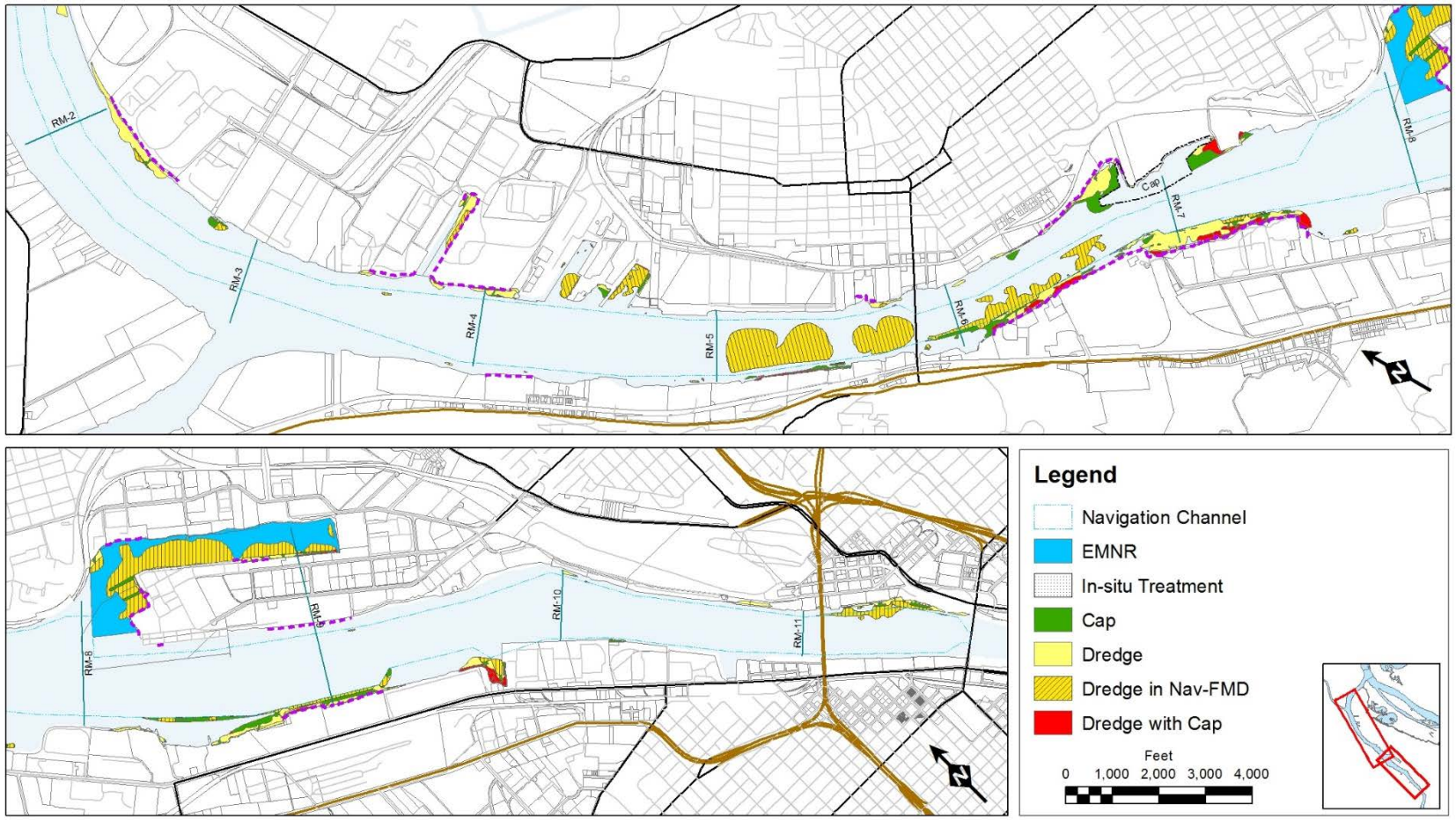



**Figure 3.6-5a. Technology Assignments, Alternative E, Site-Wide**

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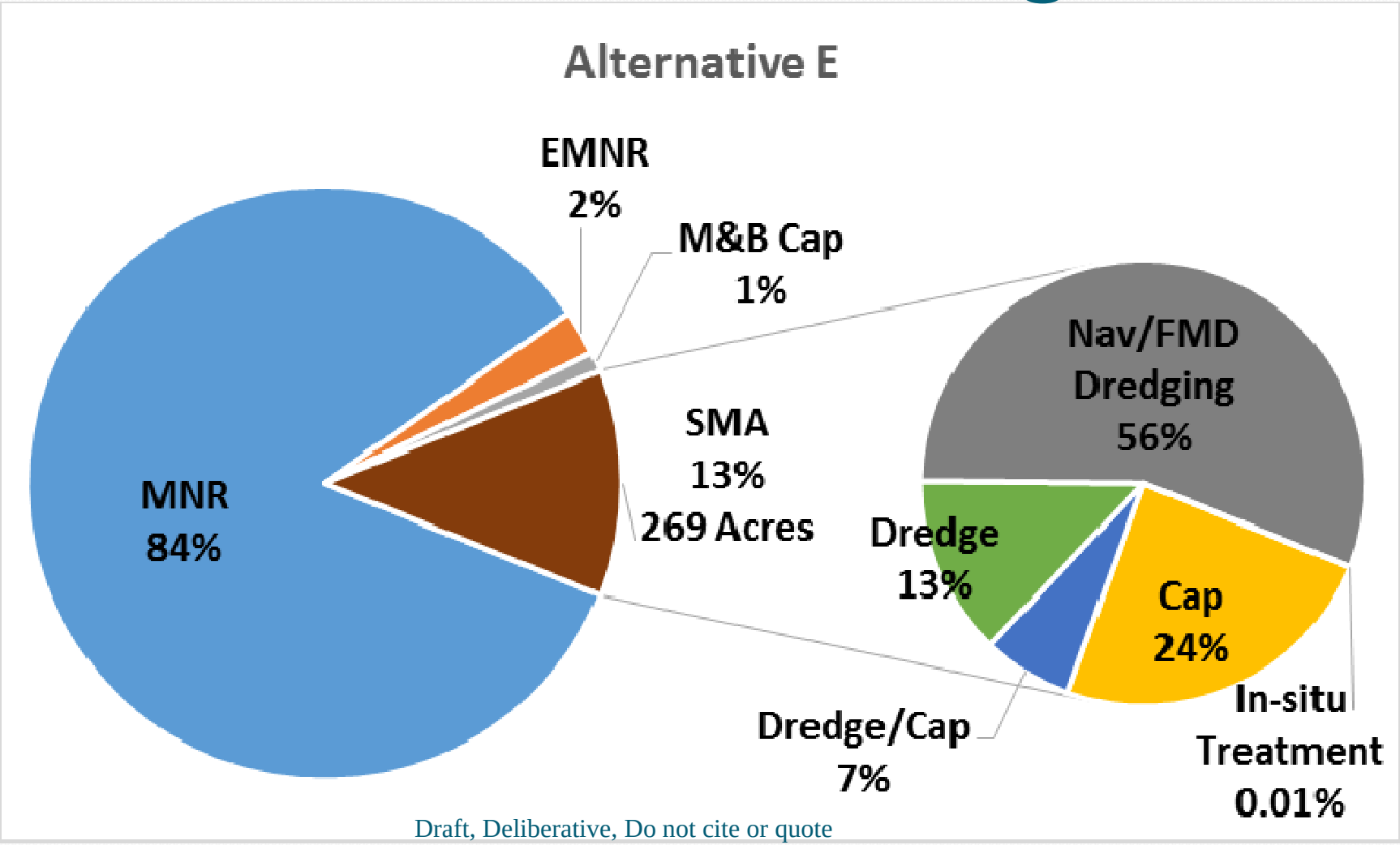
# Alternative E Technologies



# Alternative F

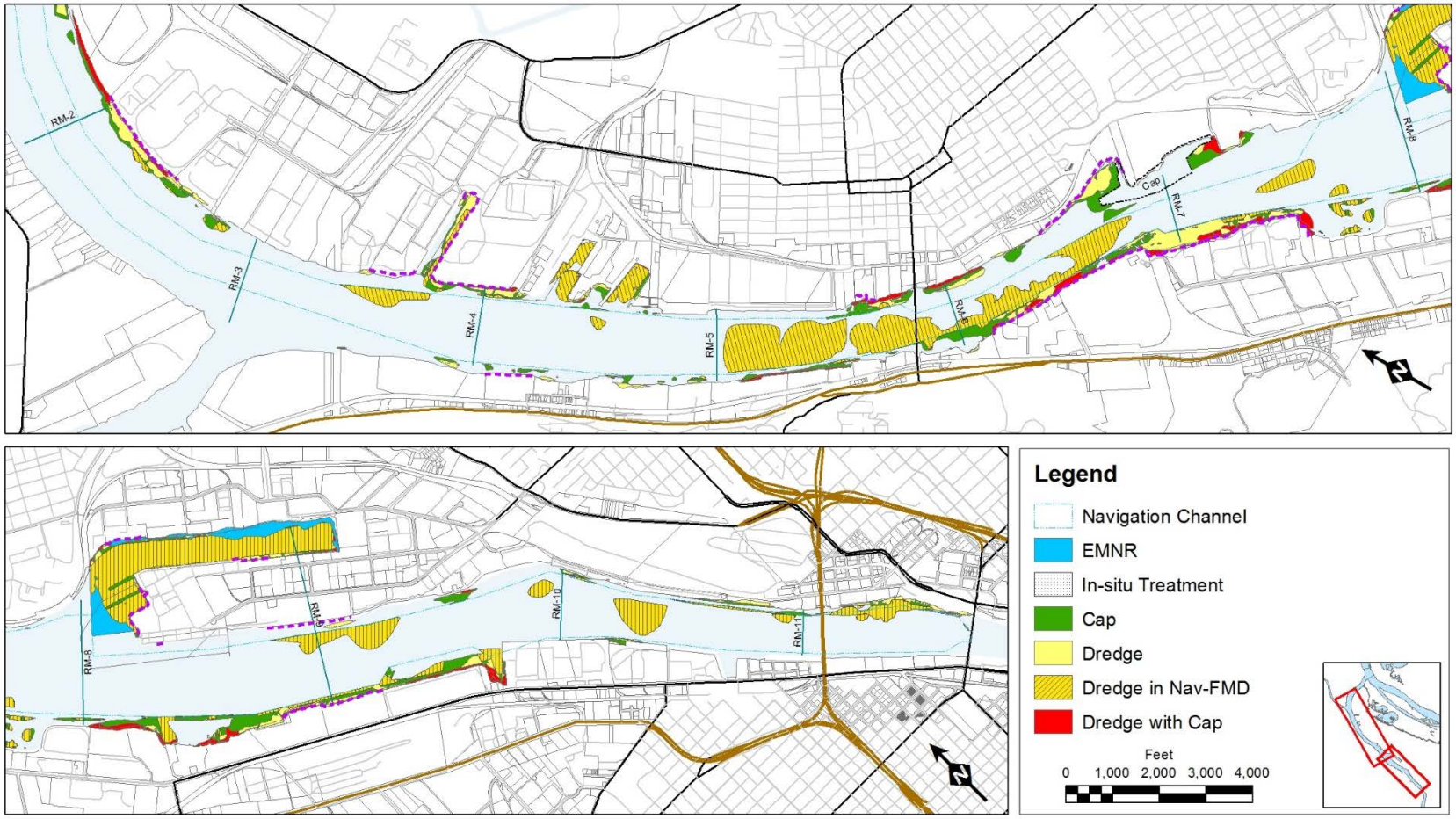



**Figure 3.6-6a. Technology Assignments, Alternative F, Site-Wide**

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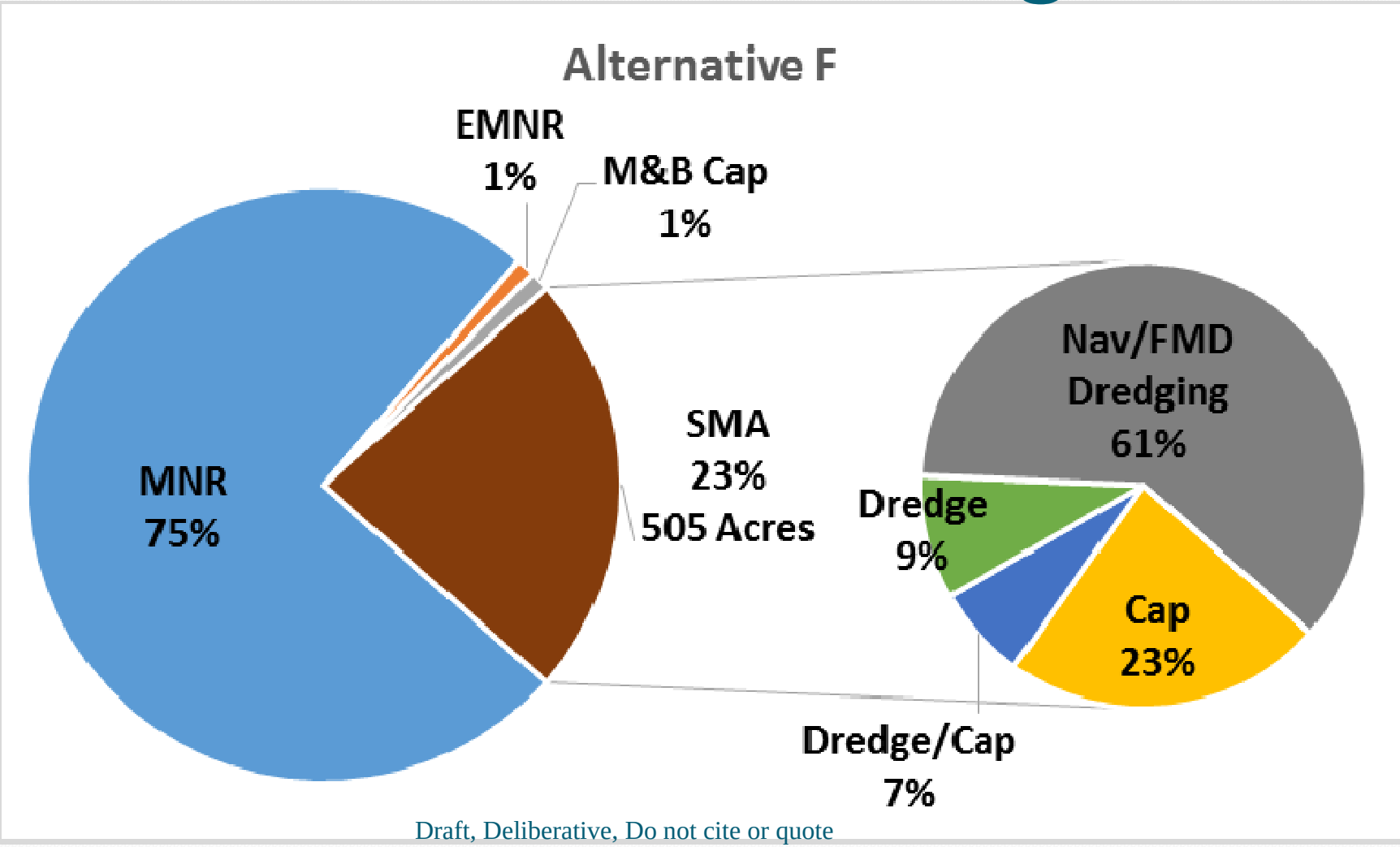
# Alternative F Technologies



# Alternative G

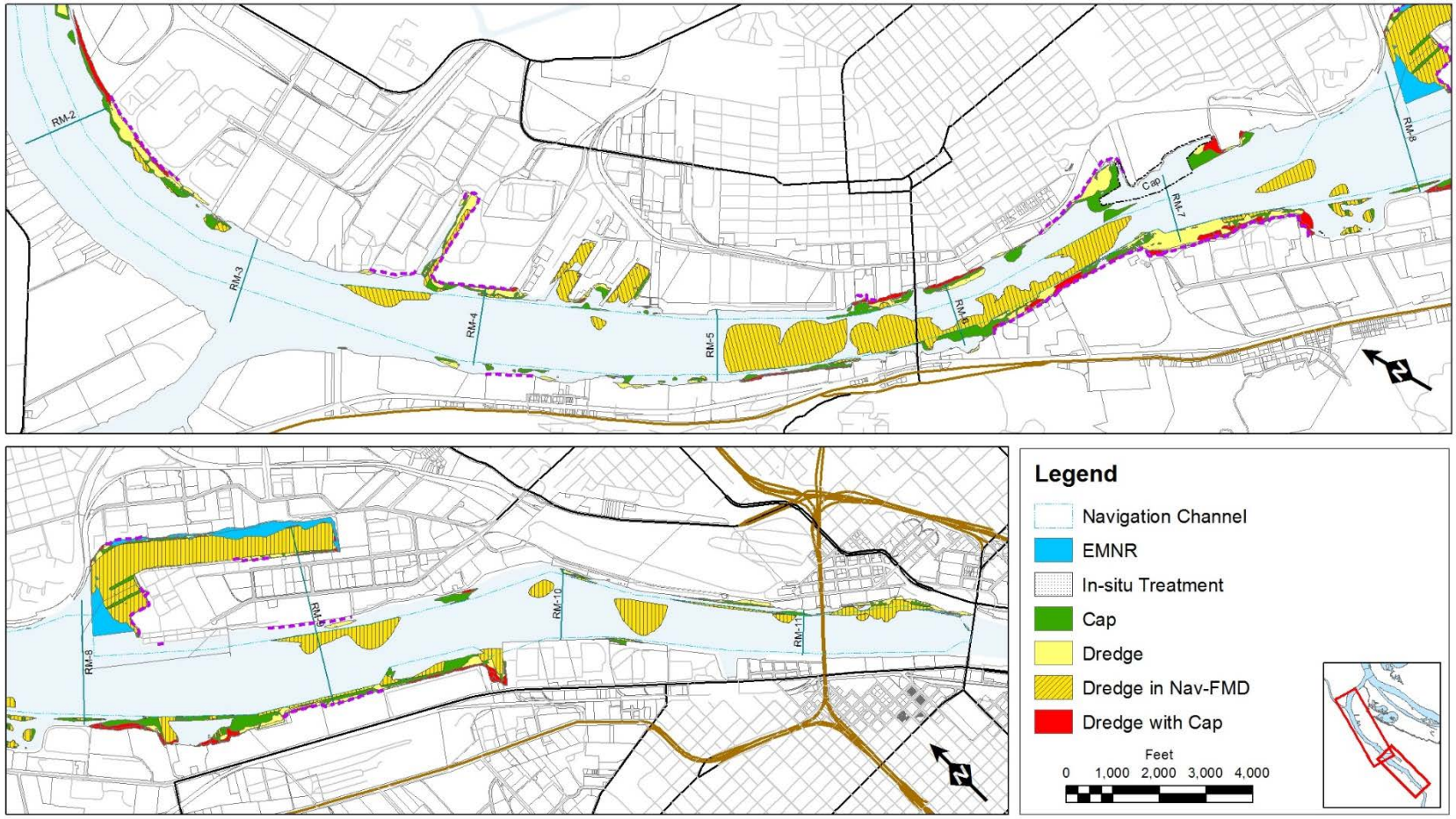
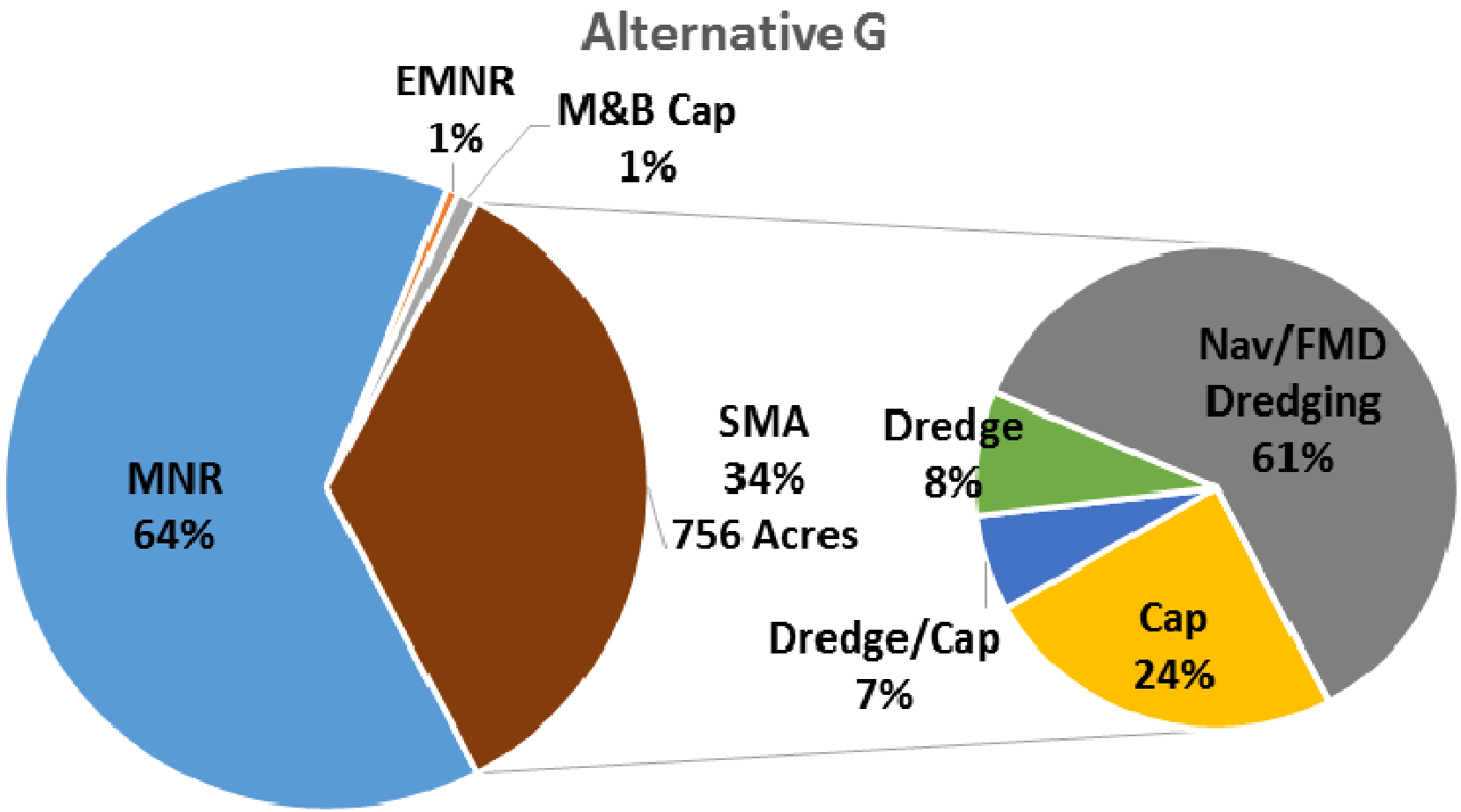



Figure 3.6-6a. Technology Assignments, Alternative F, Site-Wide

Path: E:_Projects\Portland Harbor\GIS\MapDocuments\Presentations\TechAssignment\Fig3-06-X_Tech-Assign-Site-wide.mxd, Created by: MLF

# Alternative G Technologies



# Screened Alternatives

- Alternative C
  - Essentially same as Alternative B
  - 0.1% increase in overall acres remediated
  - 8.7% reduction of focused COC concentrations

# Portland Harbor

## Detailed Analysis of Alternatives

# Site Areas

- Based on receptors
- Account for receptor mobility
- Focus on high concentration areas
- Delineate areas of capping/dredging

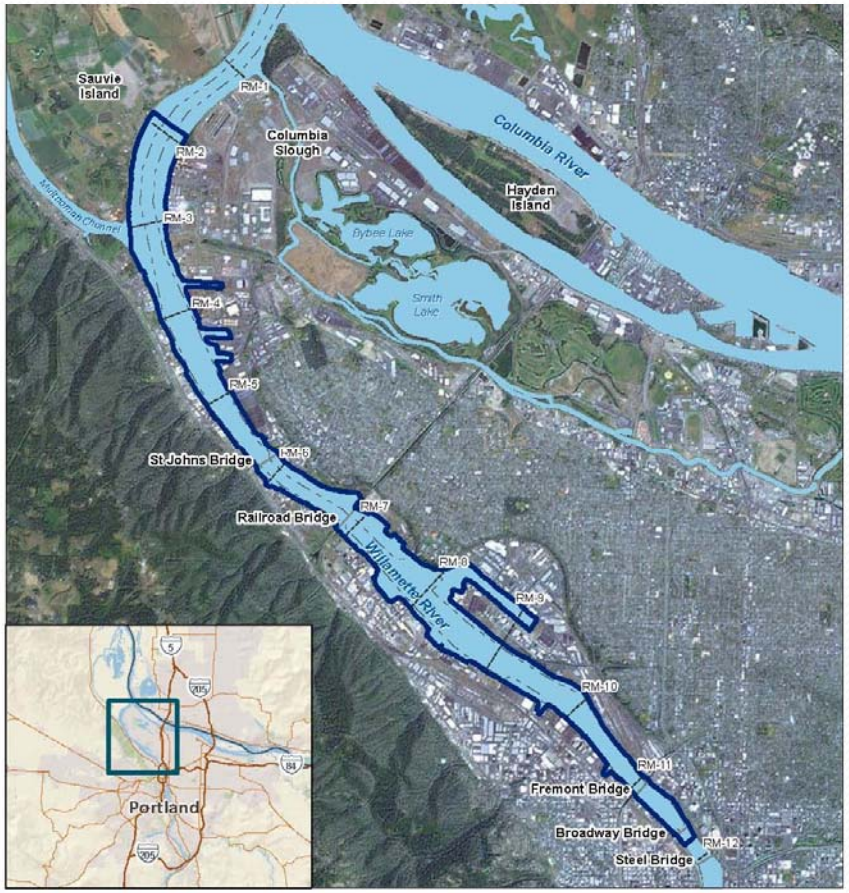
# Site-wide

Example Receptors

- Subsistence & Tribal Fishers
- Large-home range Fish
- Bald Eagle

Size

- ~10 RM
- 2,190 Acres



# River Zones

- East Nearshore Zone
- West Nearshore Zone
- Navigation Channel
- Swan Island Lagoon

# 0.1 to 0.2 River Mile

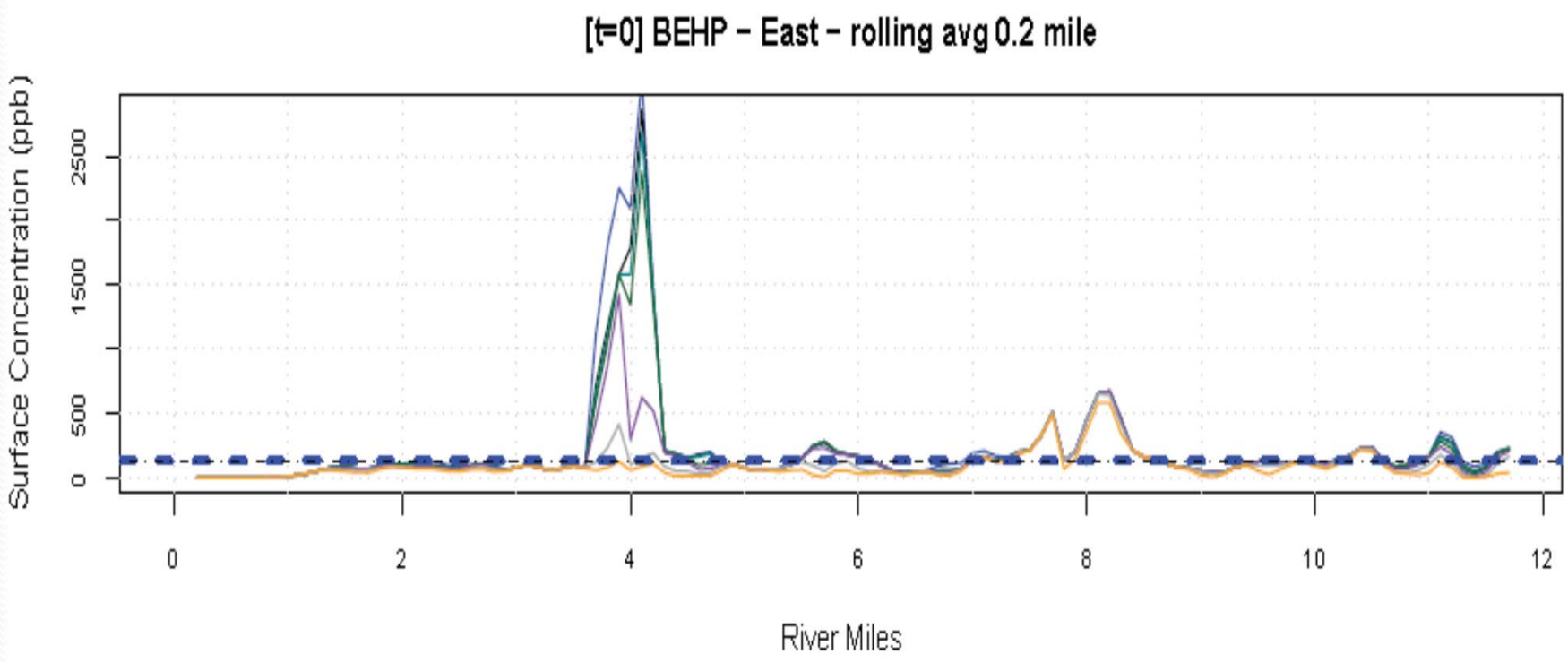
Example Receptors

- Sculpin
- Crayfish
- Benthic

Size

- Rolling 0.2 RM in River Zones

# Example Rolling 0.2 RM



# 0.5 River Mile

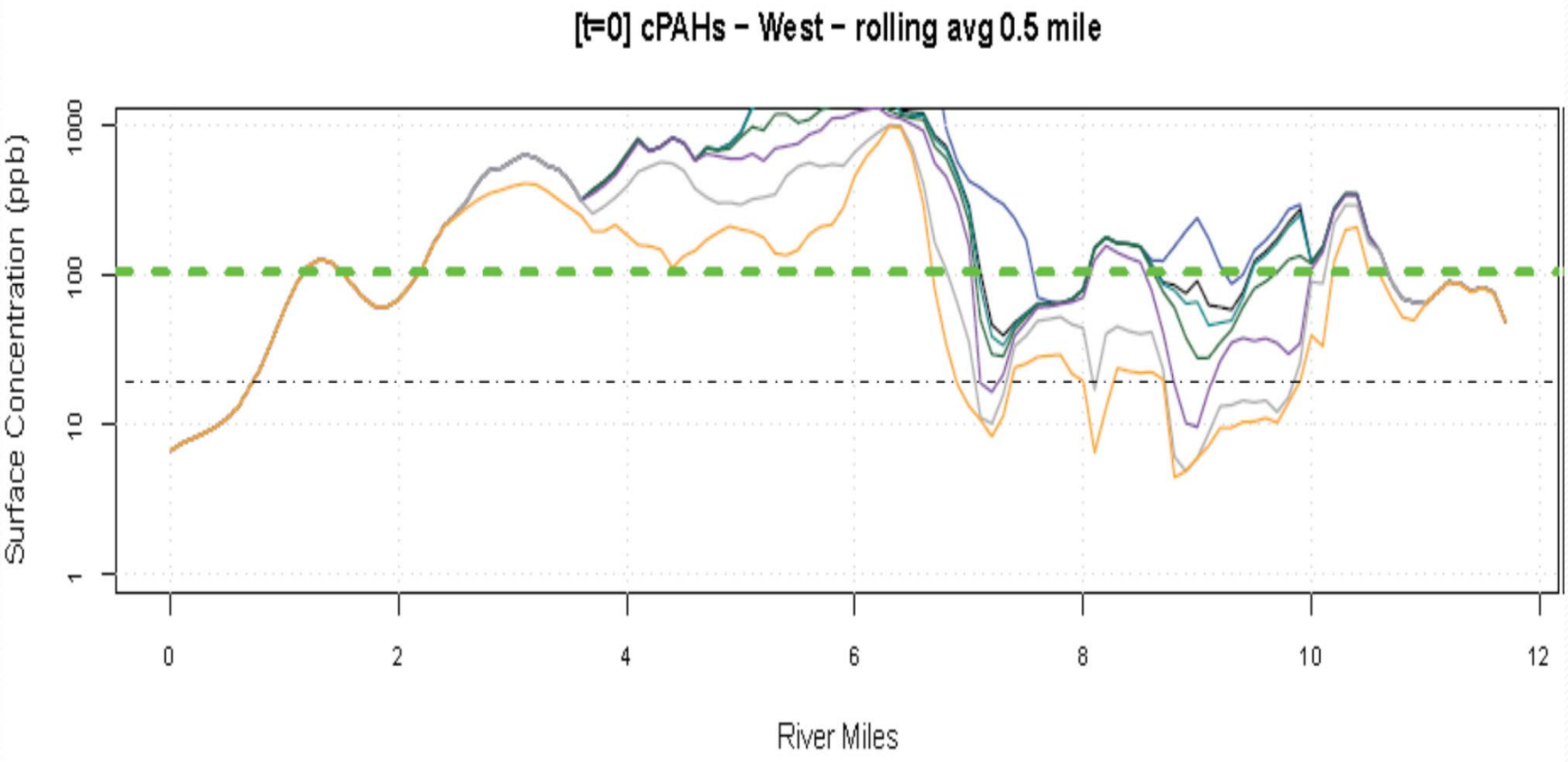
Example Receptors

- Human Direct Contact (nearshore only)

Size

- Rolling ½ RM in River Zones

# Example Rolling 0.5 RM



# 1 River Mile

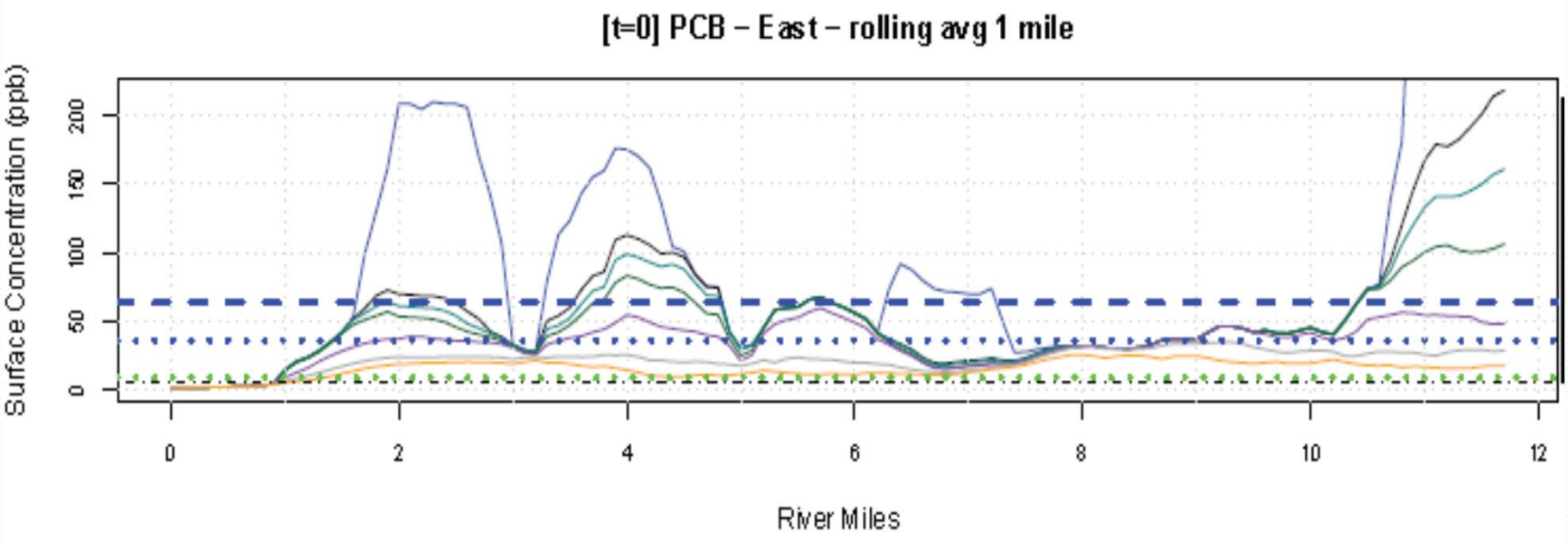
Example Receptors

- Recreational Fishers
- Smallmouth Bass
- Mink
- Osprey

Size

- Rolling RM in River Zones
- SDUs

# Example Rolling 1 RM



# Sediment Decision Units

**Develop a spatial basis for evaluating remediation**

- River Zones
- Centered on contaminant high concentration areas

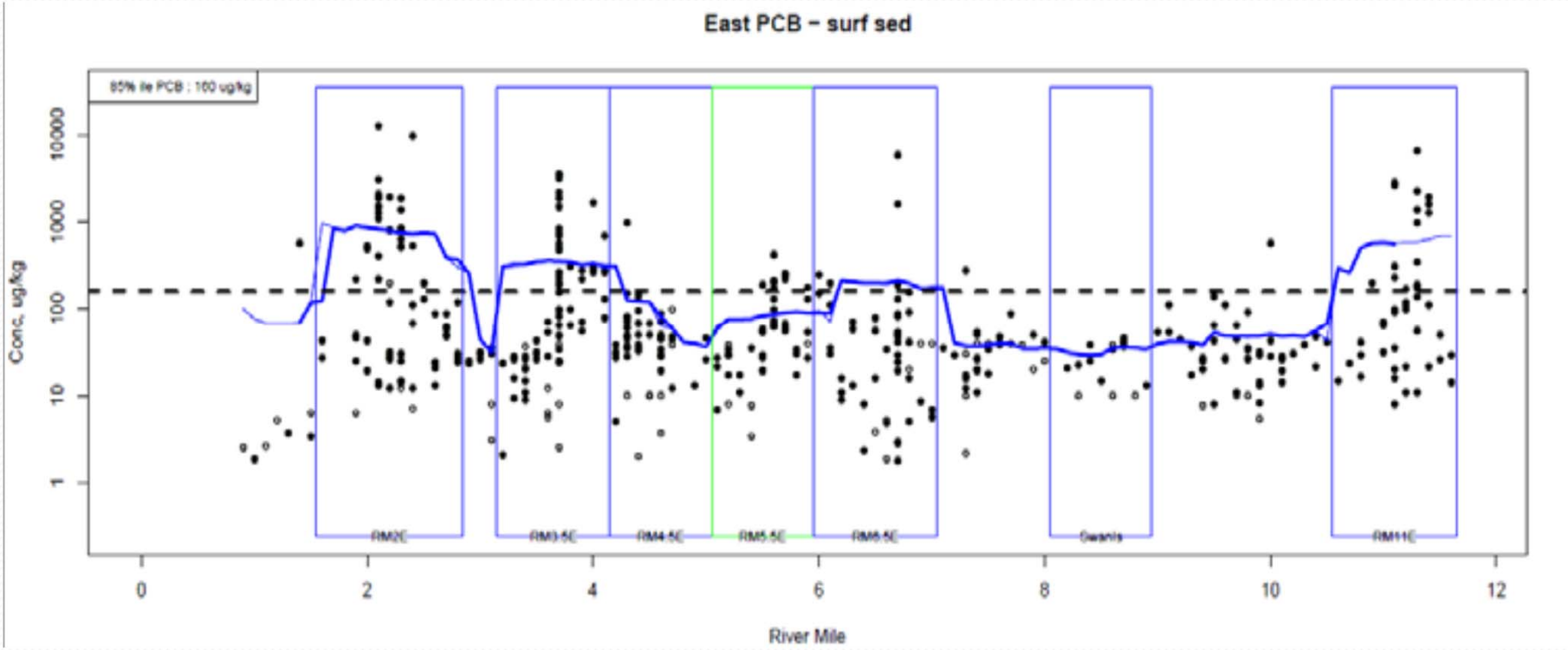
**Goal**

- Reproducible and spatially-based
- Evaluate highest risk reduction

# SDU Approach

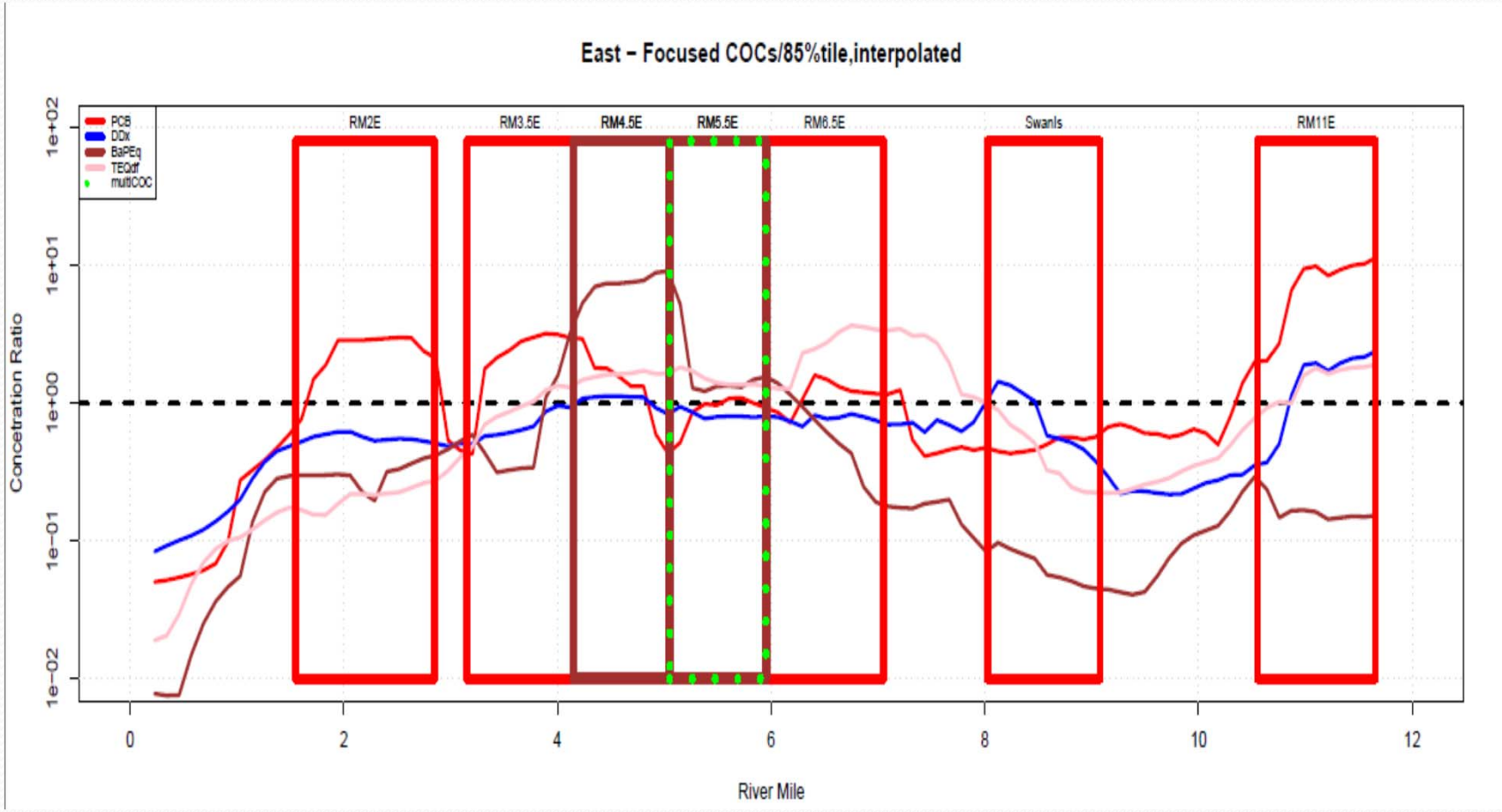
- Delineate highest concentration areas
- Based on river region
- Non-weighted surface sediment concentrations
  - Focused COCs
- Adjust SDU boundaries
  - interpolated concentration contours
- Other considerations
  - benthic risk
  - other COCs

# Example Rolling RM




Note: All SDUs shown, not just PCB related ones

# Example 85% Normalization



# Resulting SDUs

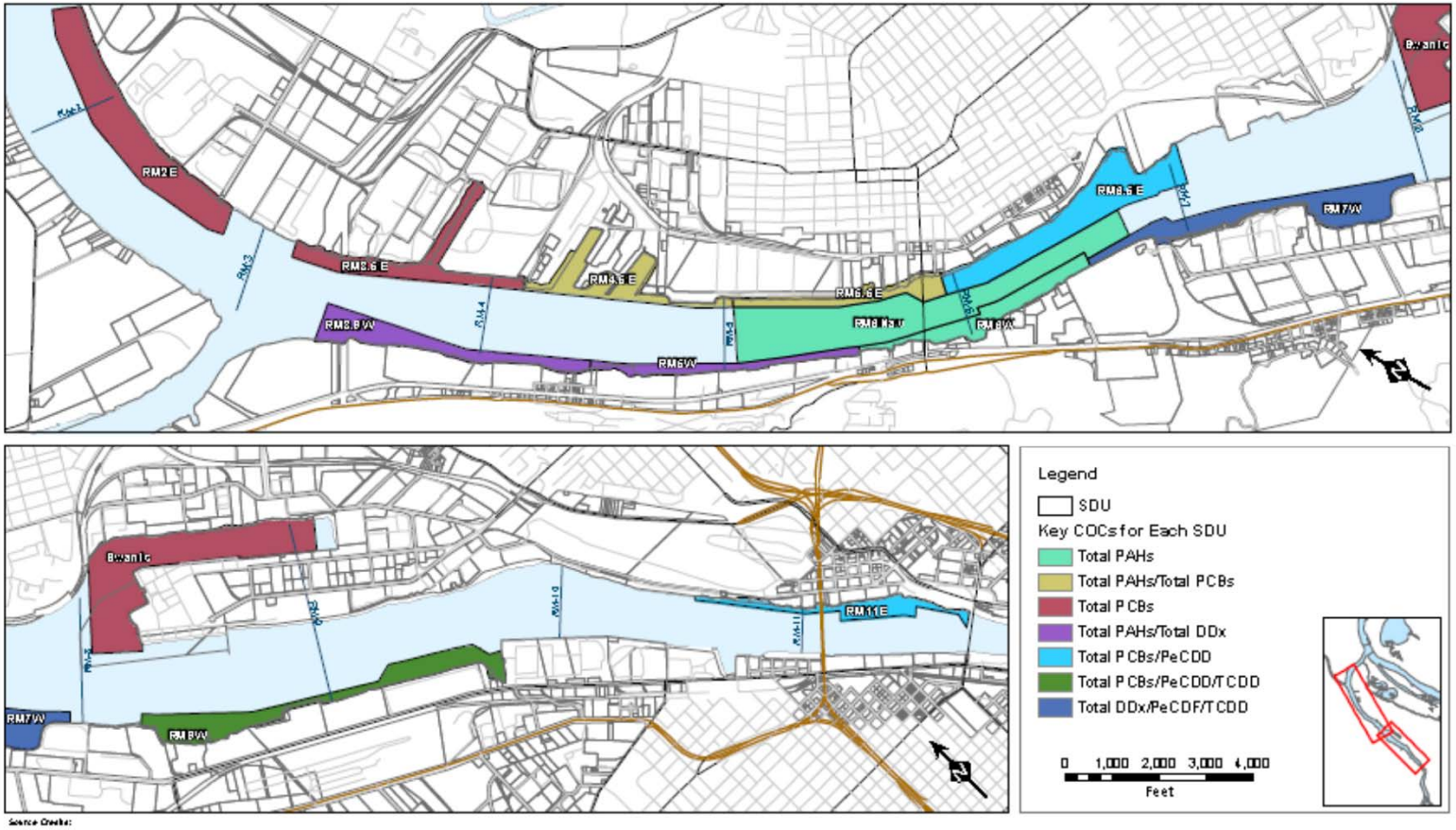



Figure 4.1-2. Sediment Decision Units and Key COCs

# Overall Protection of Human Health and the Environment

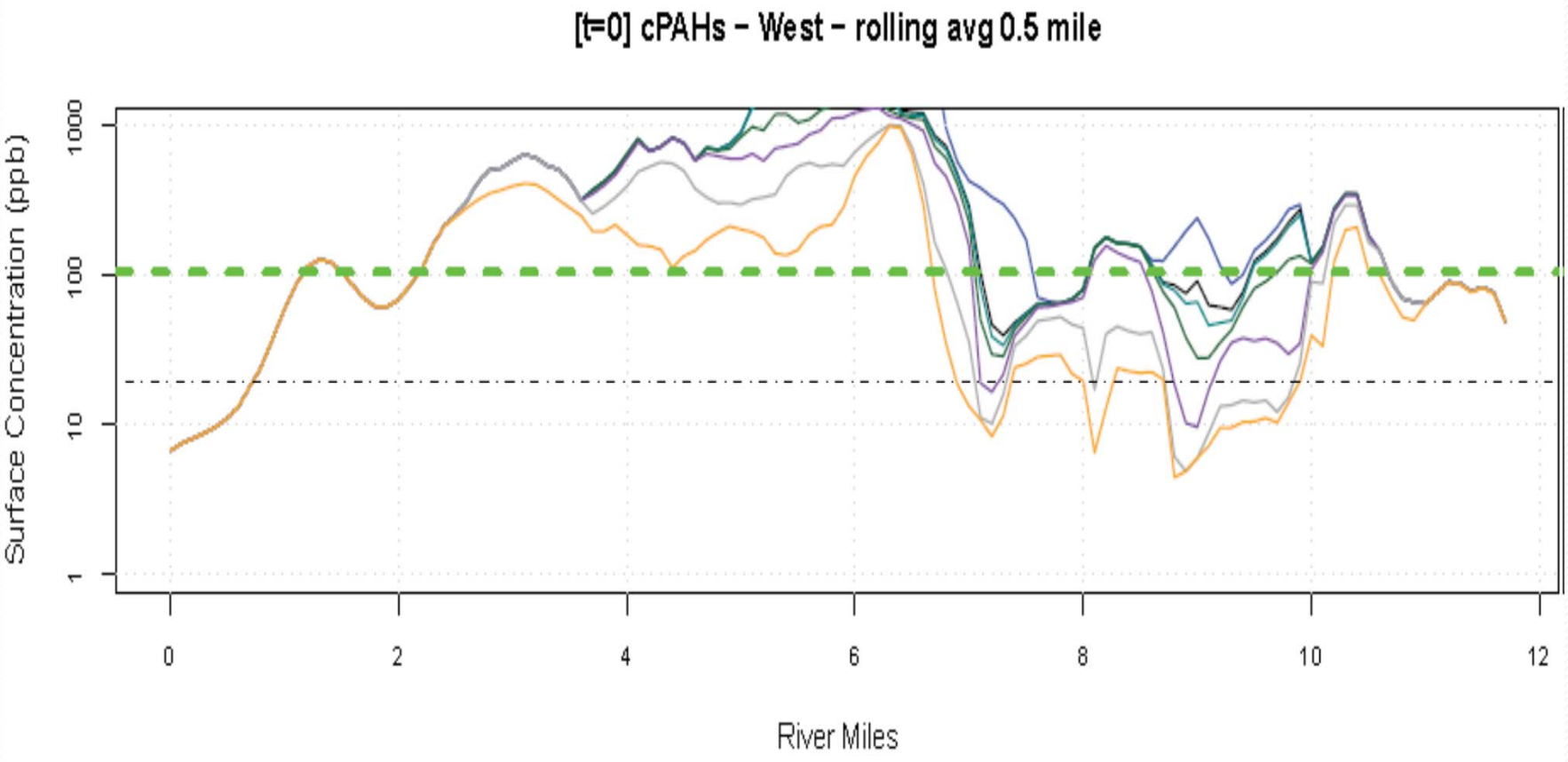
Human Health

- RAOs 1 & 2
  - Compare to PRGs
  - Residual risk
- RAOs 3 & 4
  - Qualitative

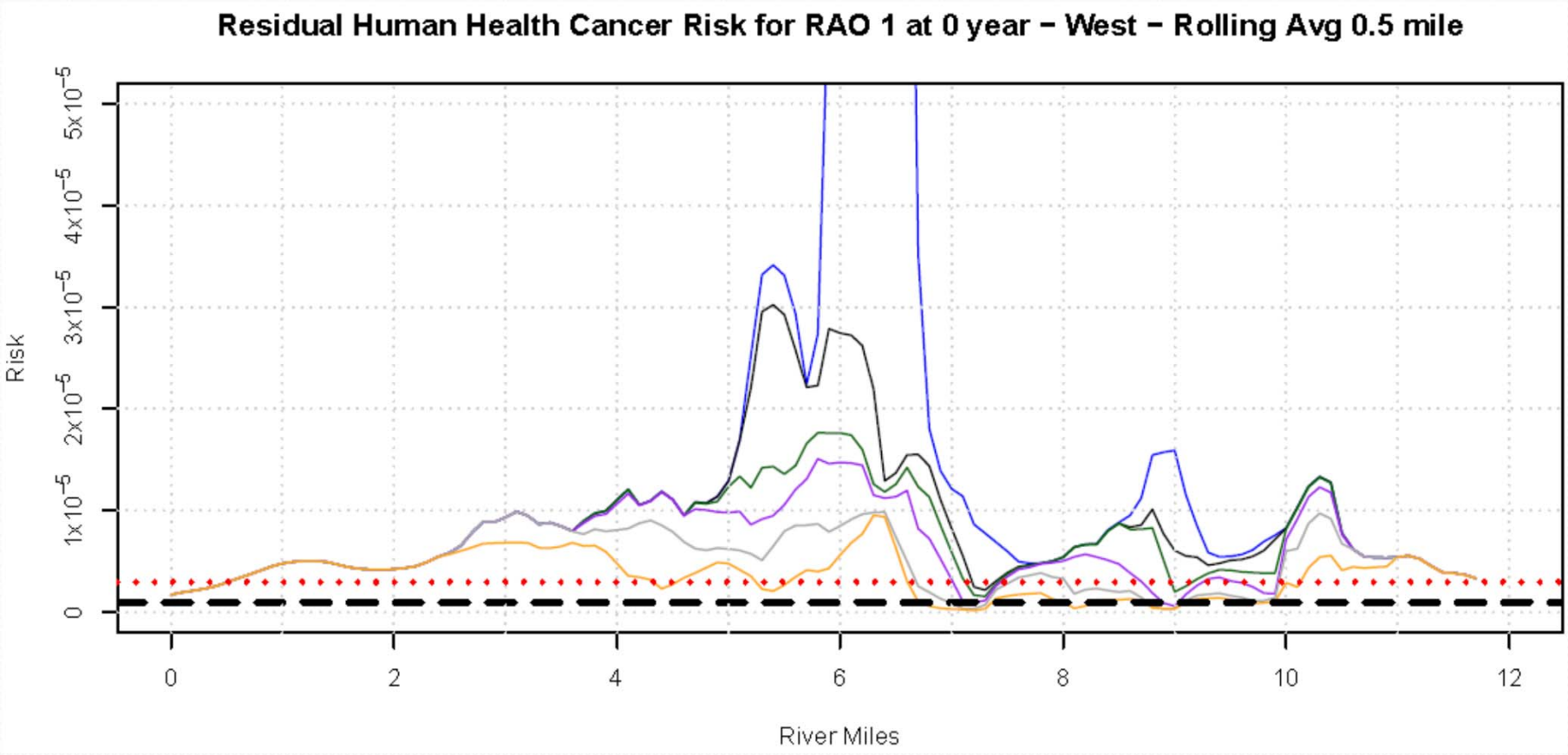
Ecological

- RAOs 5 & 6
  - Compare to PRGs
  - Residual risk
- RAOs 7 & 8
  - Qualitative

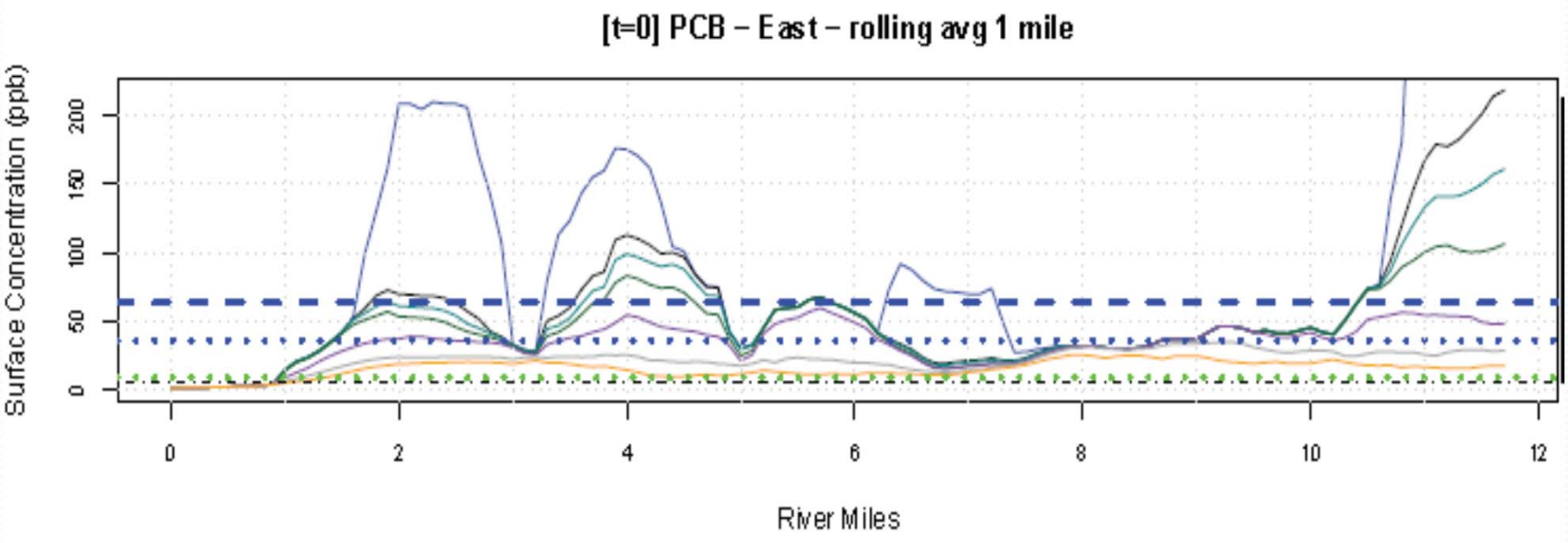
# RAO 1 – Compare to PRG



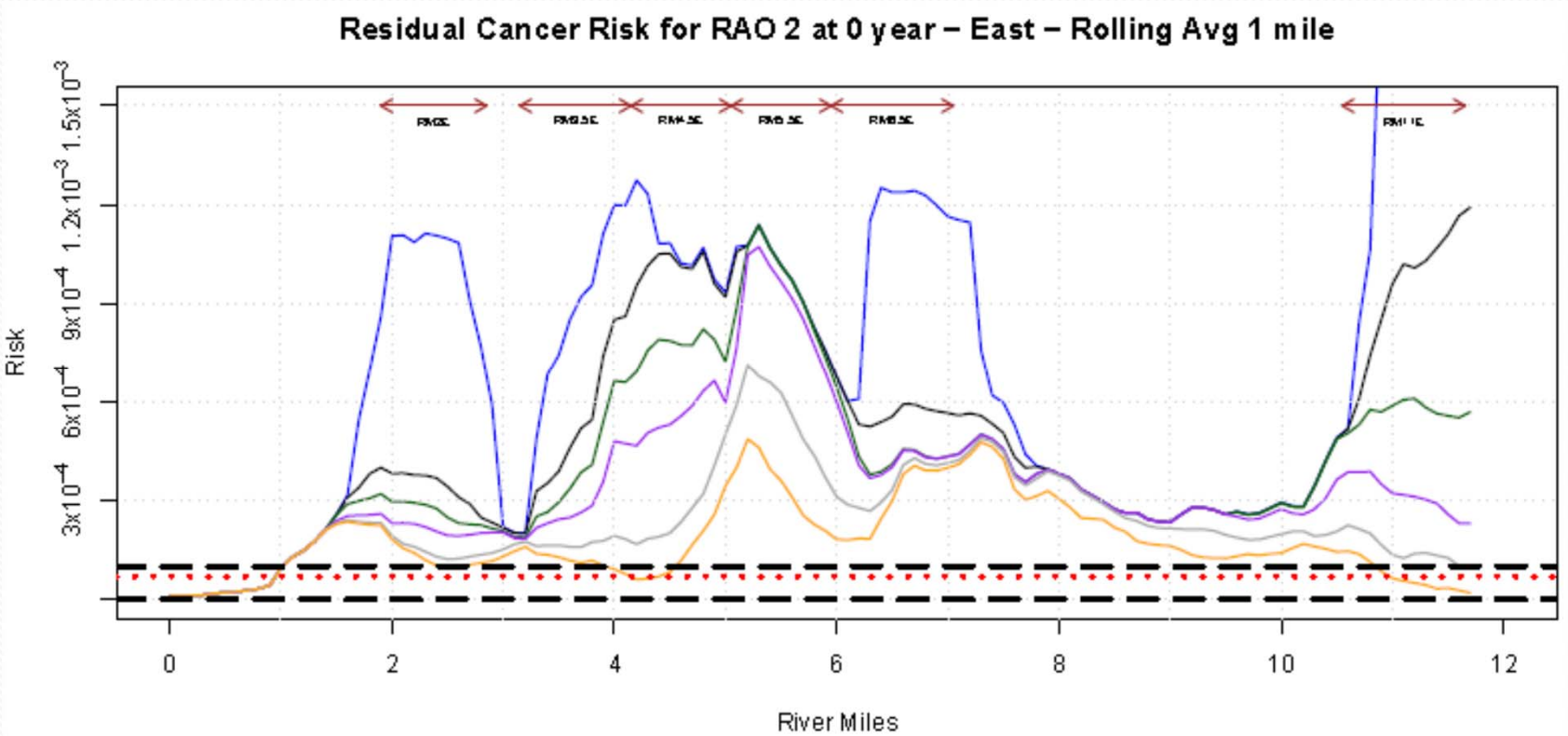
# RAO 1 – Residual Risk (cancer)



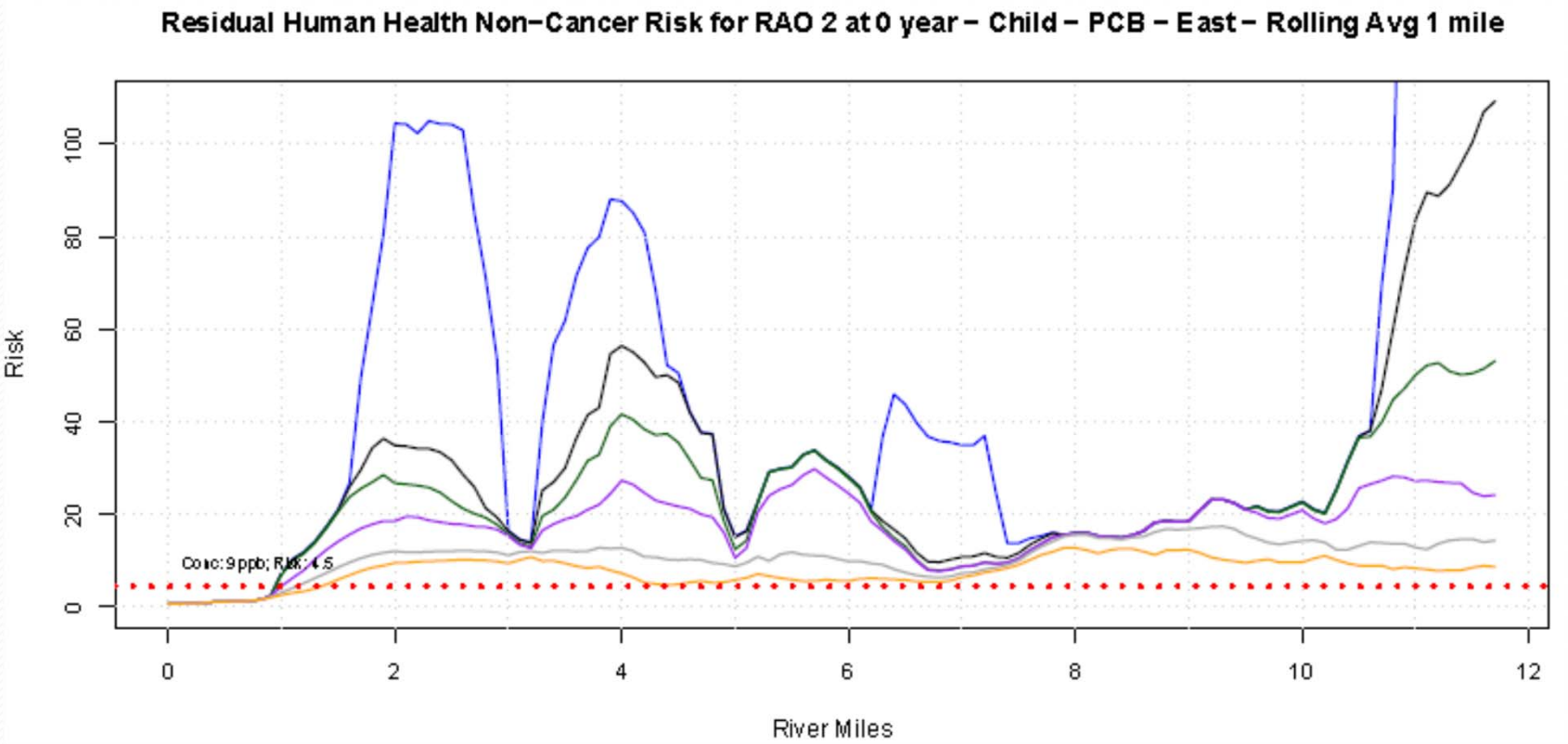
# RAO 2 – Compare to PRG



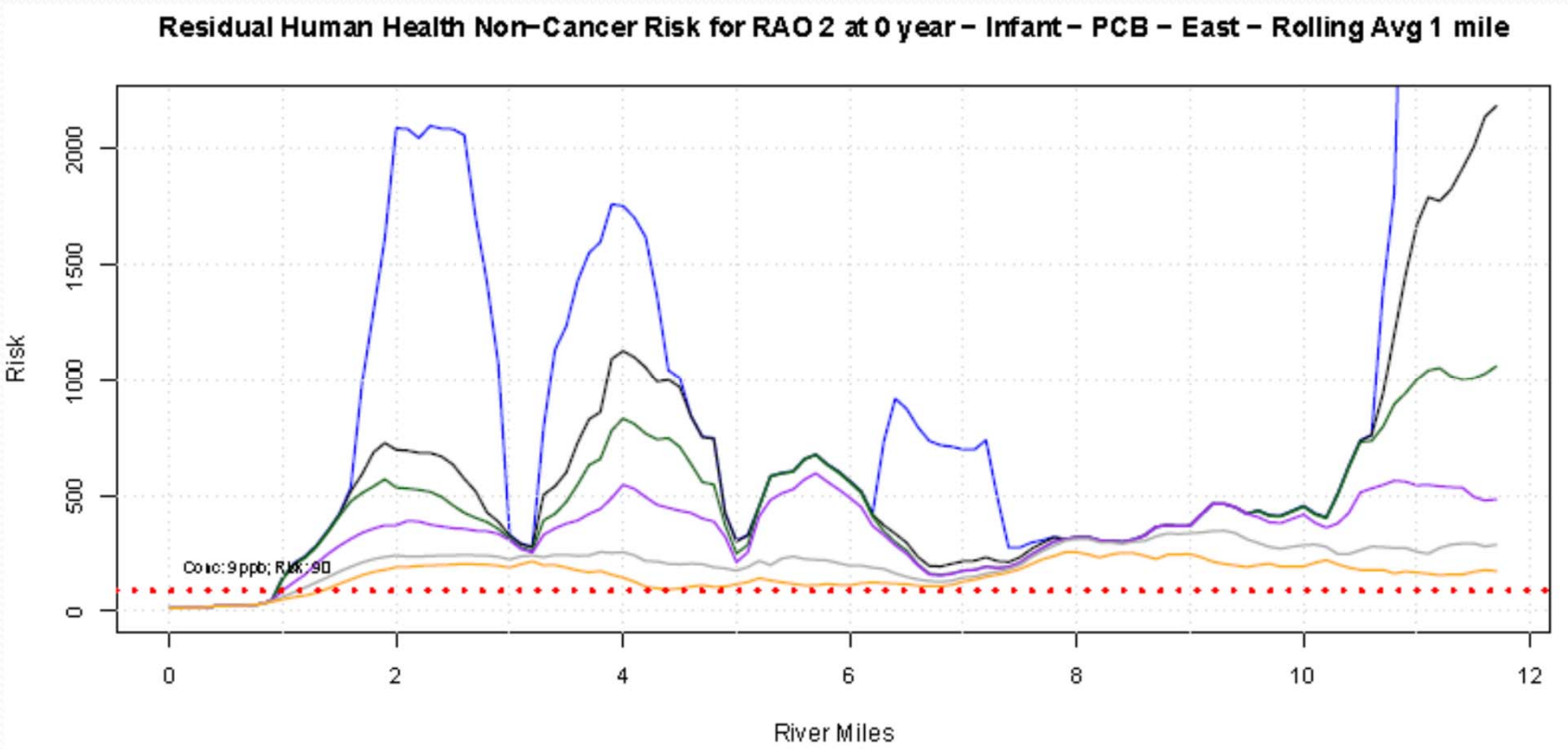
# RAO 2 – Residual Risk (cancer)



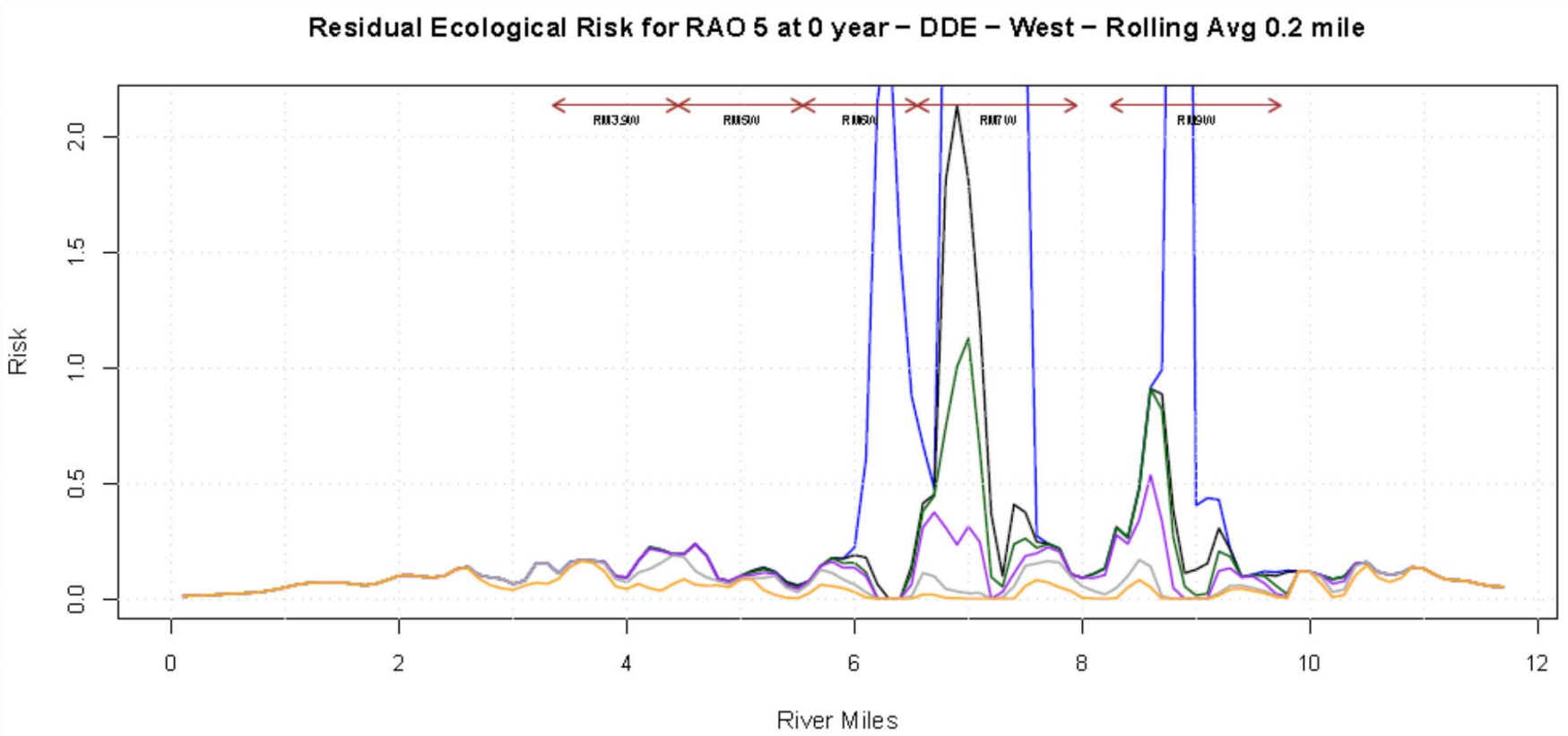
# RAO 2 – Residual Risk (child)



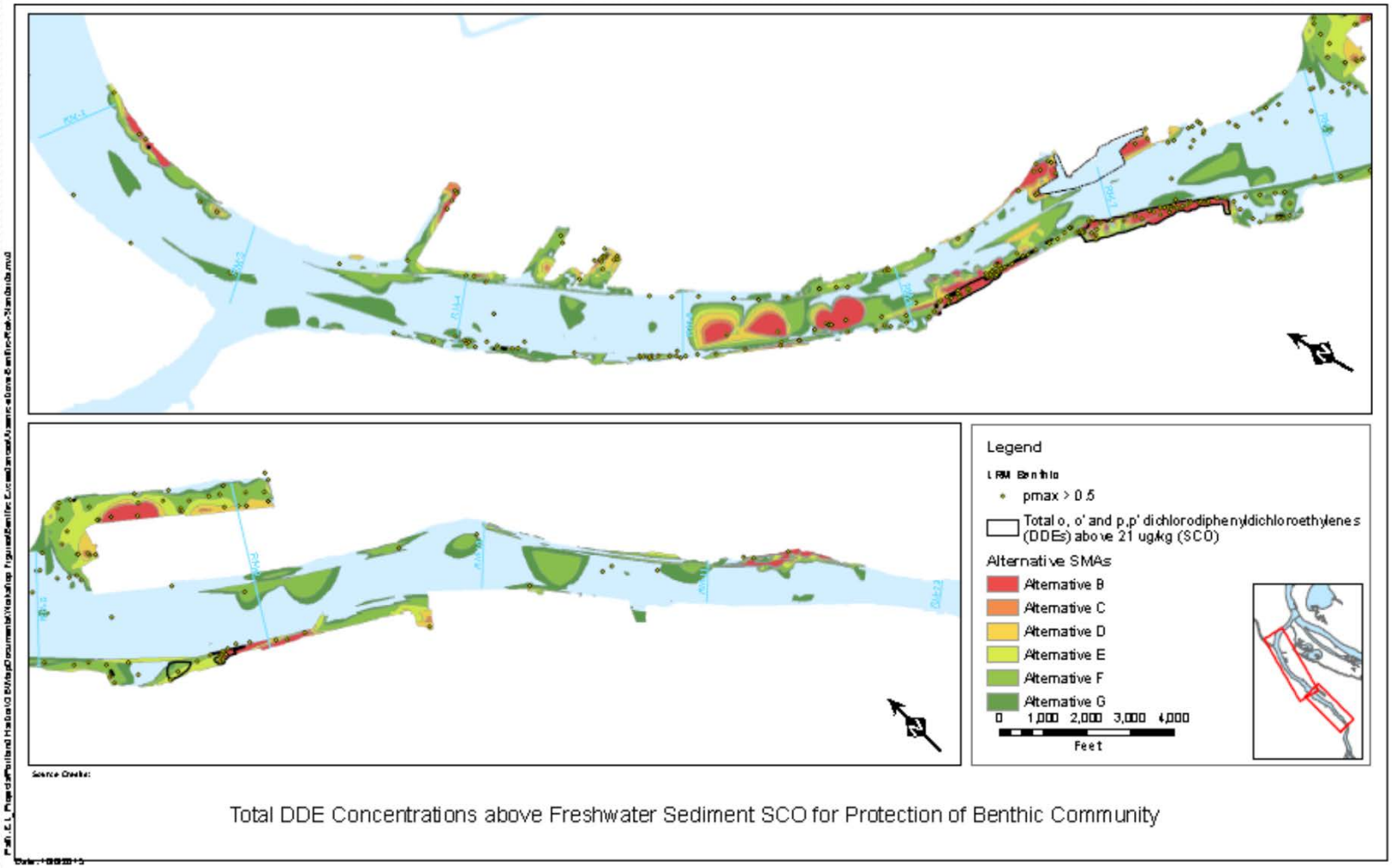
# RAO 2 – Residual Risk (infant)



# RAO 5 – Benthic Risk

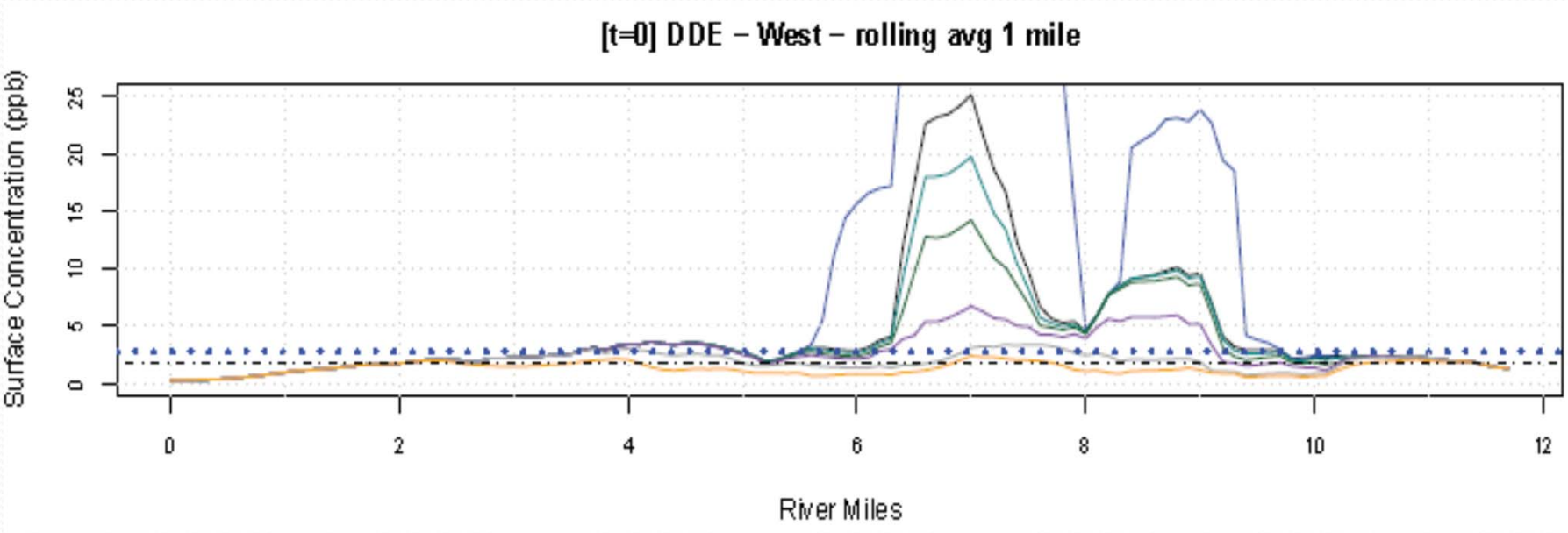


# RAO 5 – Benthic Risk Areas (DDE)

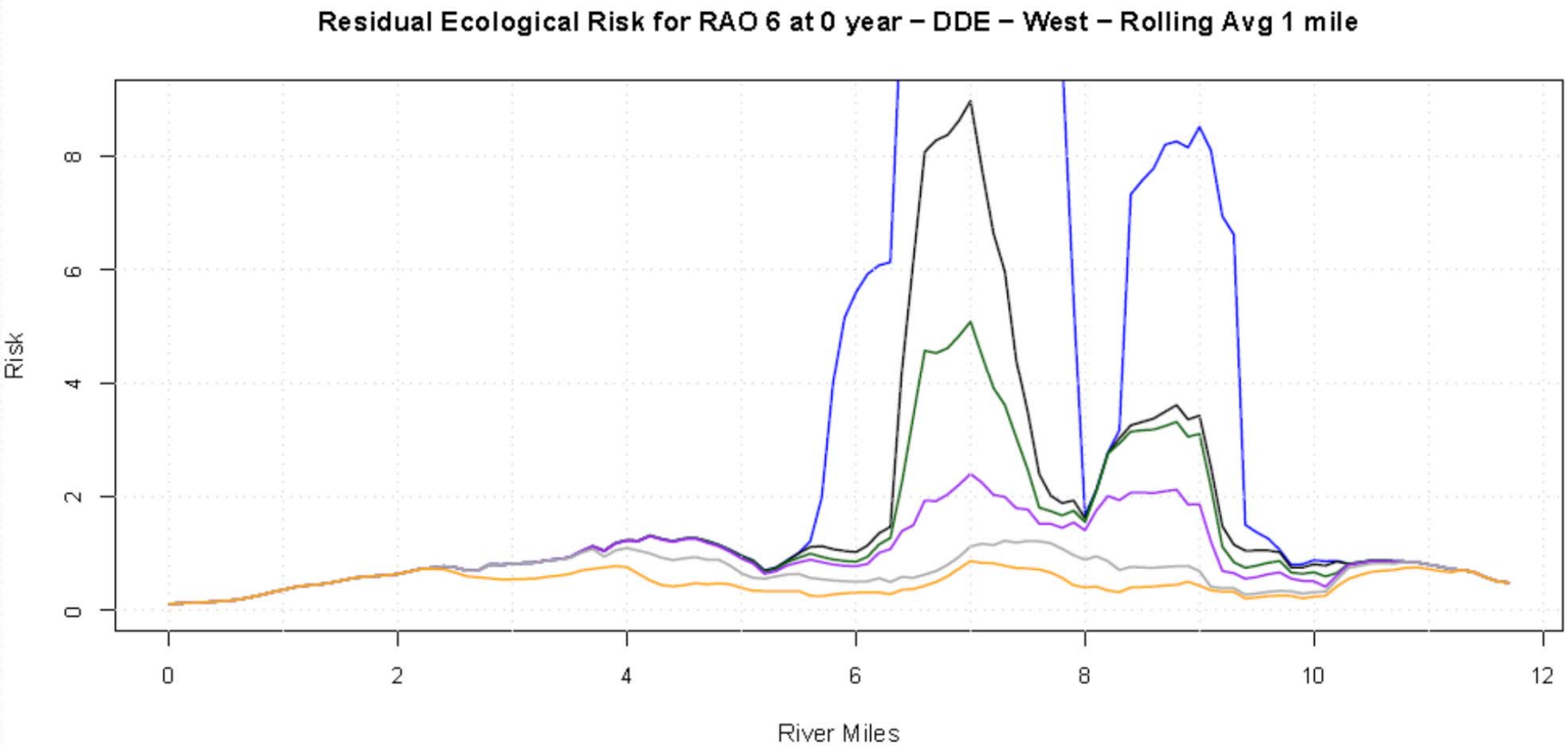



Total DDE Concentrations above Freshwater Sediment SCO for Protection of Benthic Community

# RAO 6 – Compare to PRG



# RAO 6 – Residual Risk



# Compliance with ARARs

- Chemical specific ARARs
  - AWQCs – national and state
    - Assumed all sources were controlled
    - Assumed MNR will meet sediment PRGs
    - If PRGs met in surface sediment, would not contribute to exceedance
  - MCLs
    - Assumed all groundwater plumes controlled
    - Assumed Reactive caps to deal with residuals
  - WA Freshwater Sediment – Benthic Risk
    - Ensure benthic risk due to CERCLA COCs addressed
  - Oregon Cleanup Laws
    - Meet at construction complete or with MNR
    - PRGs set at $10^{-6}$, HQ=1, or background
    - Need ICs for background

# Compliance with ARARs

- Action specific ARARs
  - CWA 404
    - Clean fill requirements for material
  - Mitigation
    - Required for all armored caps
    - Dredge/cap in nearshore
    - Beach mix nearshore and banks
    - Layback bank slope
  - Rivers & Harbors
    - No caps in federal navigation channel
    - Remove high concentration contamination

# Compliance with ARARs

- Action specific ARARs (cont.)
  - ODFW Management Plan (TBC)
    - Operations within work window (July 1 through October 31)
  - Disposal
    - Oregon Pesticide Rule
    - Oregon Solid Waste Rule
    - RCRA – OR delegated state
    - TSCA
  - CAA
    - Ensure emissions requirements during removal

# Compliance with ARARs

- Location specific ARARs
  - ESA & EFH
    - Actions will not impede migration
    - Actions will not degrade habitat
  - FEMA
    - Net zero elevation in nearshore areas
  - NHPA & Indian Graves
    - No known areas
    - Artifacts are present throughout
    - Requirements during removal

# Long-term Effectiveness and Permanence

- Magnitude of Residual Risk
  - Human Health
    - Rolling river mile by three zones
    - Cancer risks for adult
    - Non-cancer hazards for child and infant
  - Ecological
    - Same as HH
    - Most sensitive receptor
- Adequacy and Reliability of Controls
  - Engineering and Institutional Controls
- Repairs, Maintenance and Remedy Replacement

# Time to RAOs

- No Model!!!
- Too many flaws with PRP model
  - Did not correlate with delta bathymetry
  - No action curve over-predictive
  - Did not match CSM
  - PRPs unwilling to fix problems
- Tried SedCam Model
  - Too simple
  - Need more than one sedimentation rate in large system
  - No action curve over-predictive
  - Did not match CSM
- Working with USACE (Earl) to fix PRP model

# Costs

| Alternative | Total Capital Cost | Total Annual O&M Cost | Total Periodic Cost | Total Non-discounted Cost | Present Value Cost |
|---|---|---|---|---|---|
| A | $0 | $0 | $0 | $0 | $0 |
| B | $703,906,000 | $0 | $337,522,000 | $1,041,428,000 | $790,870,000 |
| D | $1,023,004,000 | $0 | $460,170,000 | $1,483,174,000 | $1,105,550,000 |
| E | $1,452,748,000 | $0 | $651,834,000 | $2,104,582,000 | $1,490,610,000 |
| F | $2,388,798,000 | $0 | $803,150,000 | $3,191,948,000 | $2,053,600,000 |
| G | $3,355,667,000 | $0 | $977,724,000 | $4,333,391,000 | $2,446,450,000 |

# Cost

- Major Point of Contention
- PRPs do not want costs underestimated for allocation
- PRPs want cost low
- Mitigation…cost too high
  - 14% capital costs – alt B
  - 58 acres – alt B
- Subtitle C
  - 45% capital costs – alt B
- Dredging unit costs (from LWG 2012)
  - $38.03/cy – open water
  - $53.66/cy - confined

# FS Section 4

Comparative Analysis

# Qualitative Comparative Analysis

| Remedial Alternative | Description | Threshold Criteria | | Balancing Criteria | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of Toxicity, Mobility, or Volume through Treatment | Short-Term Effectiveness | Implementability | Present Value Cost (Dollars) |
| **Contaminated Sediment Alternatives** | | | | | | | | |
| A | No Action/No Further Action | — | — | NA | NA | NA | NA | NA |
| B | Dredge 83 acres; Contain 4 acres<br>Dredge/Cap 3 acres; EMNR 103 acres<br>MNR 2,250 acres; In-situ 7 acres<br>Ex-situ 321,120 cy; Disposal 892,000 cy | + | + | ○ | ◔ | ◔ | ● | $ |
| D | Dredge 161 acres; Contain 7 acres<br>Dredge/Cap 6 acres; EMNR 88 acres<br>MNR 2,185acres; In-situ 3 acres<br>Ex-situ 395,060 cy; Disposal 1,766,000 cy | + | + | ◔ | ◑ | ◔ | ◕ | $ |
| E | Dredge 249 acres; Contain 10 acres<br>Dredge/Cap 10 acres; EMNR 60 acres<br>MNR 2,121 acres; In-situ 0 acres<br>Ex-situ 431,560 cy; Disposal 3,100,000 cy | + | + | ◑ | ◕ | ● | ◑ | $$ |
| F | Dredge 479 acres; Contain 18 acres<br>Dredge/Cap 17 acres; EMNR 24 acres<br>MNR 1,913 acres; In-situ 0 acres<br>Ex-situ 495,830 cy; Disposal 7,115,000 cy | + | + | ◕ | ● | ◕ | ◔ | $$$ |
| G | Dredge 741 acres; Contain 22 acres<br>Dredge/Cap 18 acres; EMNR 15 acres<br>MNR 1,655 acres; In-situ 0 acres<br>Ex-situ 518,010 cy; Disposal 11,722,000 cy | + | + | ● | ● | ◑ | ○ | $$$$ |

# Portland Harbor

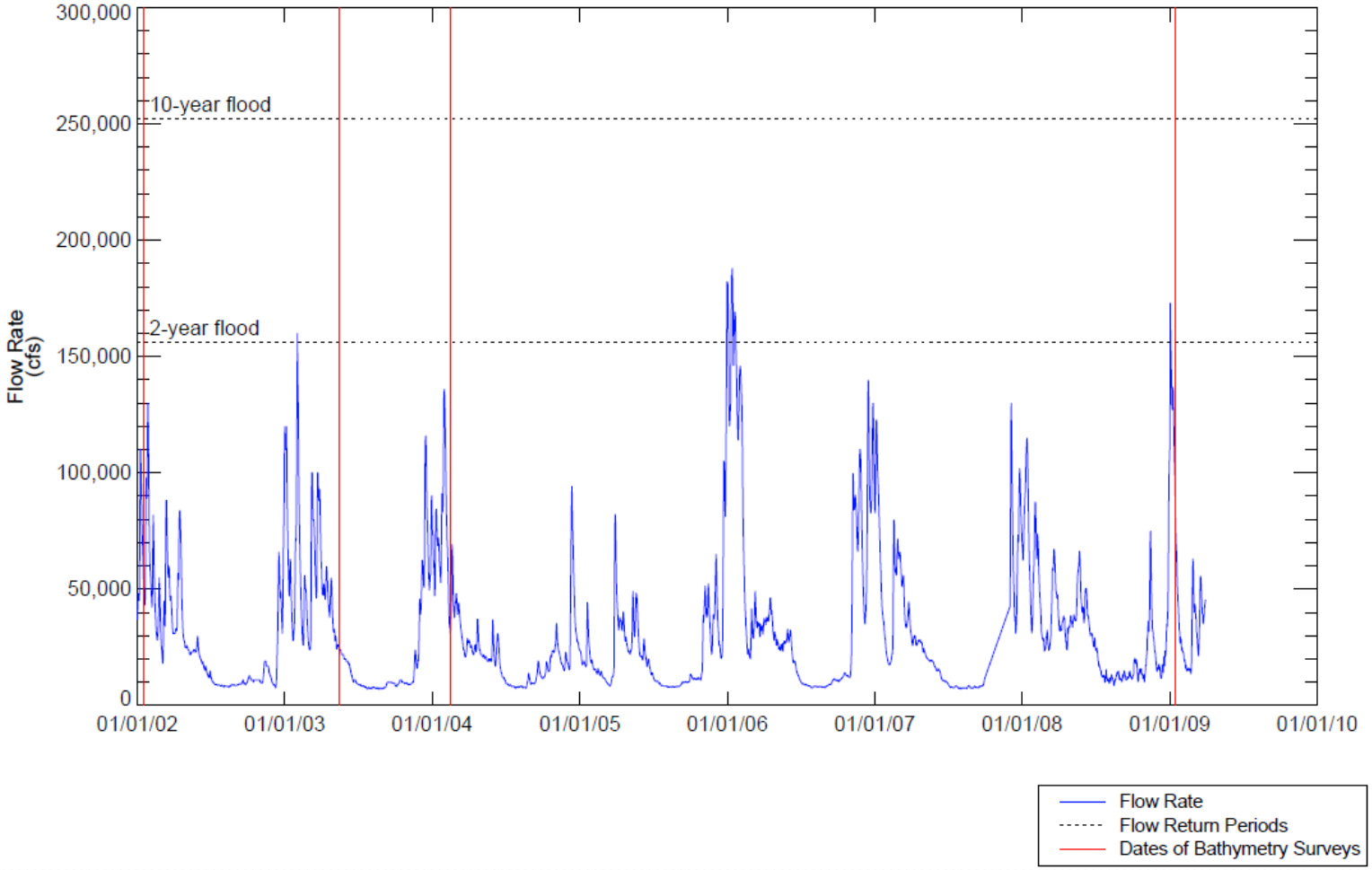
## Modeling MNR

# LWG hydrodynamic and sediment transport (HST) model

- Submitted in draft FS (2012)
- Used channel flow (EFDC) and channel sediment transport (SEDZLJ)
- Rejected by EPA
  - Models not coupled
  - Calibration was only for bathymetry, not chemistry
  - Complex system
    - Tidal fluctuations
    - Reverse flows
  - Did not account for bedload transport
  - Does not match CSM

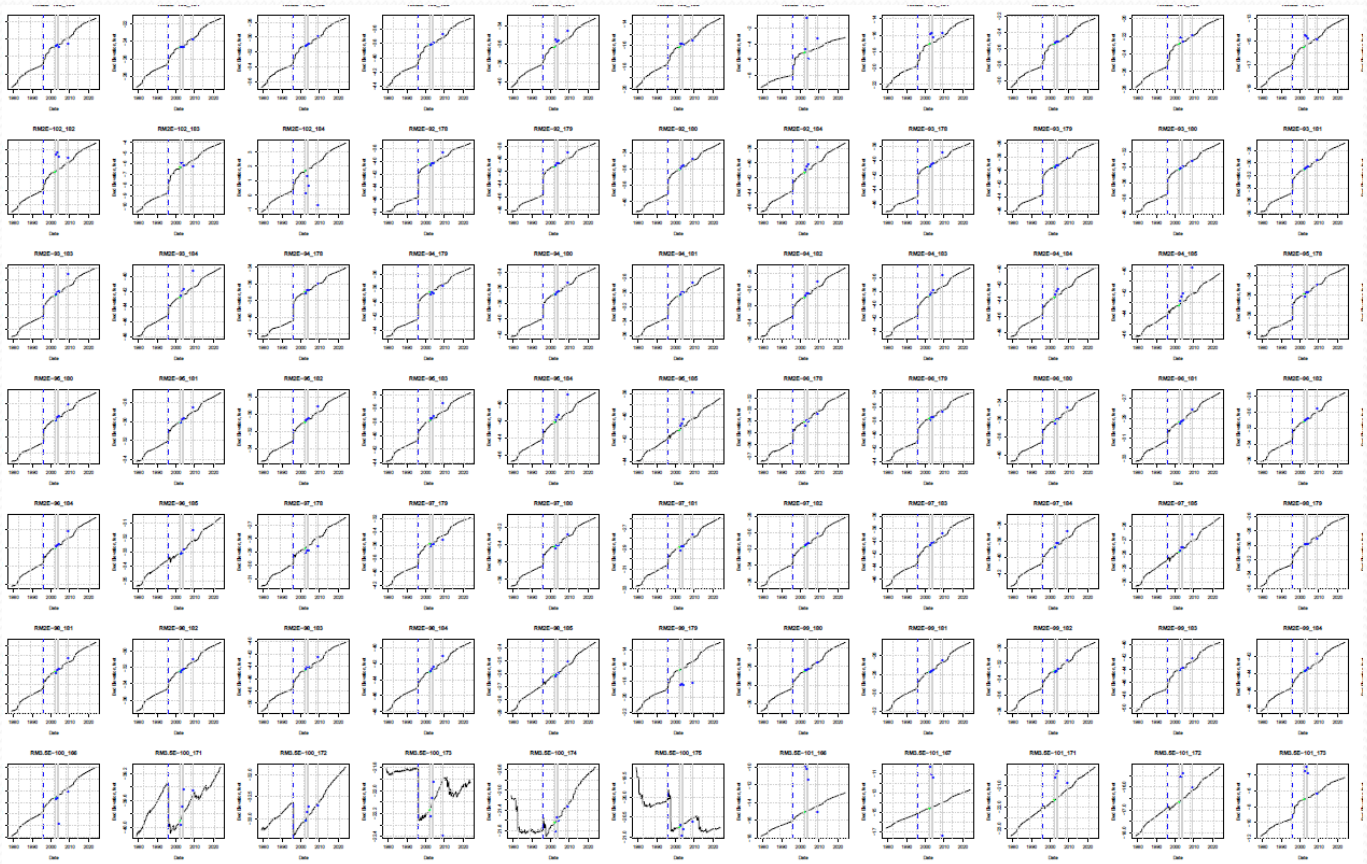
# Model Grid Cells Example

# Bathymetric Surveys



# t>0 discussion

- LWG Model performance vs. Bathymetry graphs



# Example of LWG Model Prediction

This figure, and those like it, show sediment concentrations over time projected for each remedial alternative. The upper panel shows the model best estimate or "base case", and the lower panel shows the most conservative (high concentration) "lower bound" estimate within the model calibration.

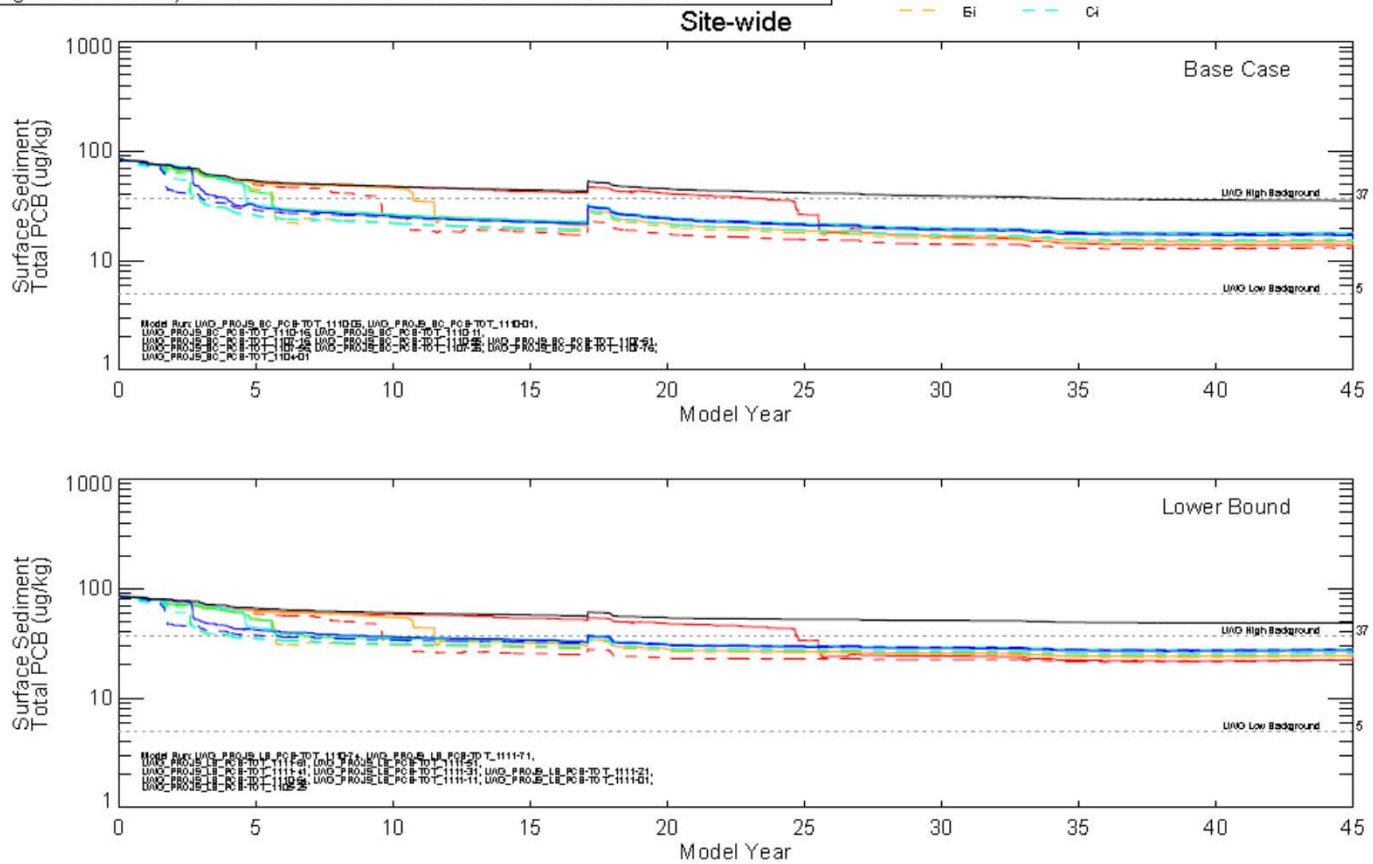



Figure 8.2.2-1

**Portland Harbor RI/FS**

Draft Feasibility Study

Simulation of FS Alternatives

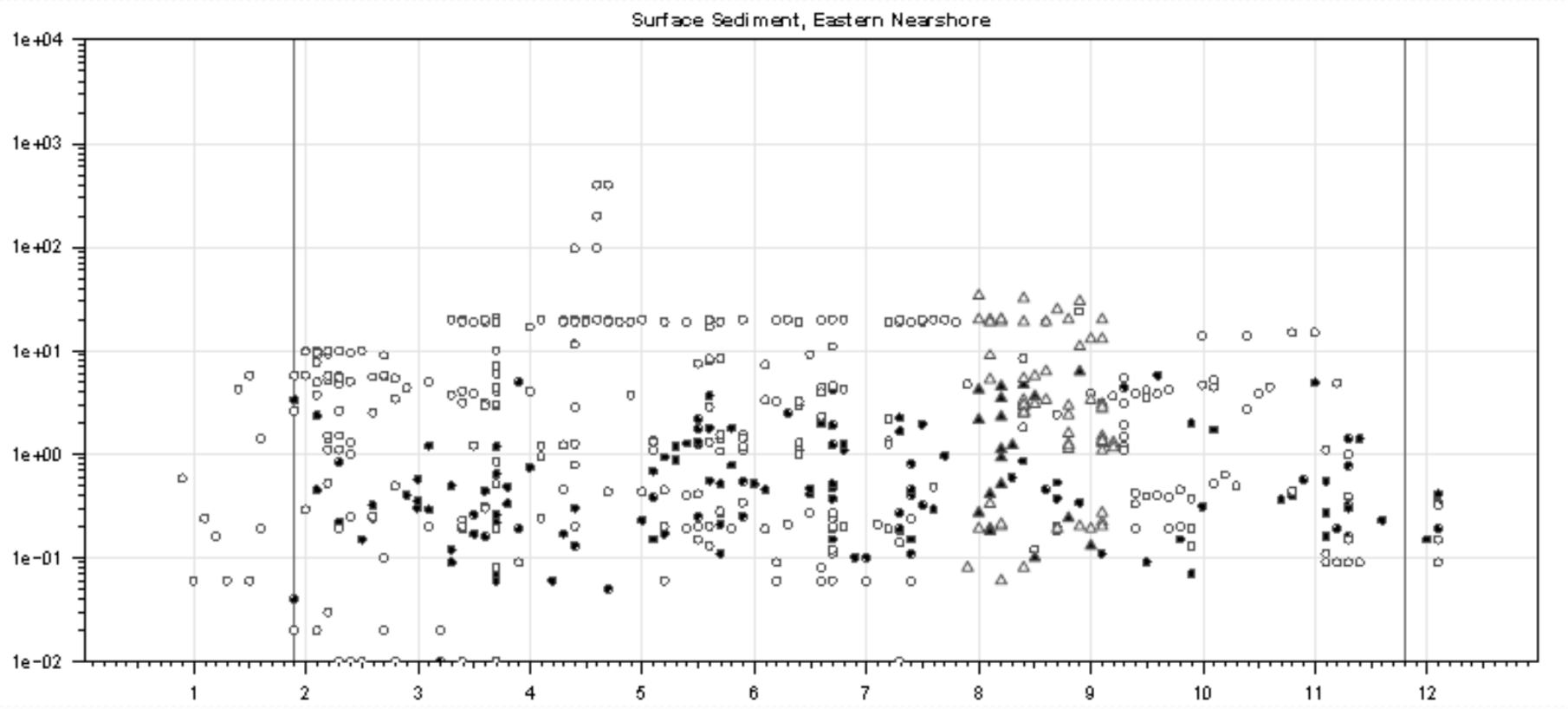
Time Series of Surface Sediment (Top 1-ft) Total PCB Concentrations (Site-wide Average)

ANCHOR QEA

LWG Lower Willamette Group

DO NOT QUOTE OR CITE
This document is currently under review by US EPA and its federal, state, and tribal partners, and is subject to change in whole or in part.

# Portland Harbor

High-biasing Non-detects in Data Set

# Example of High-biasing ND Hexachlorobenzene