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
  - 1×10^{-6} individual contaminant
  - 1×10^{-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

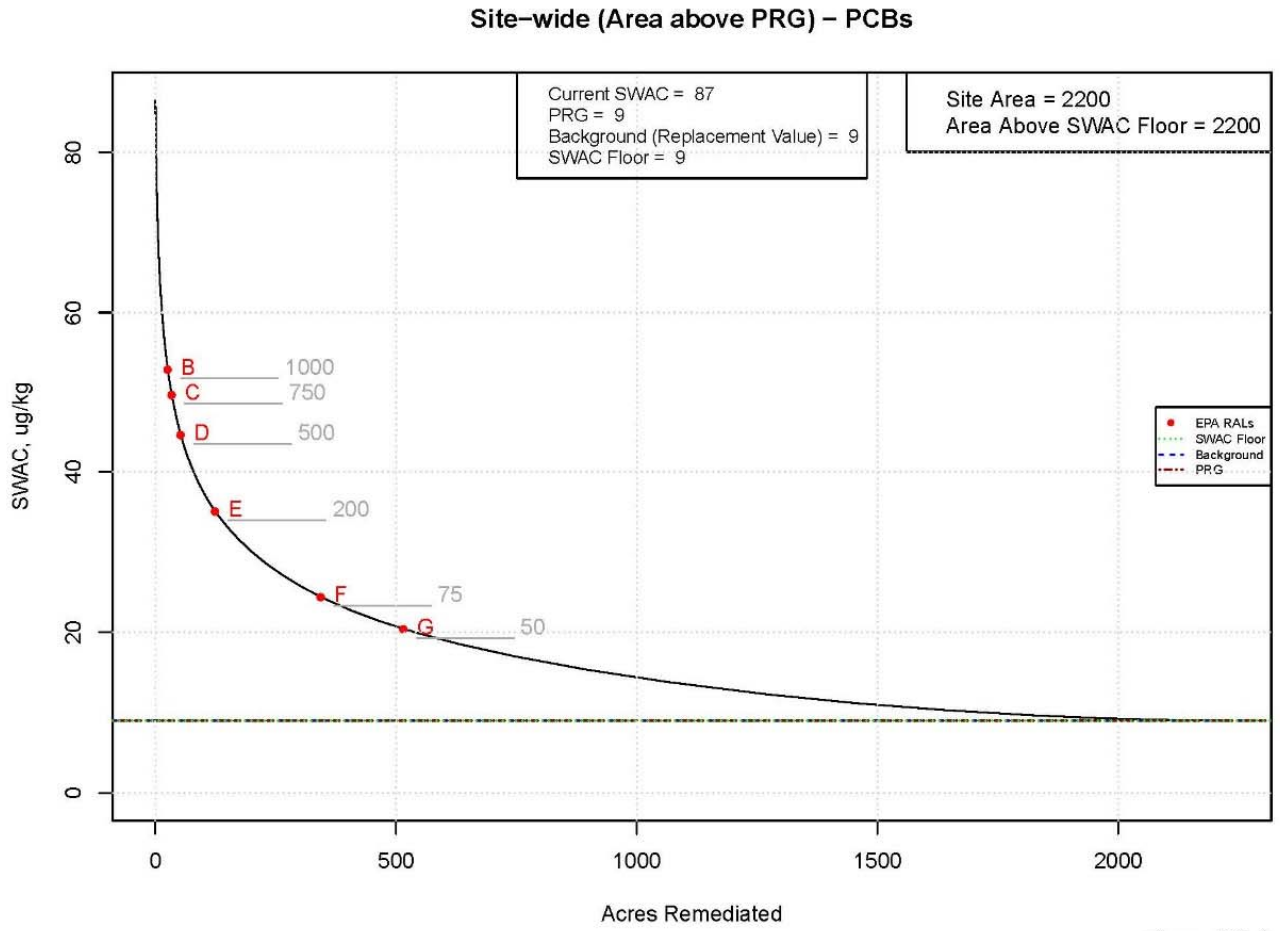


Figure 3.3-1
PCBs Site-wide RAL Curves

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

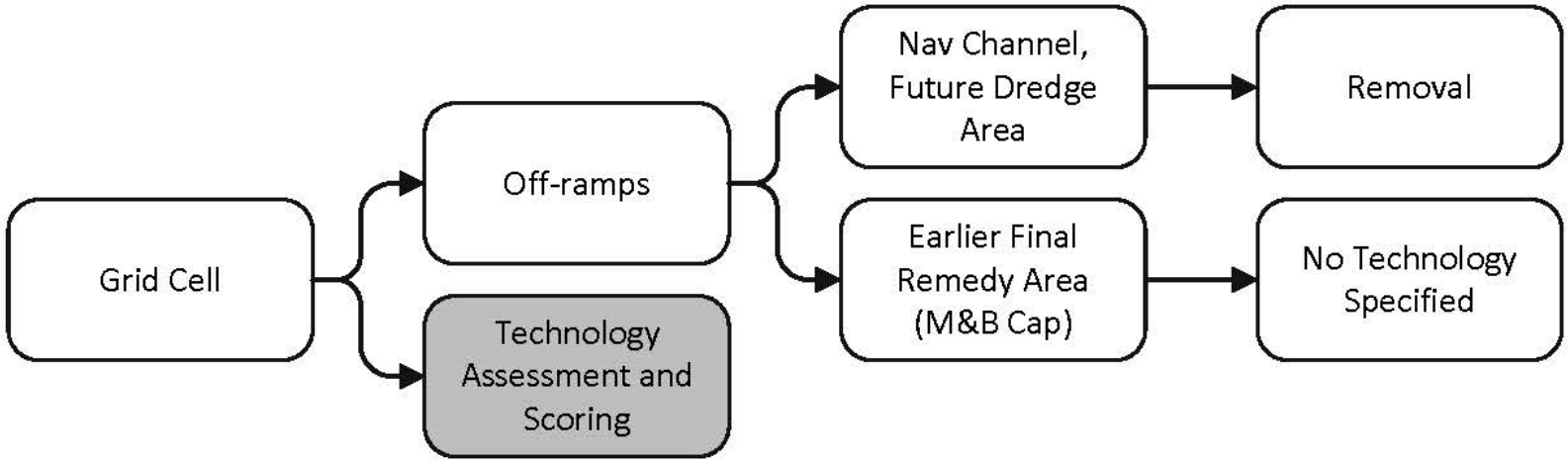
- Based on environmental conditions
  - Hydrodynamics
  - Sediment bed characteristics
  - Anthropogenic conditions
- Uses a decision-based approach:
  - Engineered Cap
  - Armored Cap
  - Dredging

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

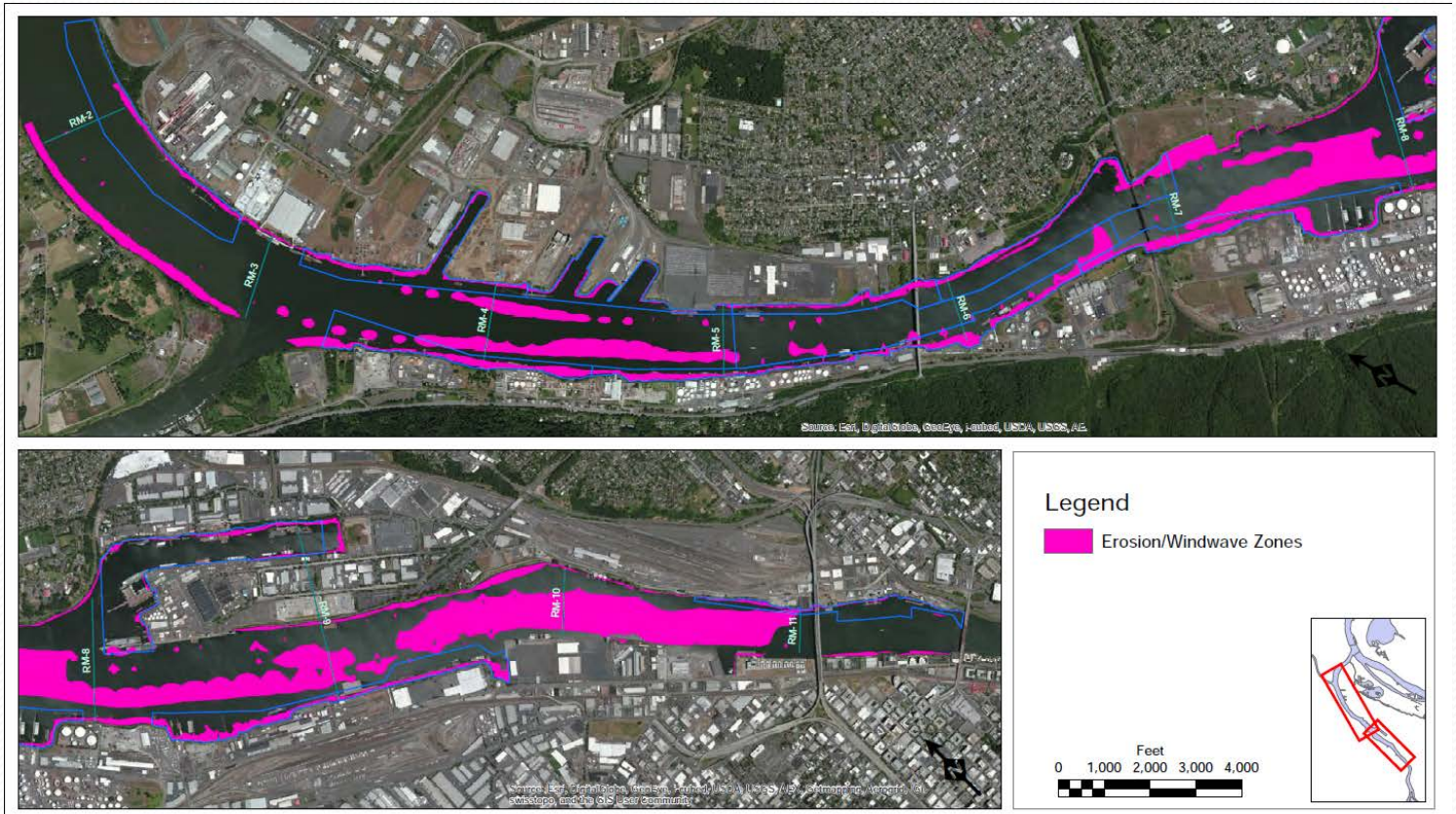
Depositional

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

Shallow

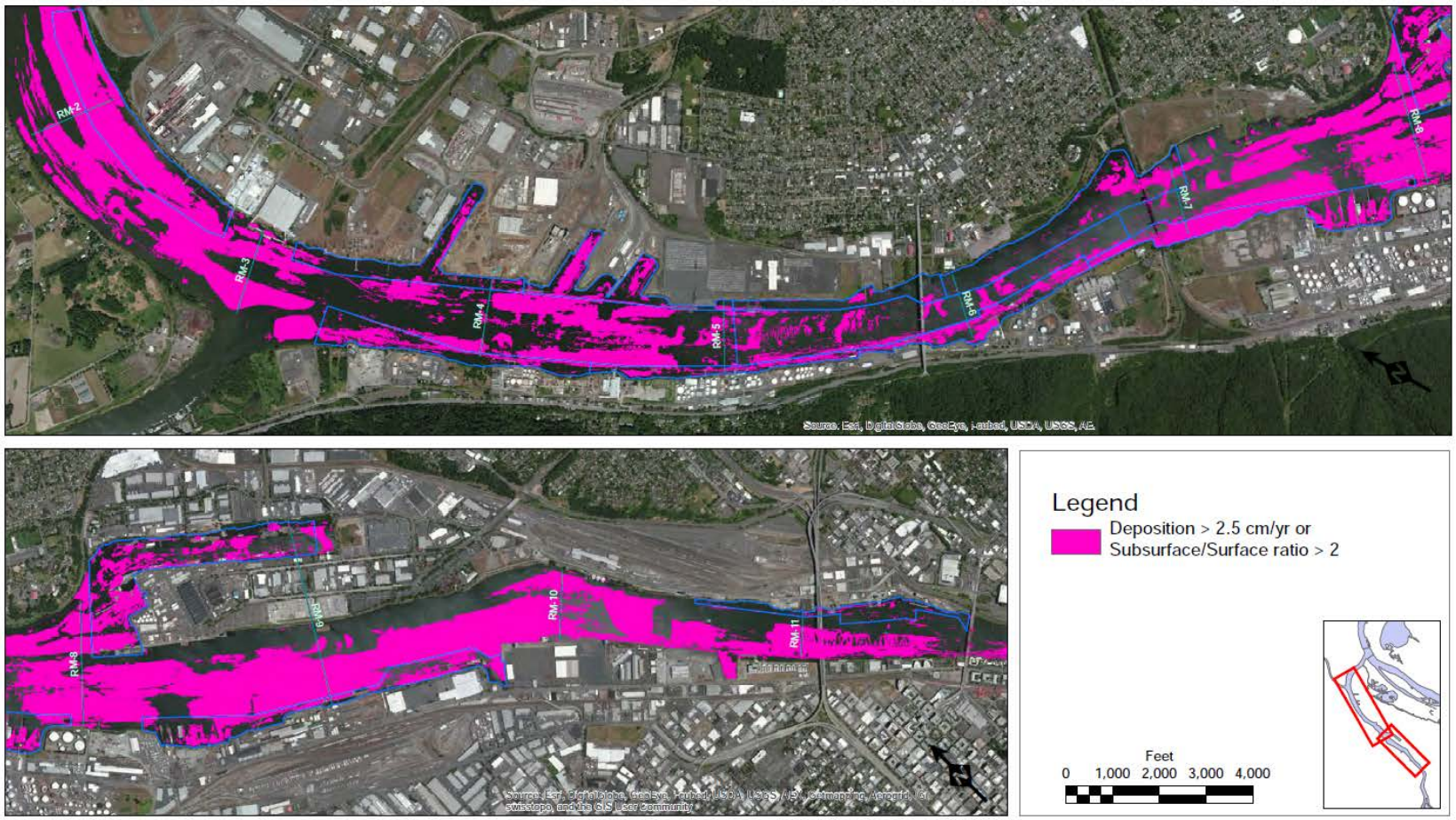
- Shallow - <1 m at low water level, >2 feet NAVD 88

Wind/Wave Zone



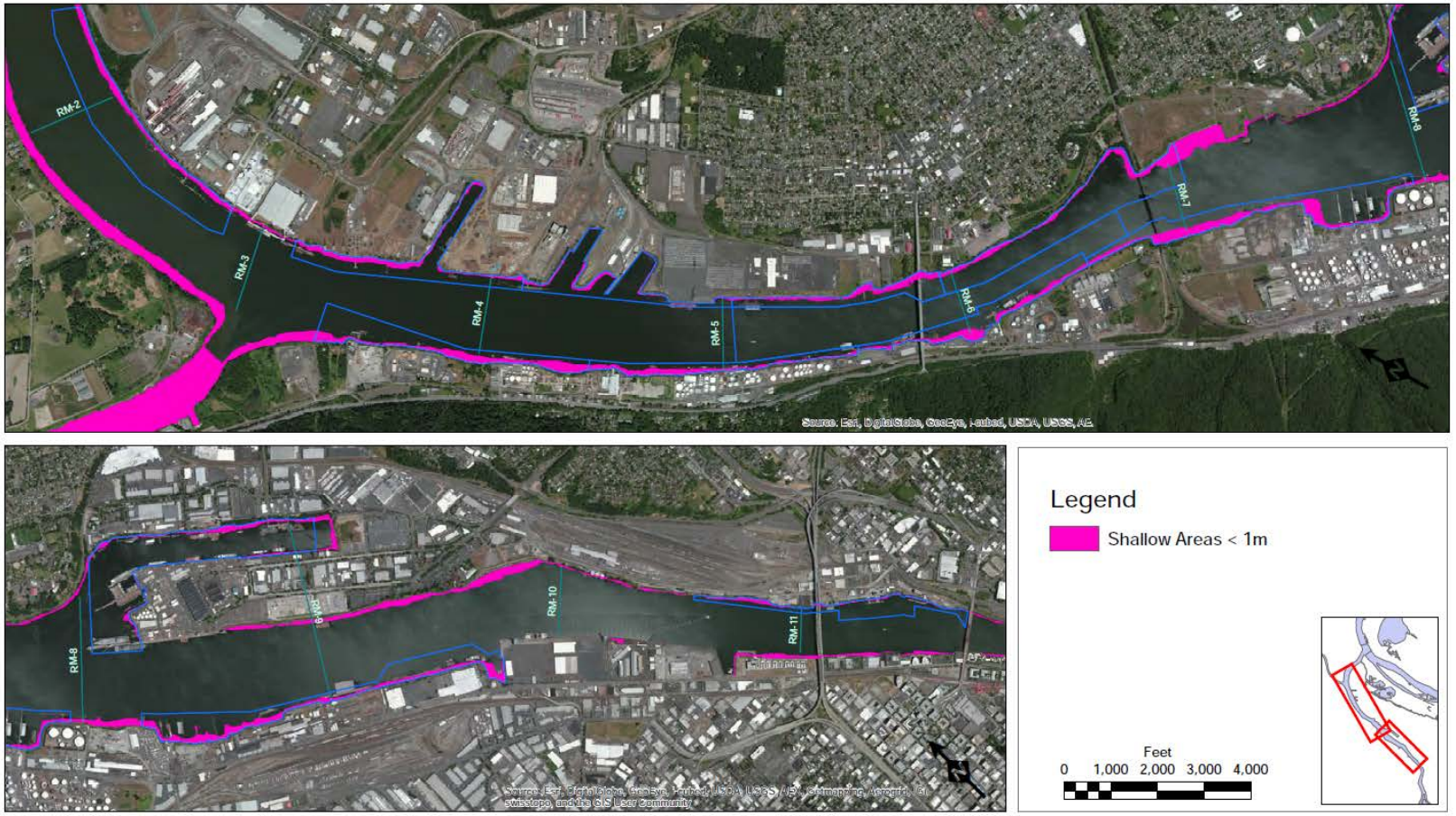
Erosion/Windwave Zones

Depositional



Depositional Areas

Shallow Areas

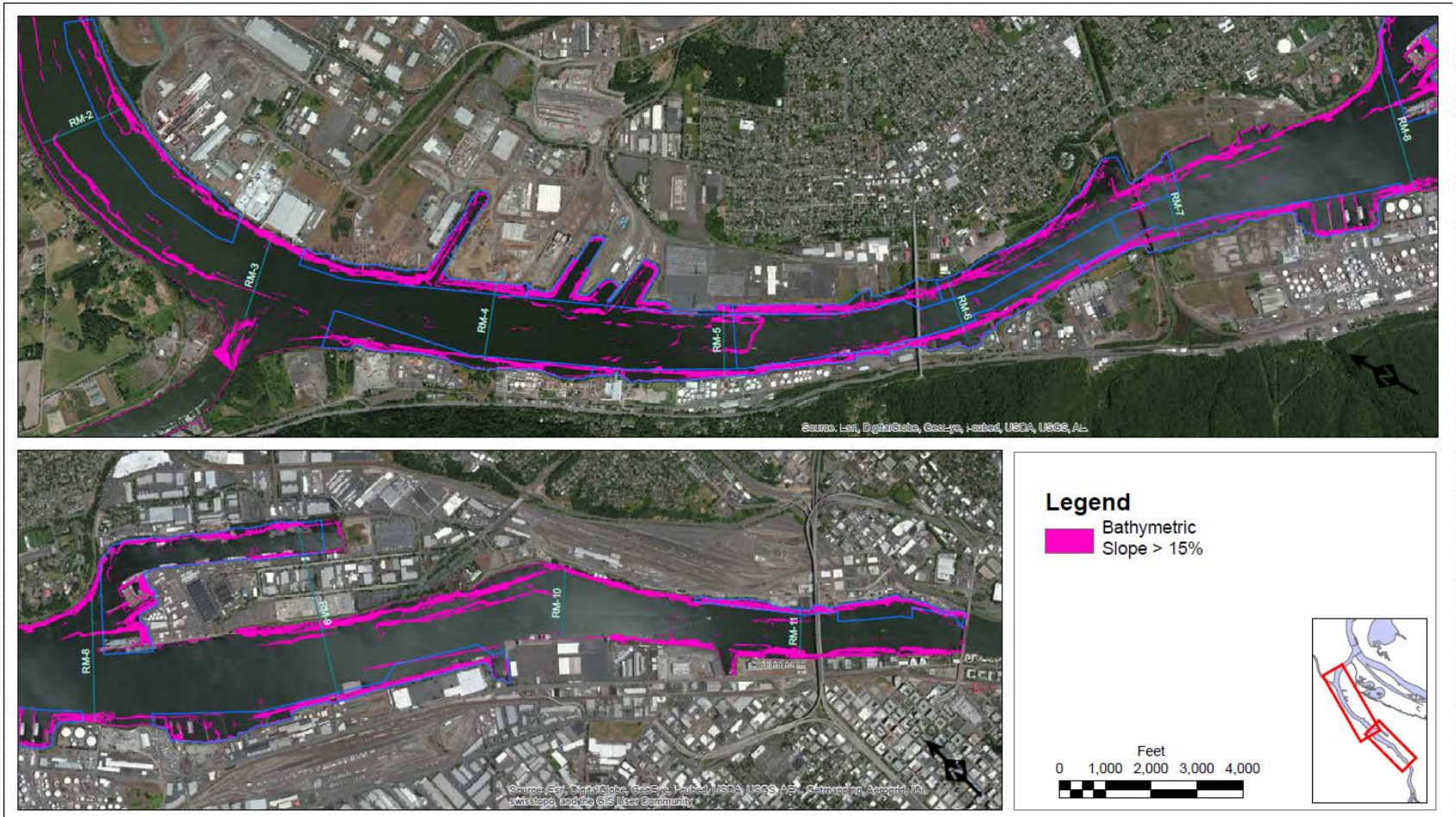


Shallow Areas

Sediment Bed Characteristics Criteria

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

Bathymetry/Slope

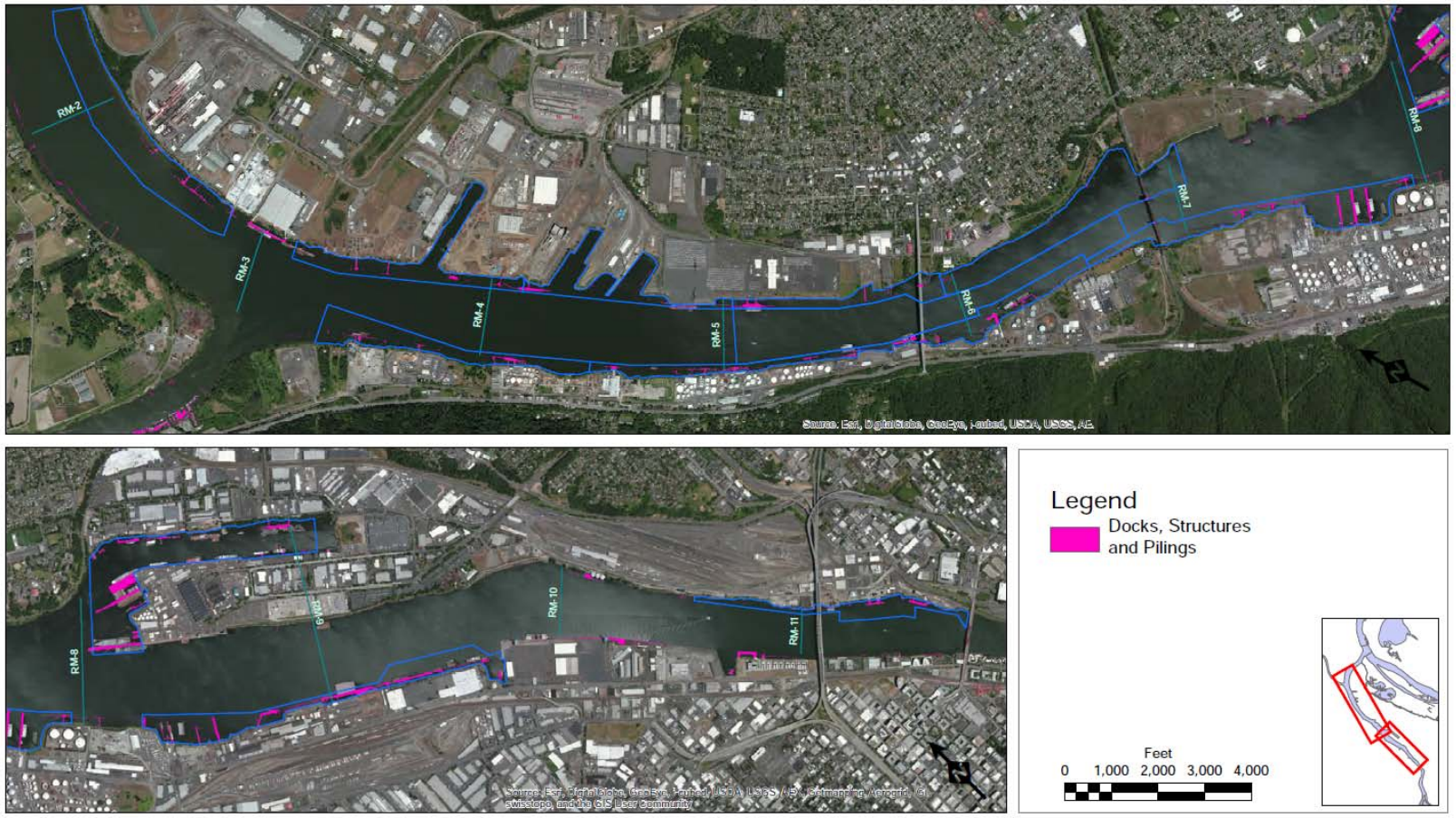


Bathymetric Slope

Anthropogenic Influences Criteria

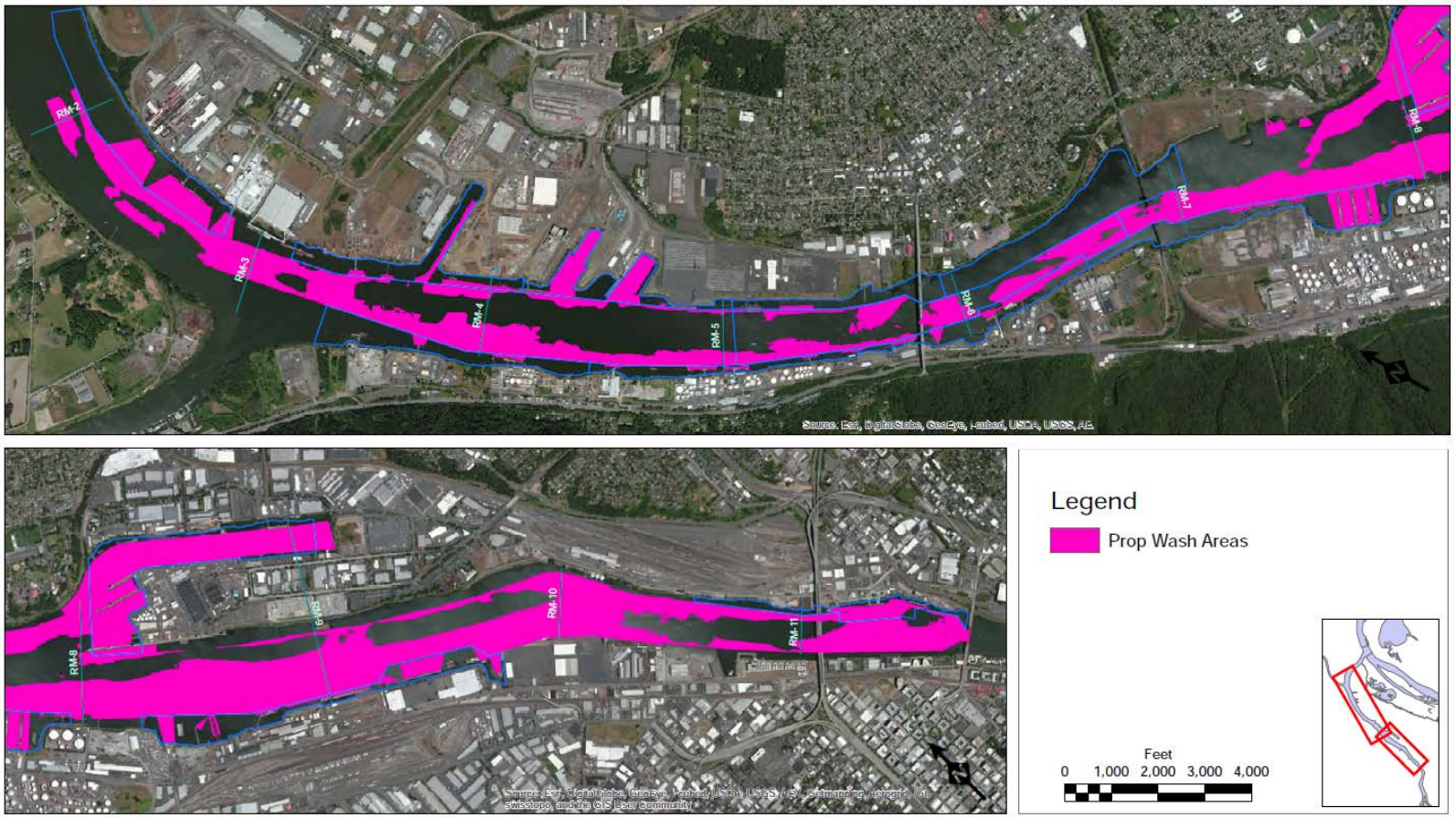
- Structures and Pilings
- Prop Wash Zone
- Debris as indicated by side/scan sonar

Structures and Pilings



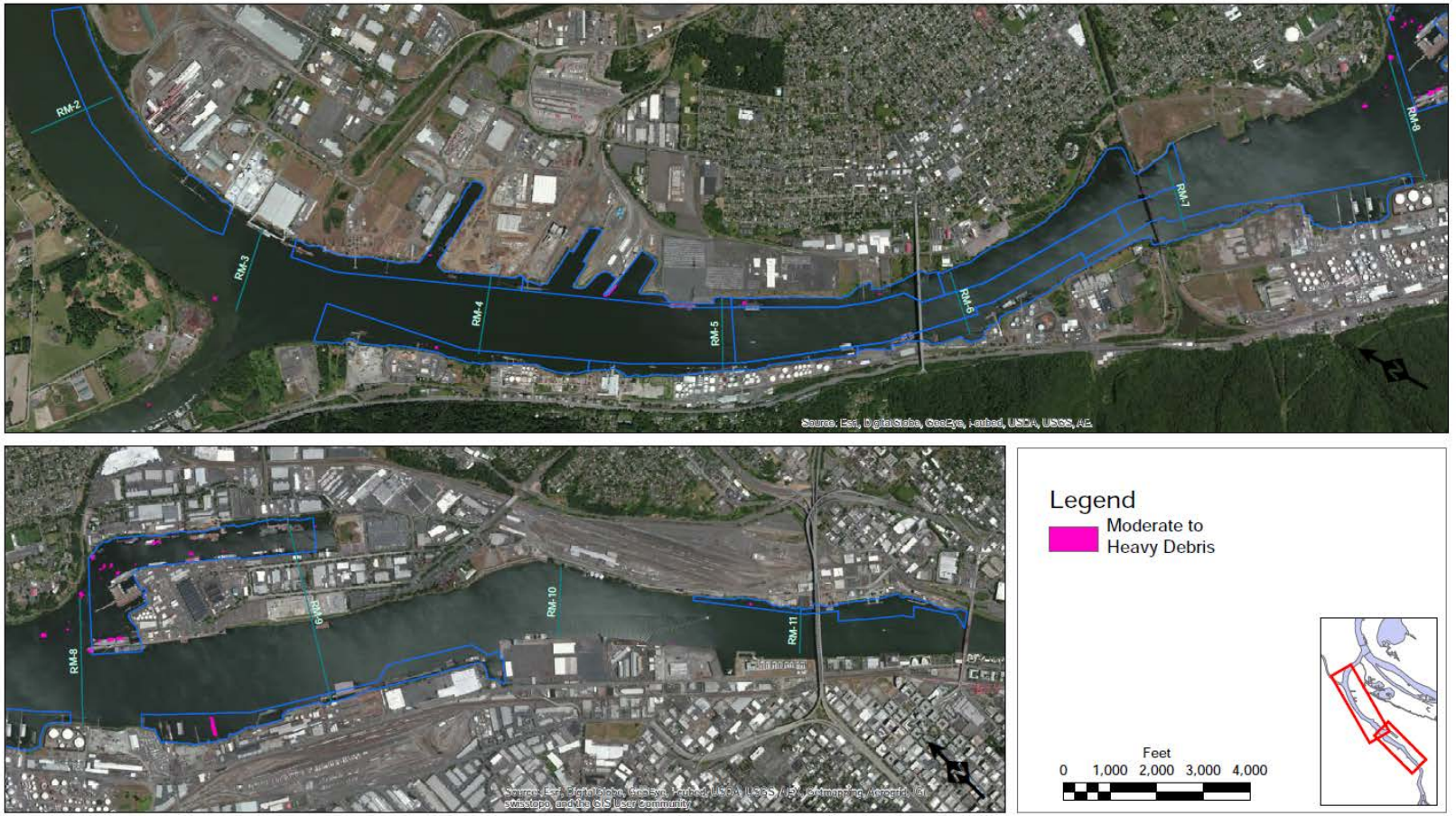
Docks, Structures and Pilings

Prop Wash Areas



Prop Wash Areas

Debris

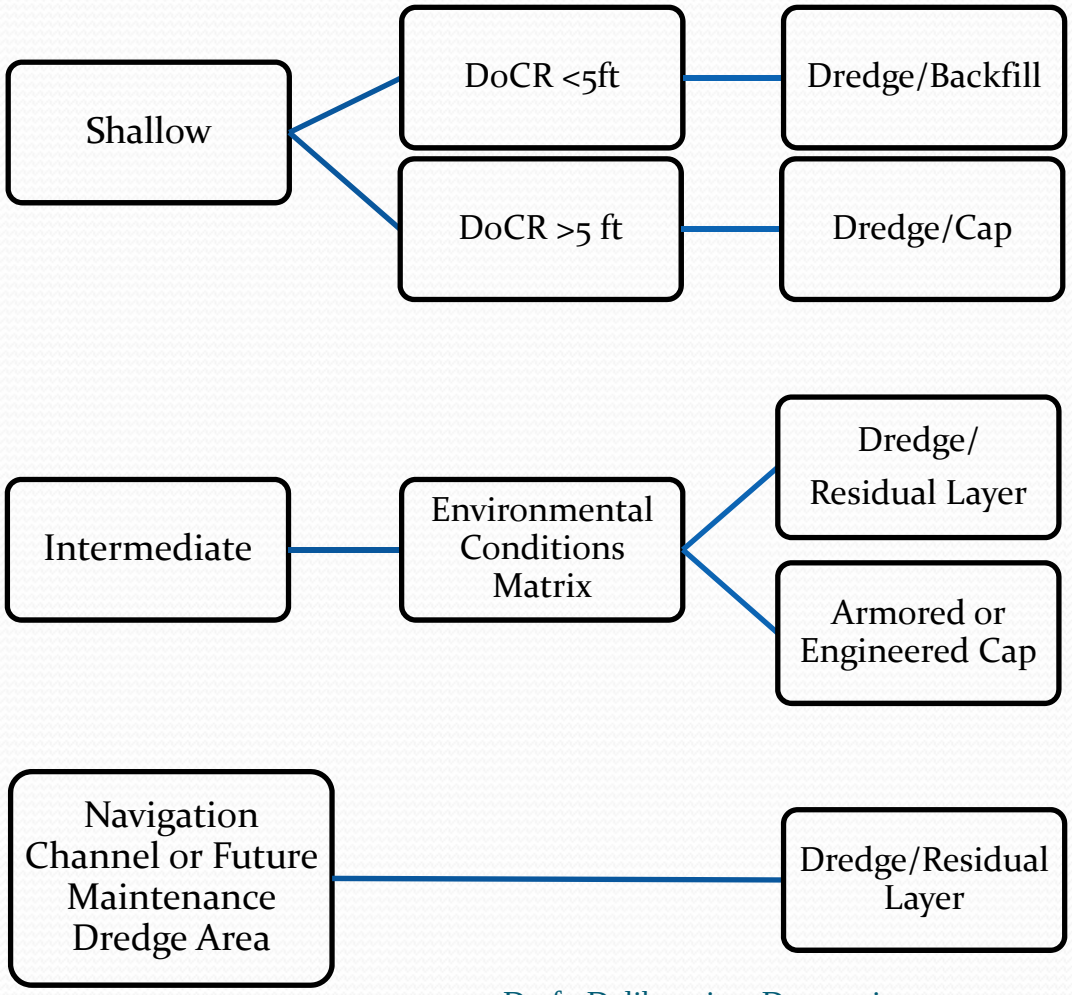


Debris

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

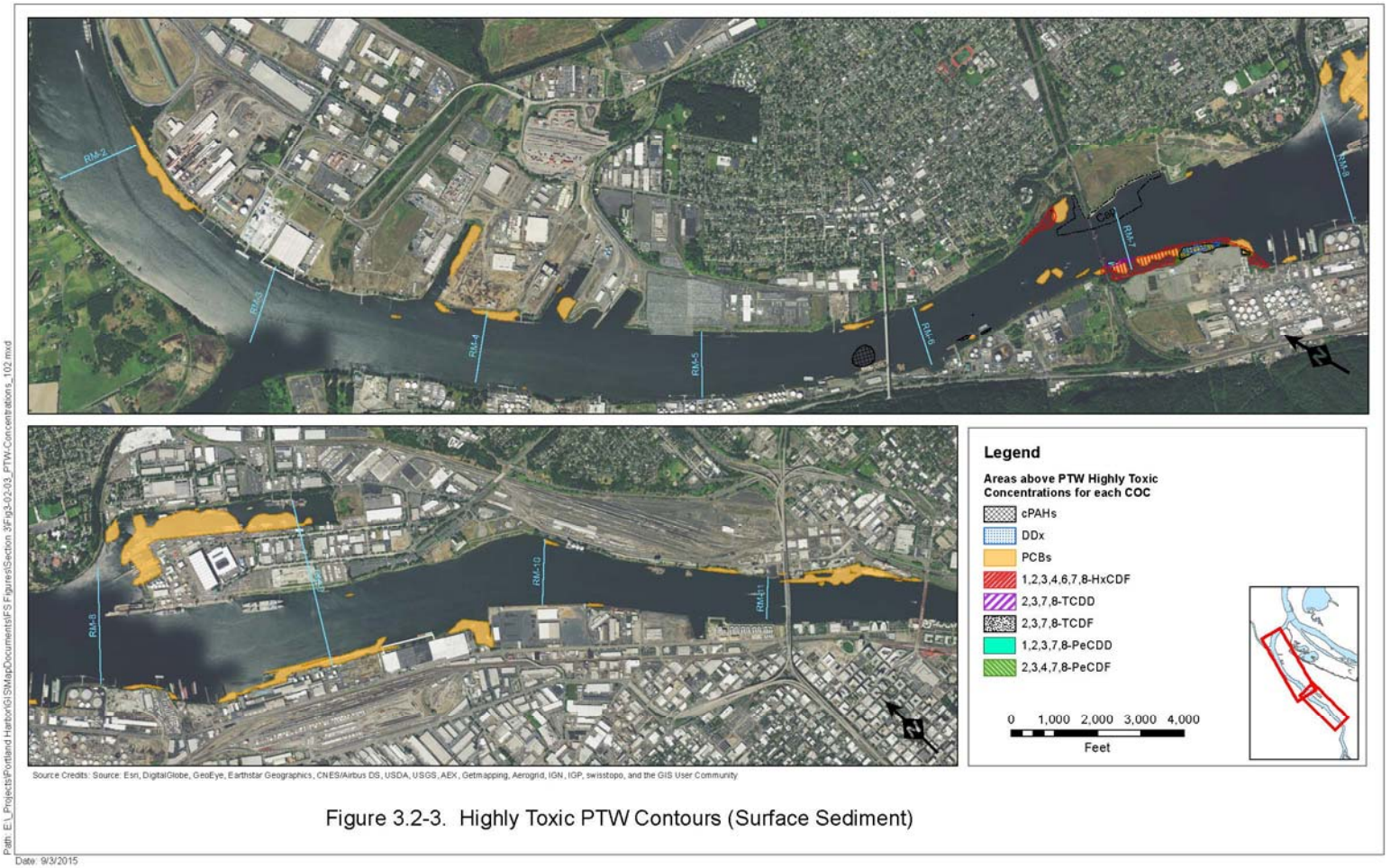


Figure 3.2-3. Highly Toxic PTW Contours (Surface Sediment)

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

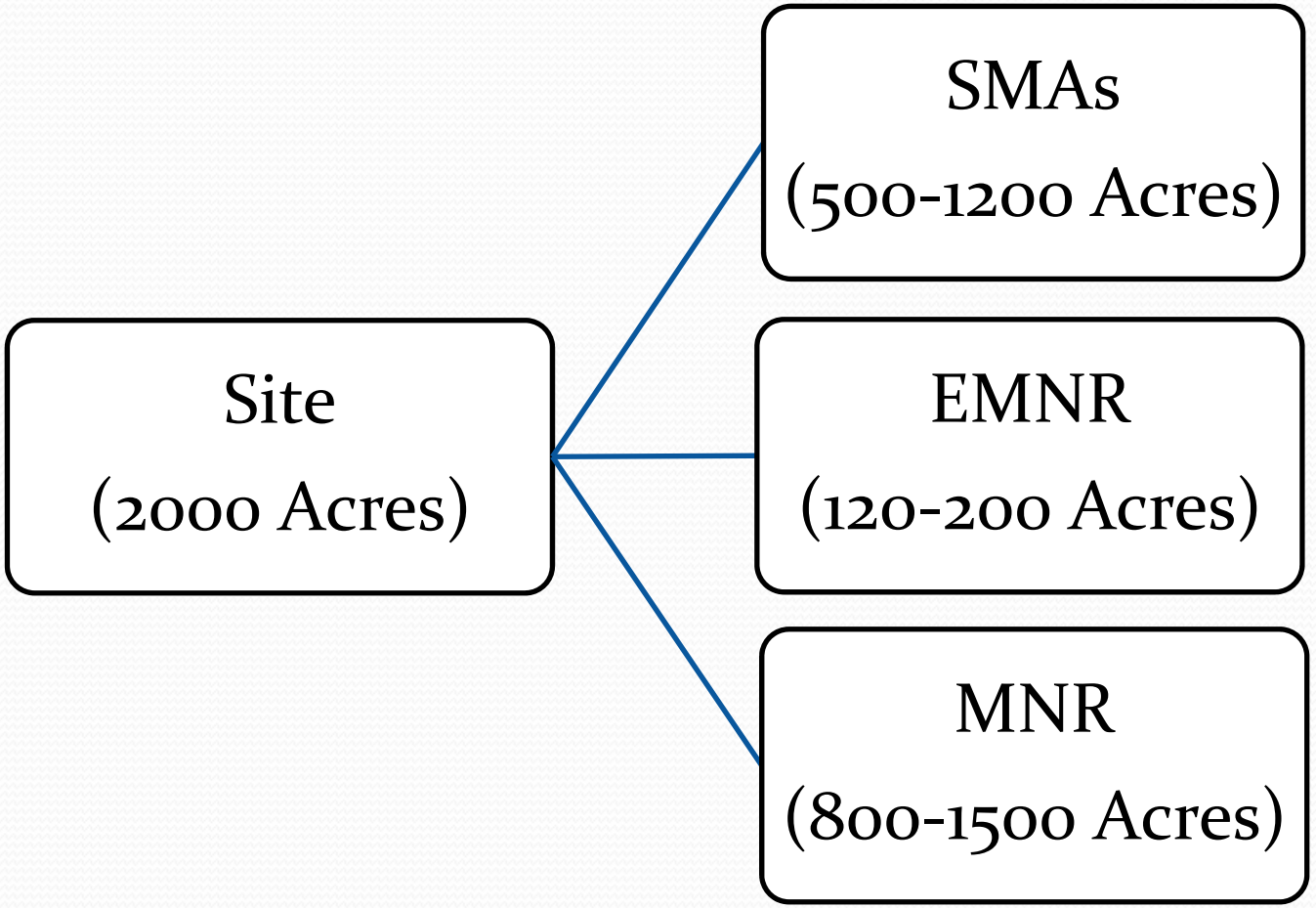
Institutional Control Assumptions

- 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 DMM 2	7
F	4,643,695	362	61	118	0	464,883	22	1,638	DMM 1 DMM 2	12
G	7,435,061	477	78	185	0	464,883	13	1,396	DMM 1 DMM 2	18

Summary of Technology Assignments



Alternative B

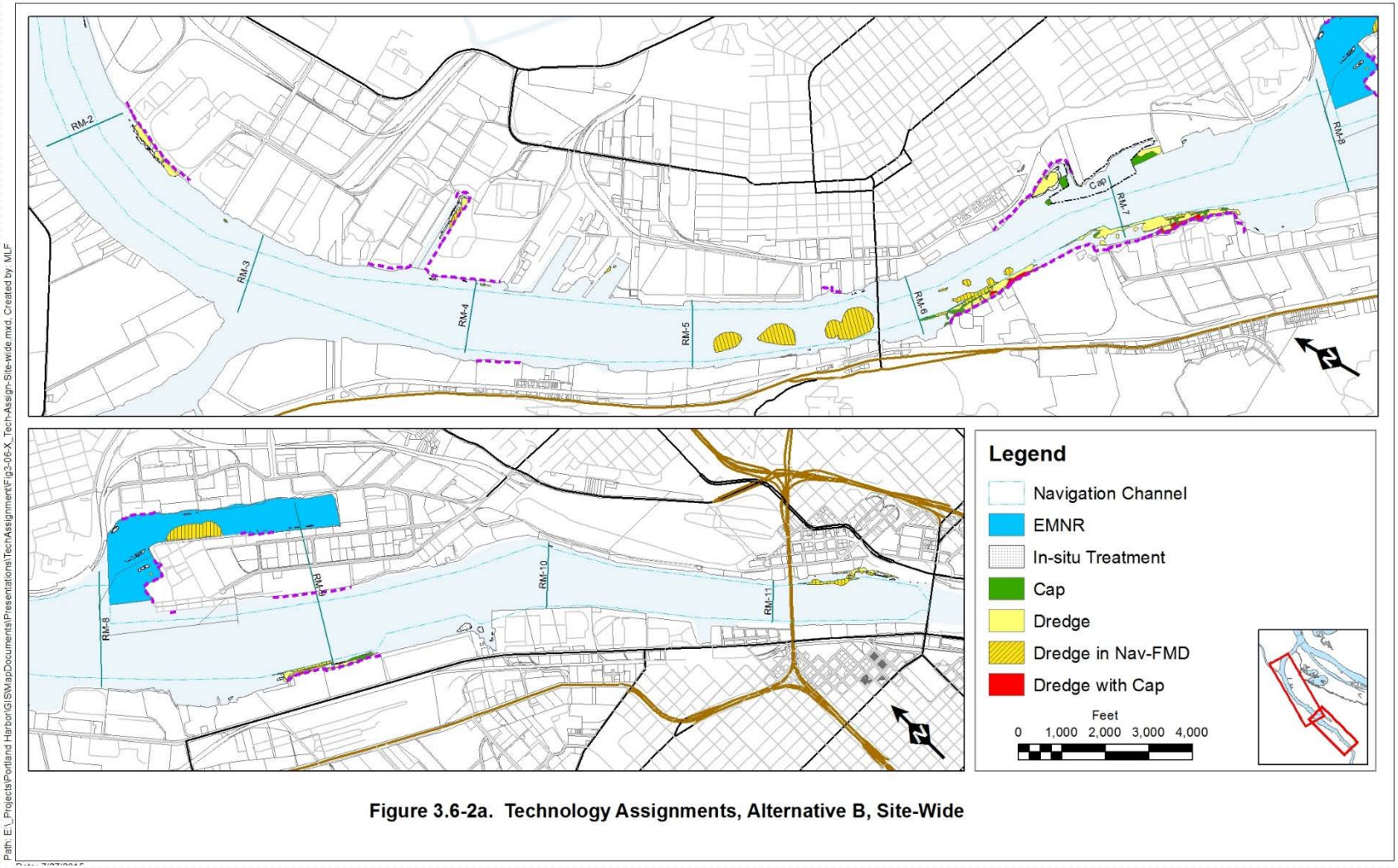
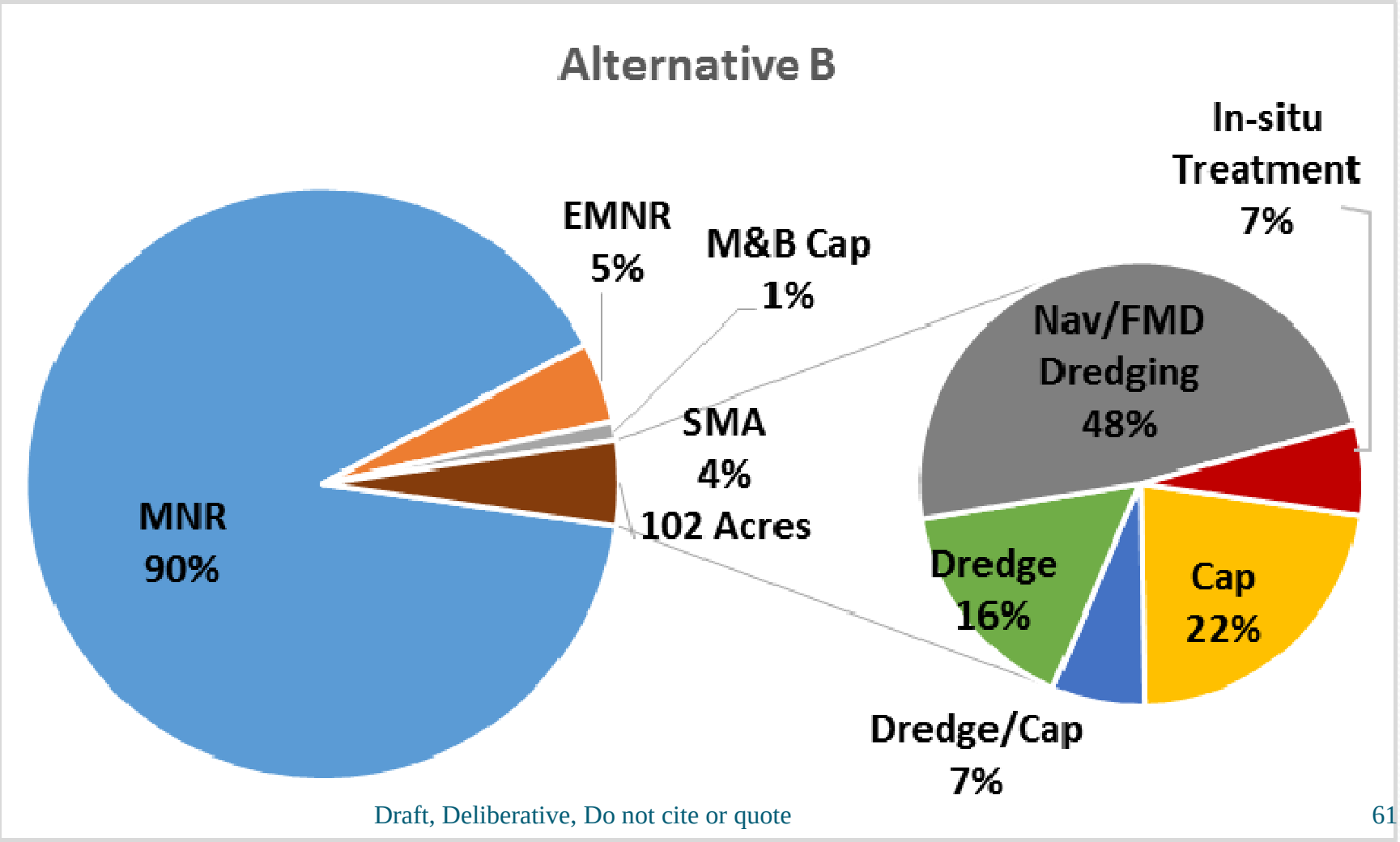


Figure 3.6-2a. Technology Assignments, Alternative B, Site-Wide

Alternative B Technologies



Alternative C

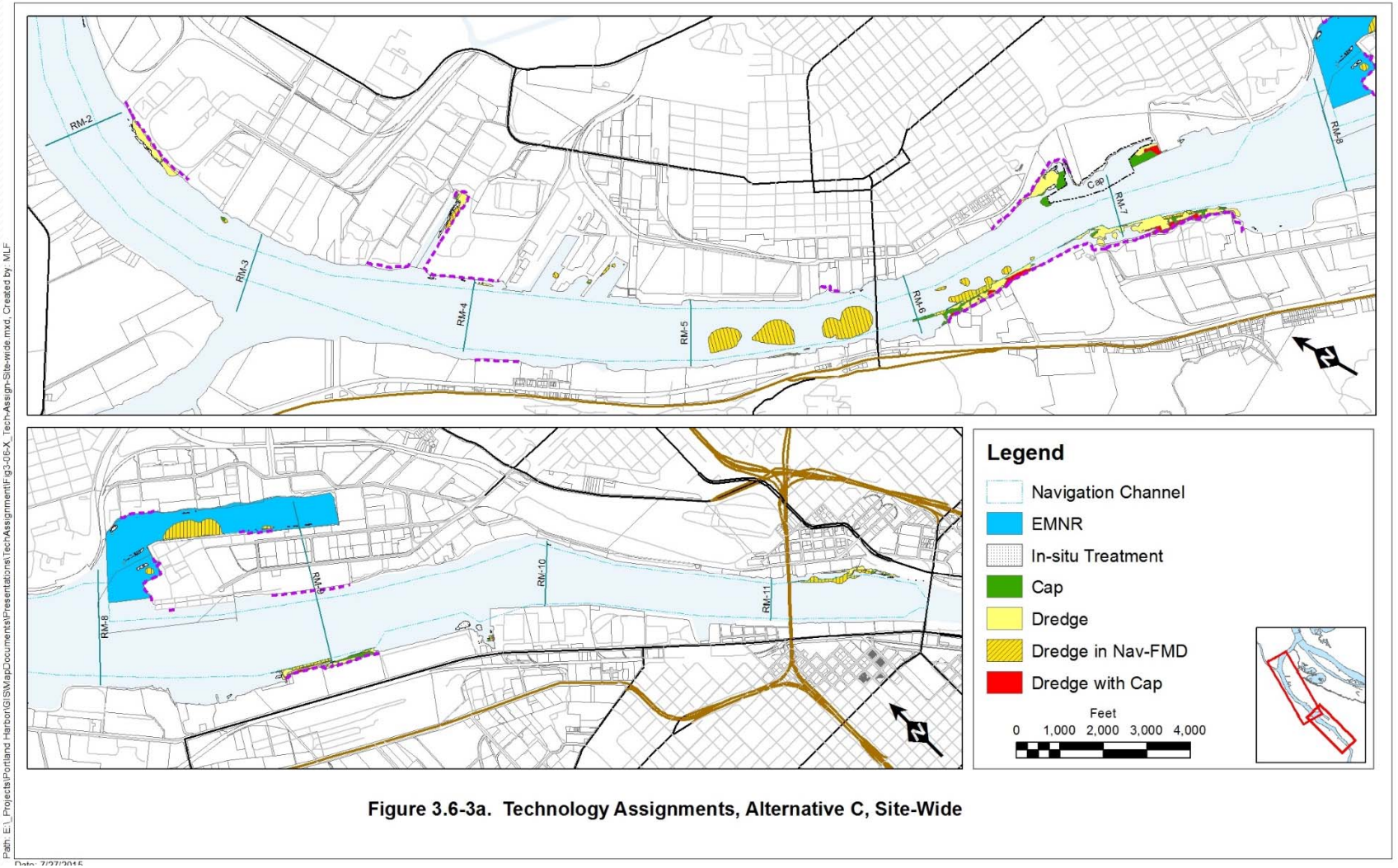


Figure 3.6-3a. Technology Assignments, Alternative C, Site-Wide

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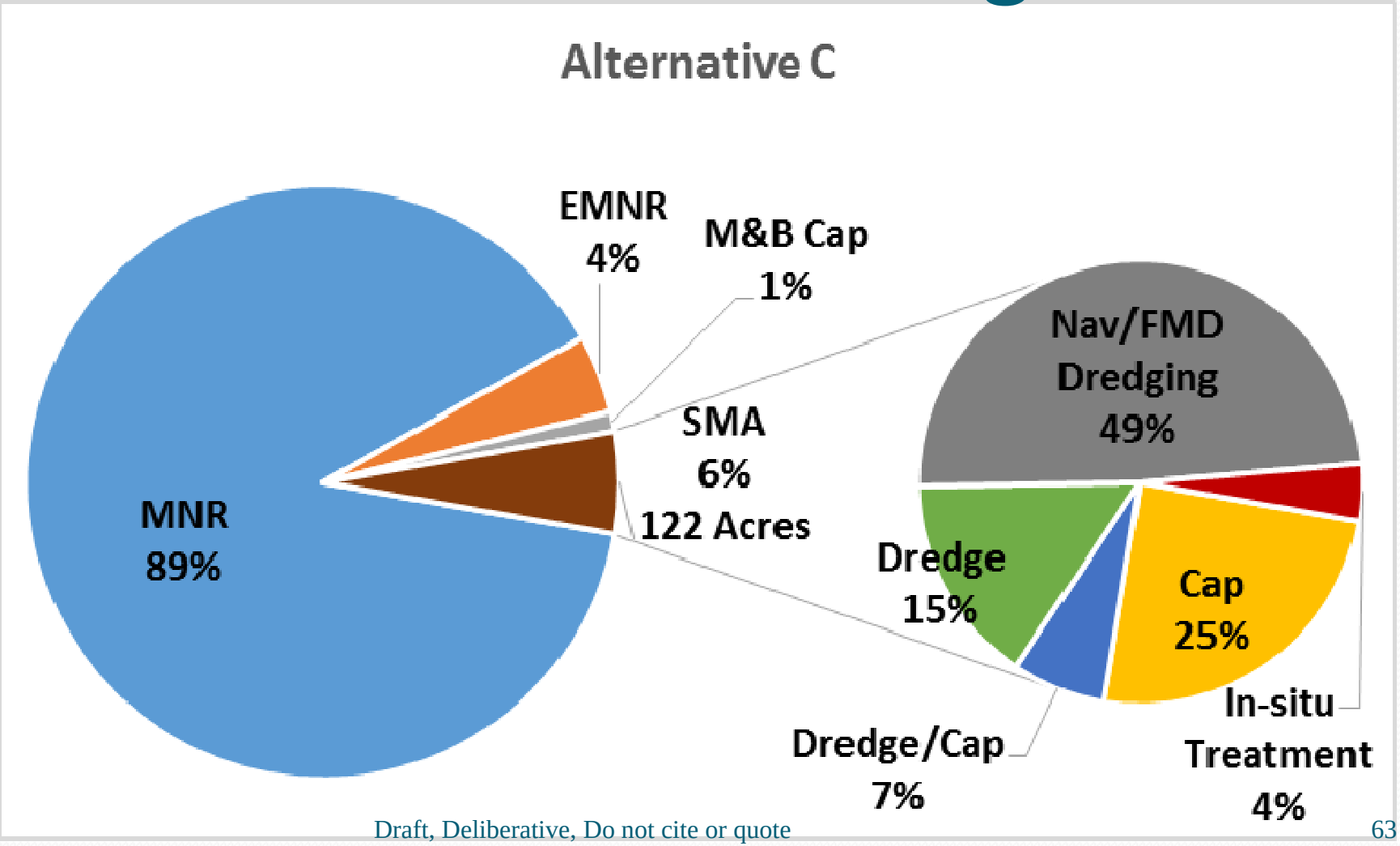
Alternative C Technologies



Alternative D

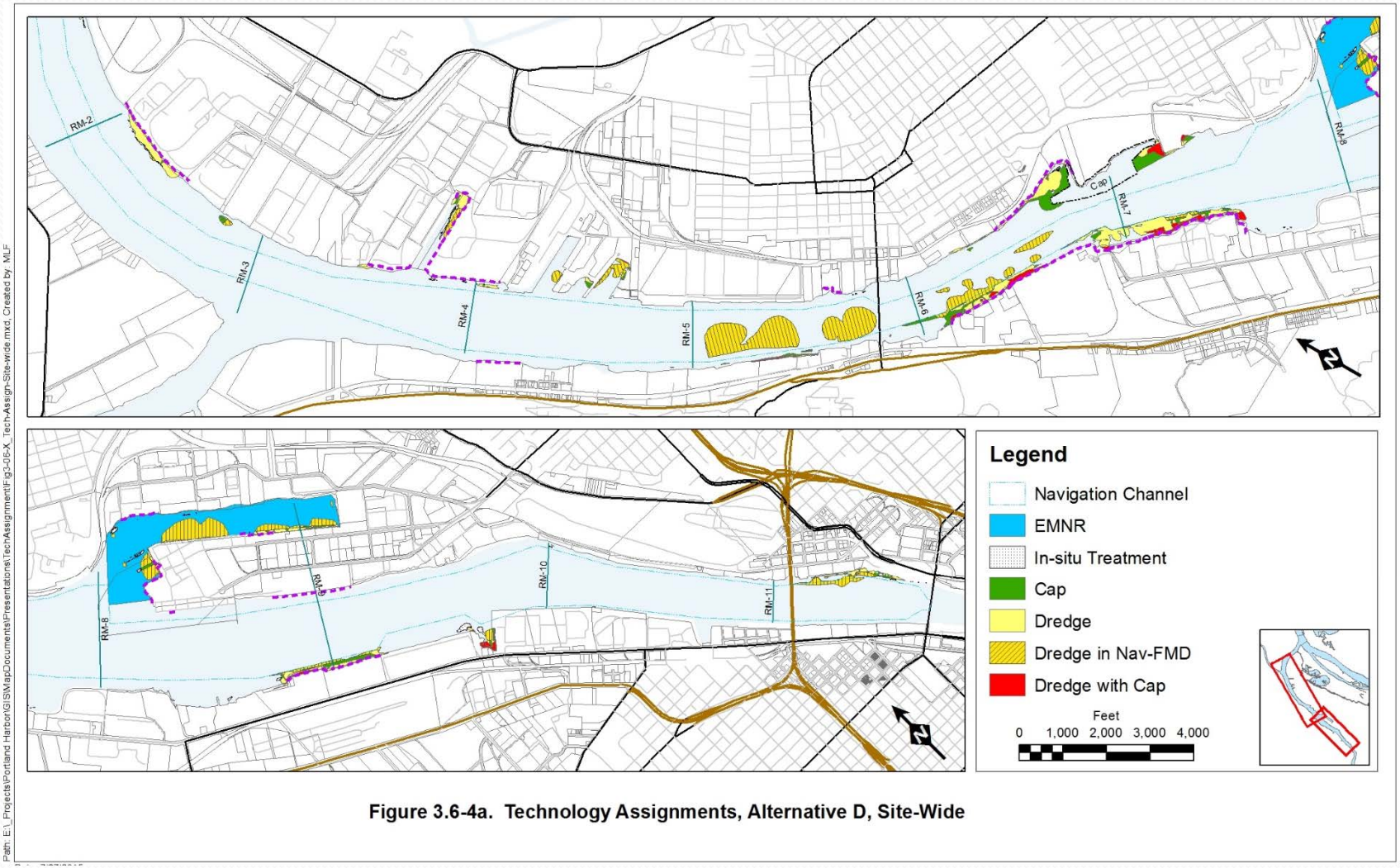
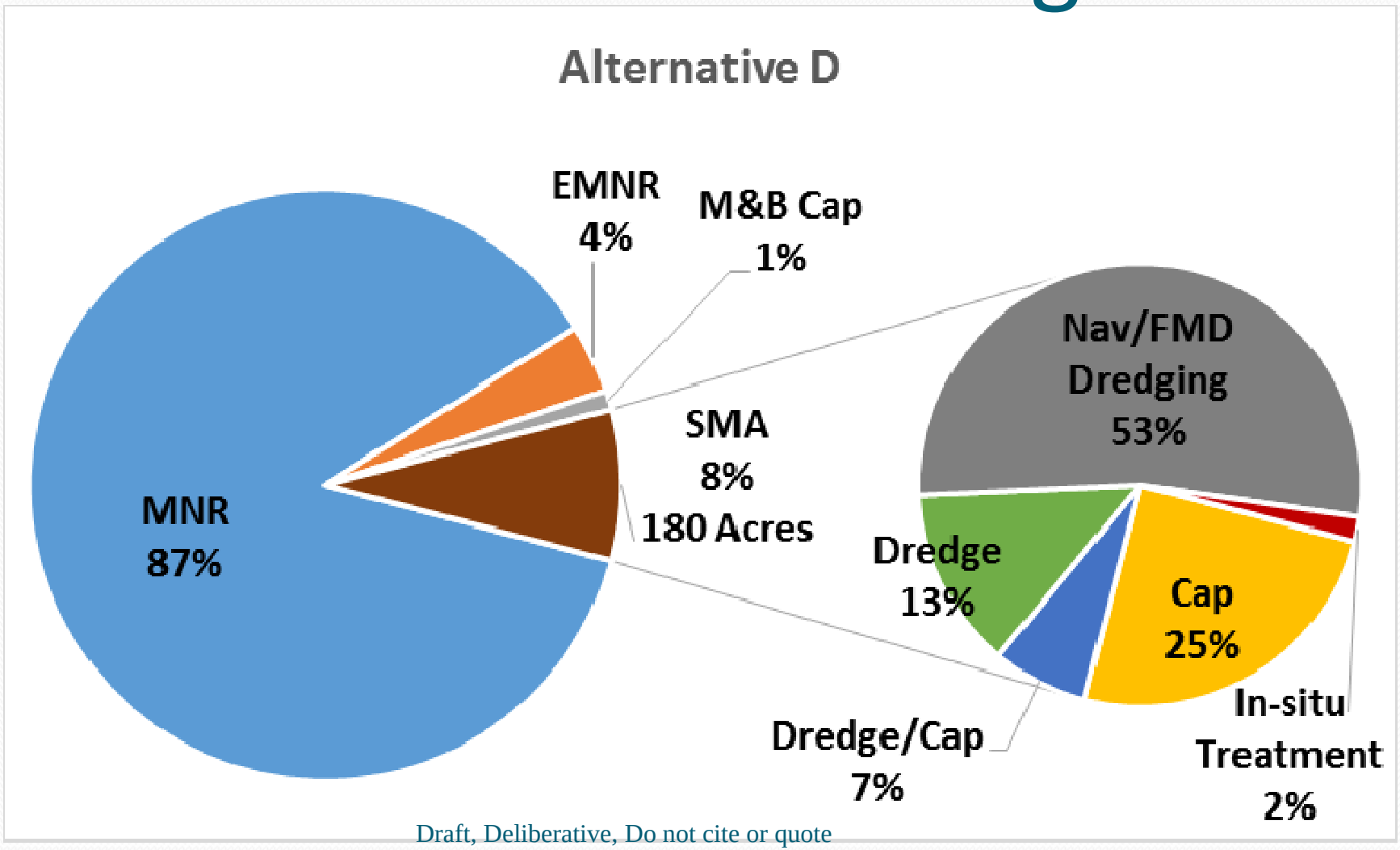


Figure 3.6-4a. Technology Assignments, Alternative D, Site-Wide

Alternative D Technologies



Alternative E

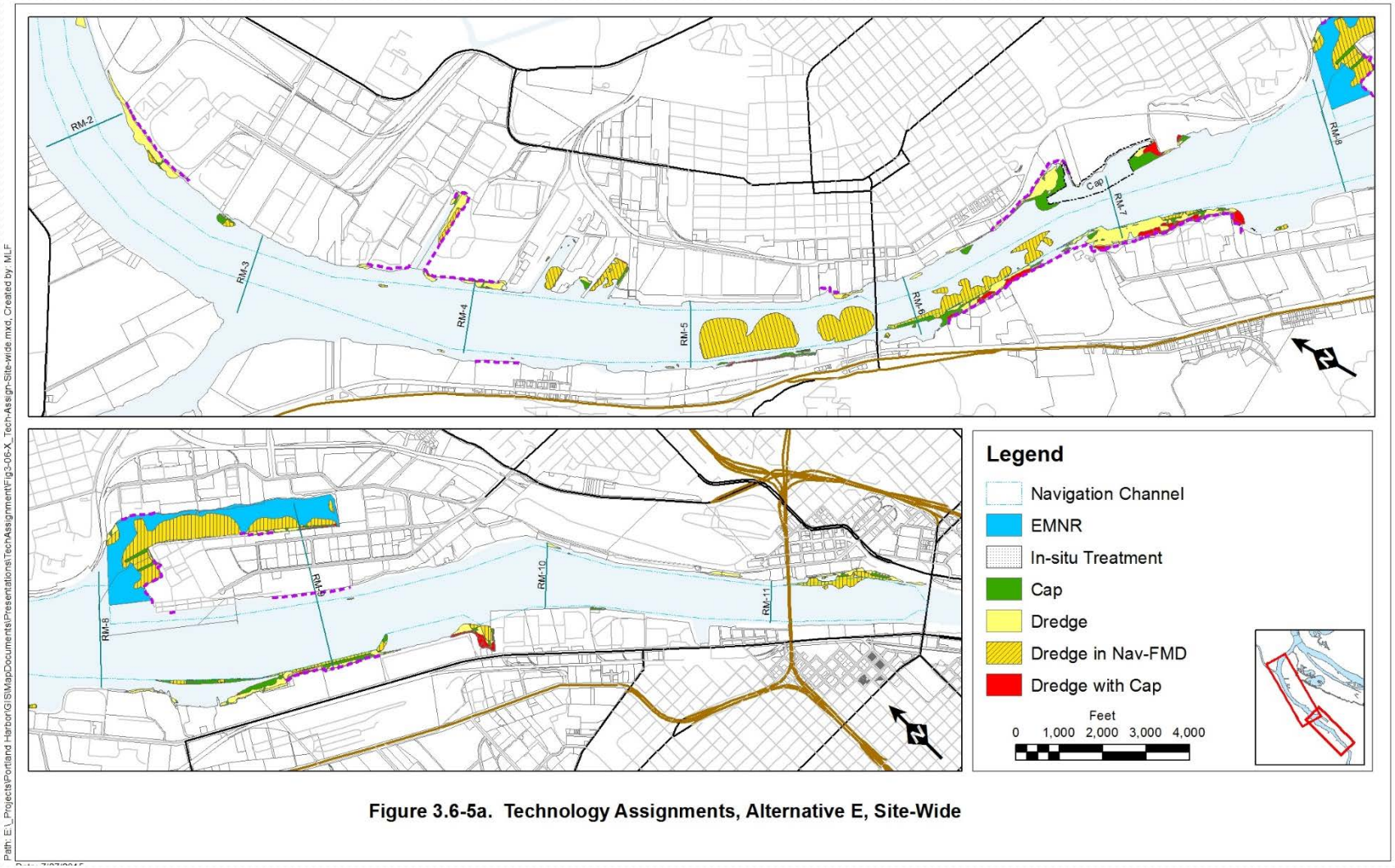
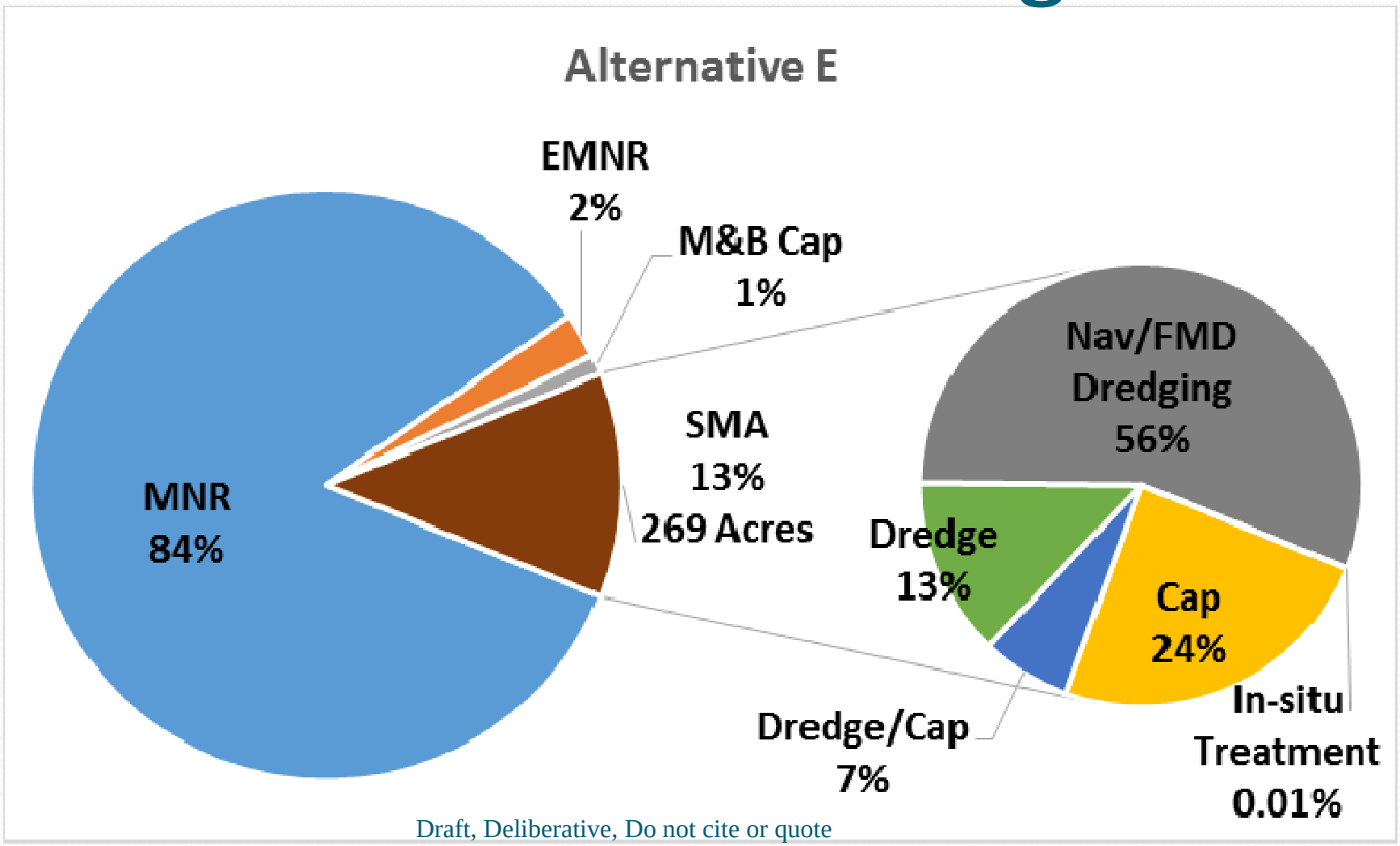


Figure 3.6-5a. Technology Assignments, Alternative E, Site-Wide

Alternative E Technologies



Alternative F

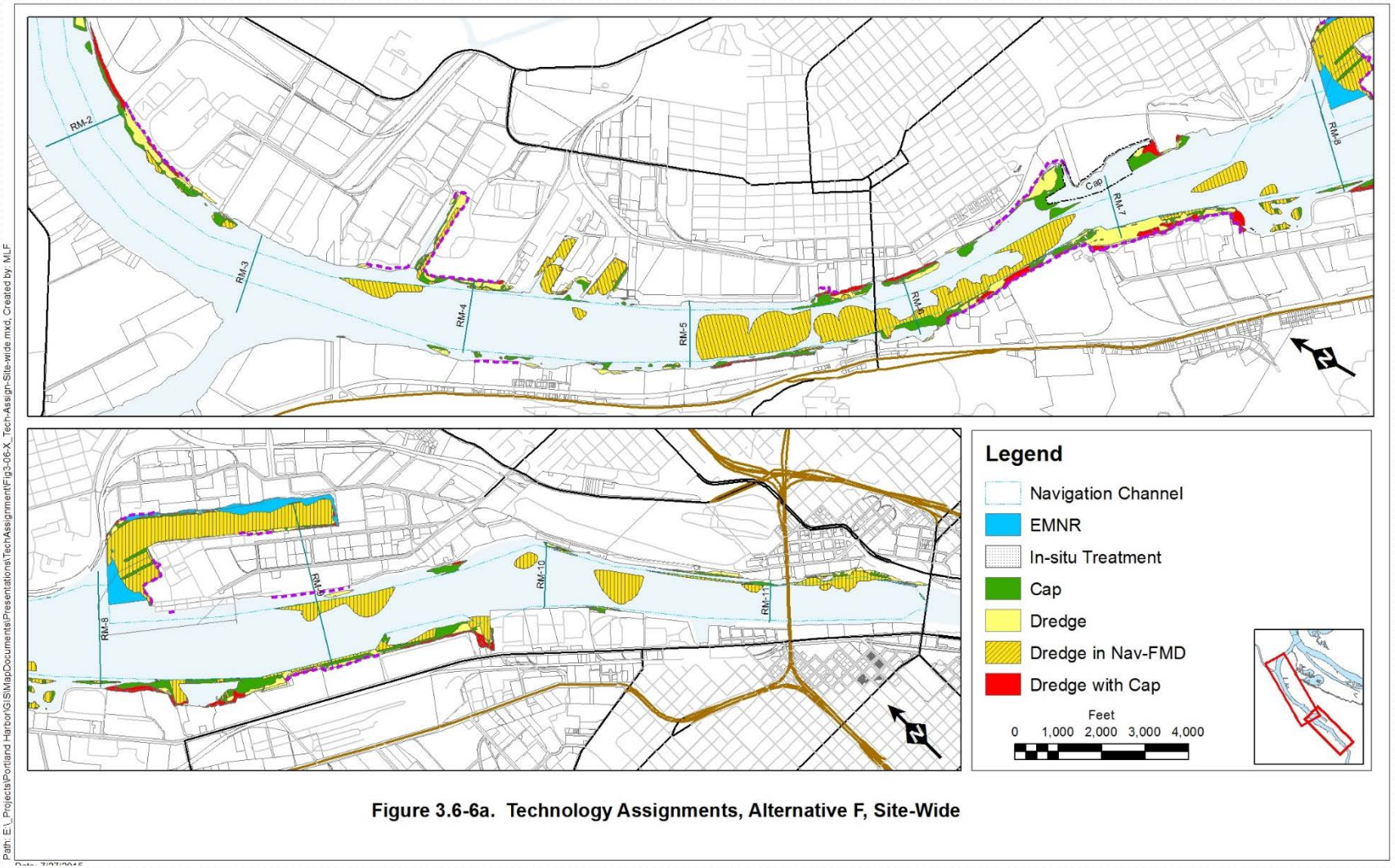
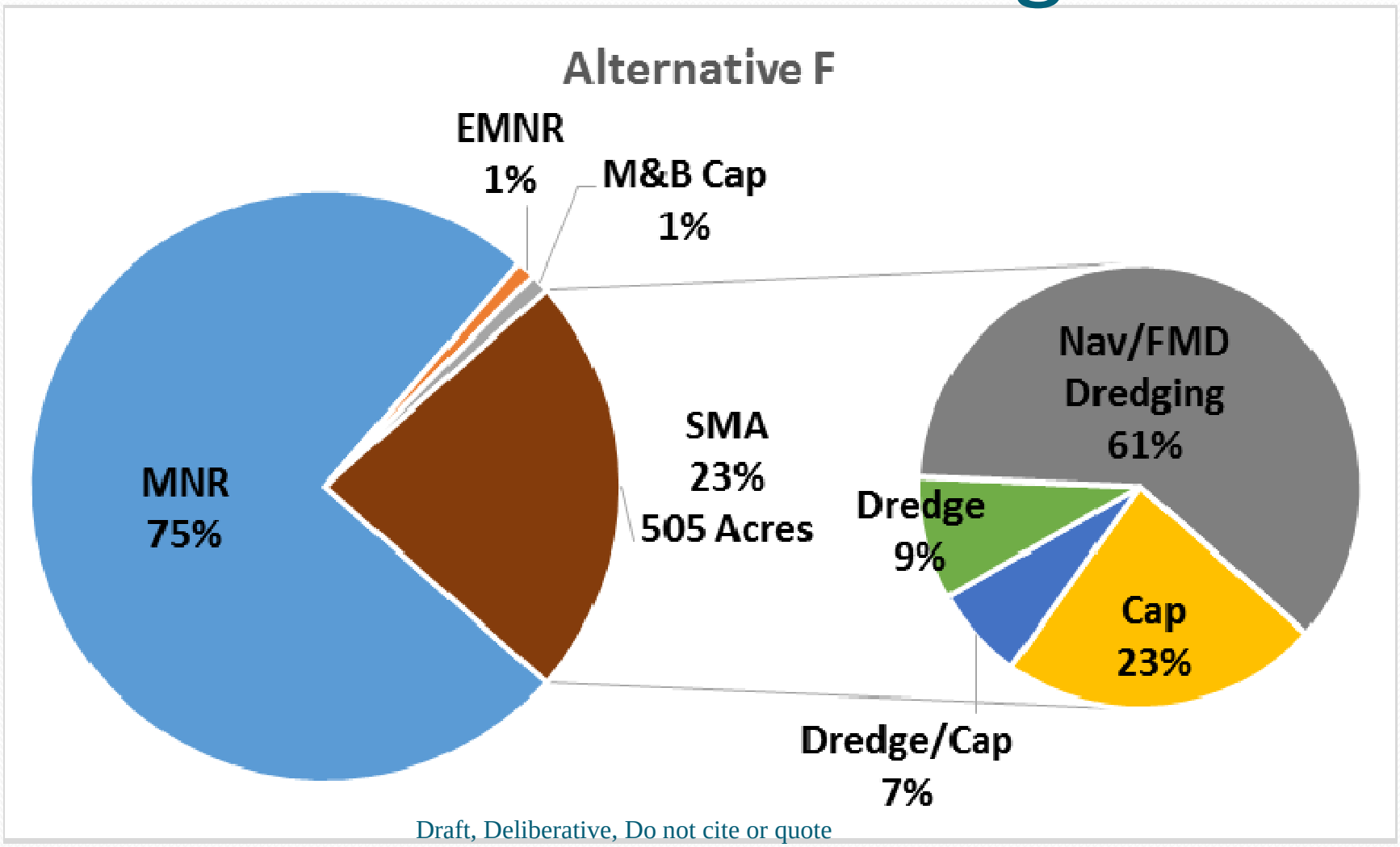


Figure 3.6-6a. Technology Assignments, Alternative F, Site-Wide

Alternative F Technologies



Alternative G

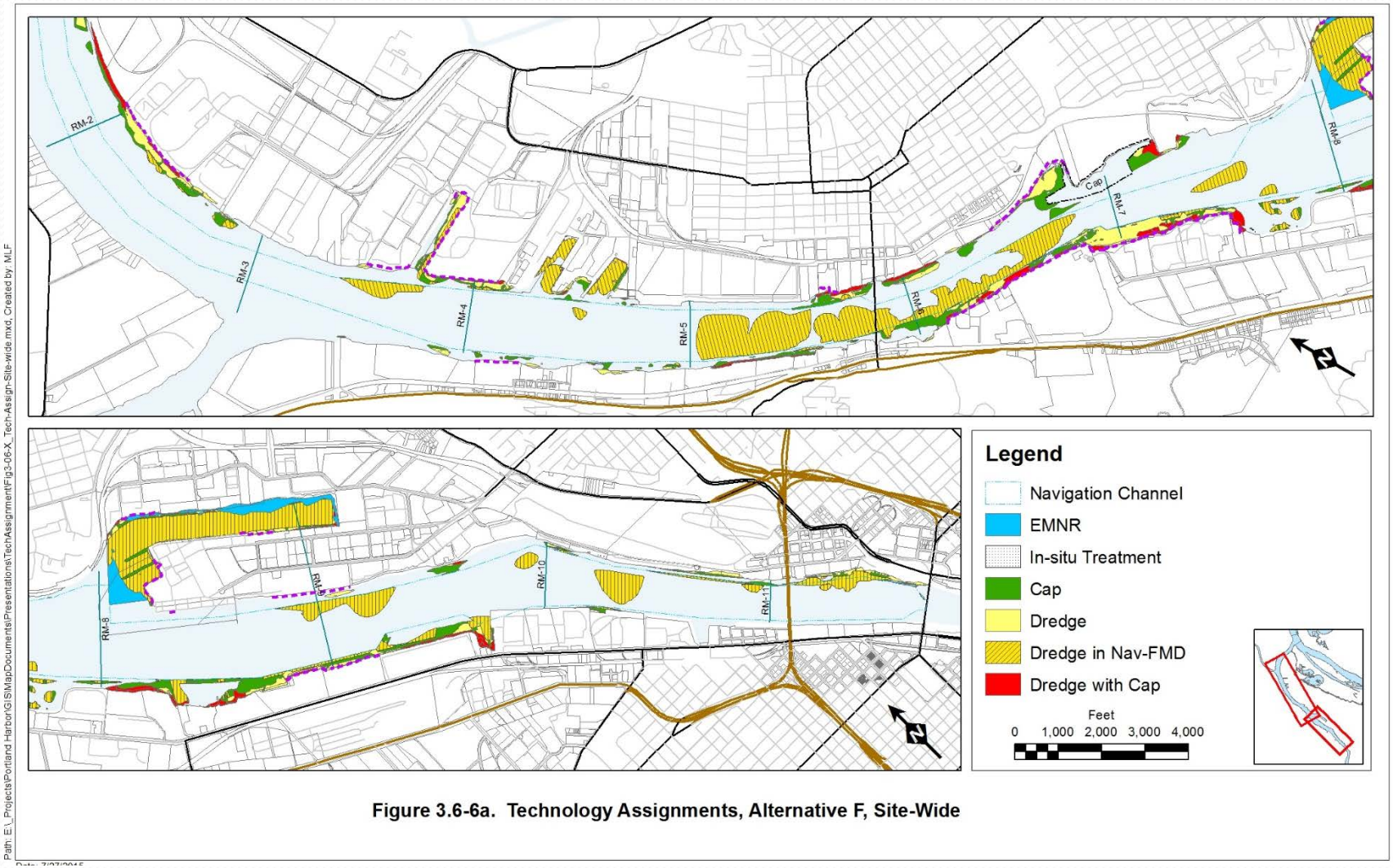
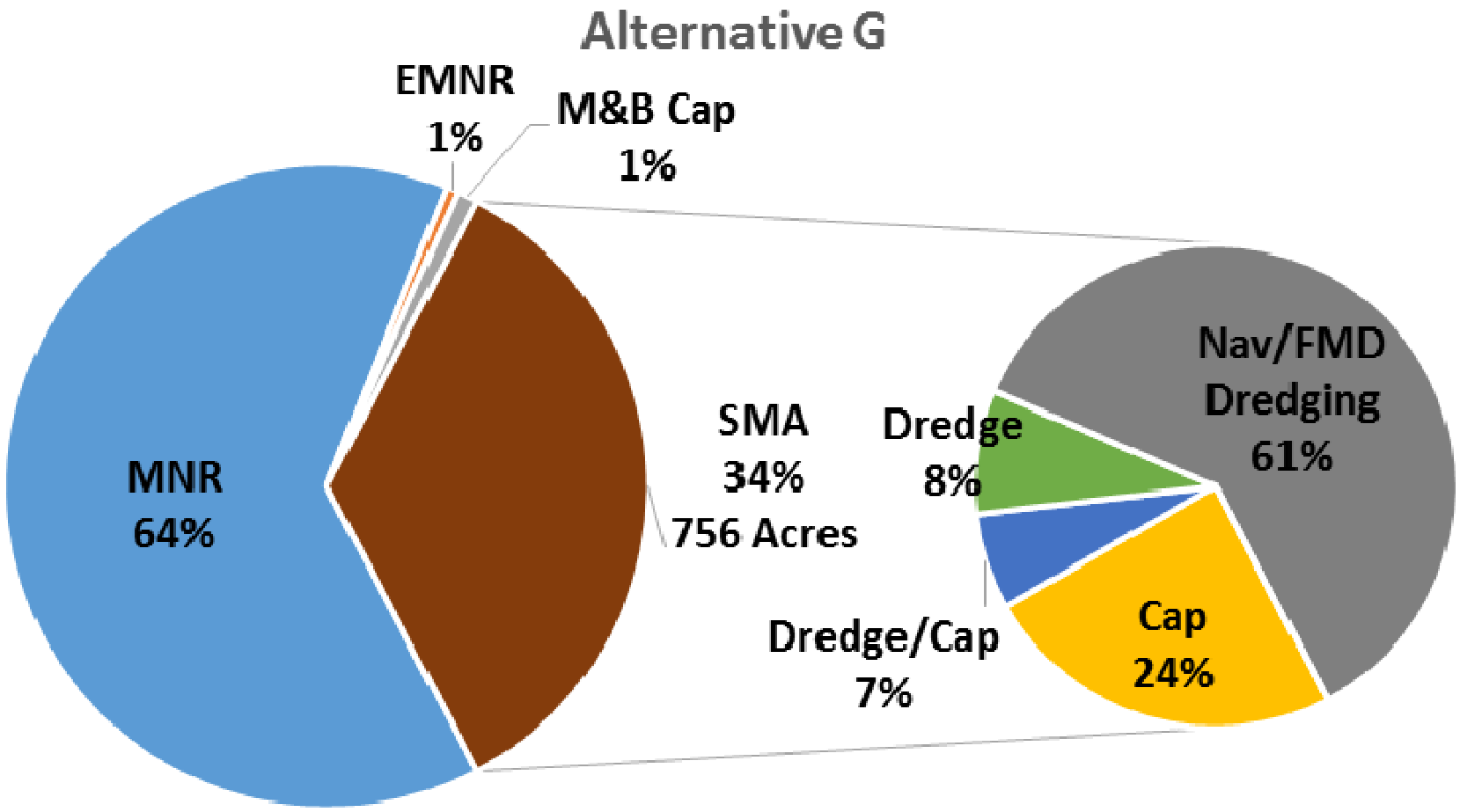


Figure 3.6-6a. Technology Assignments, Alternative F, Site-Wide

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

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Detailed Analysis of Alternatives

Site Areas

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

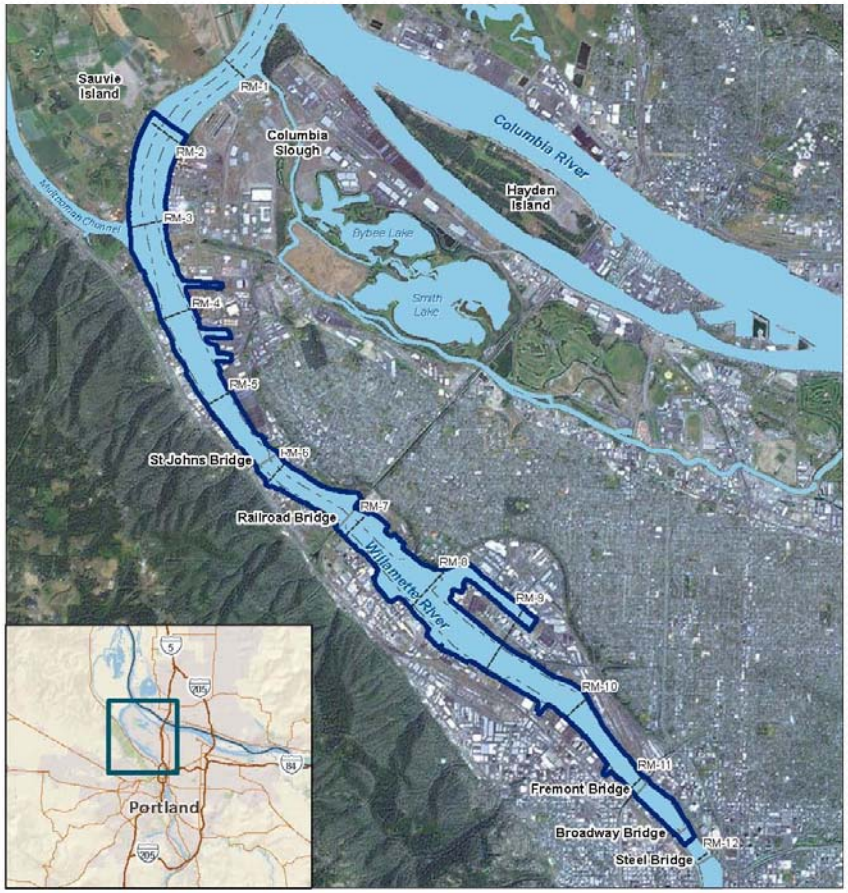
Site-wide

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

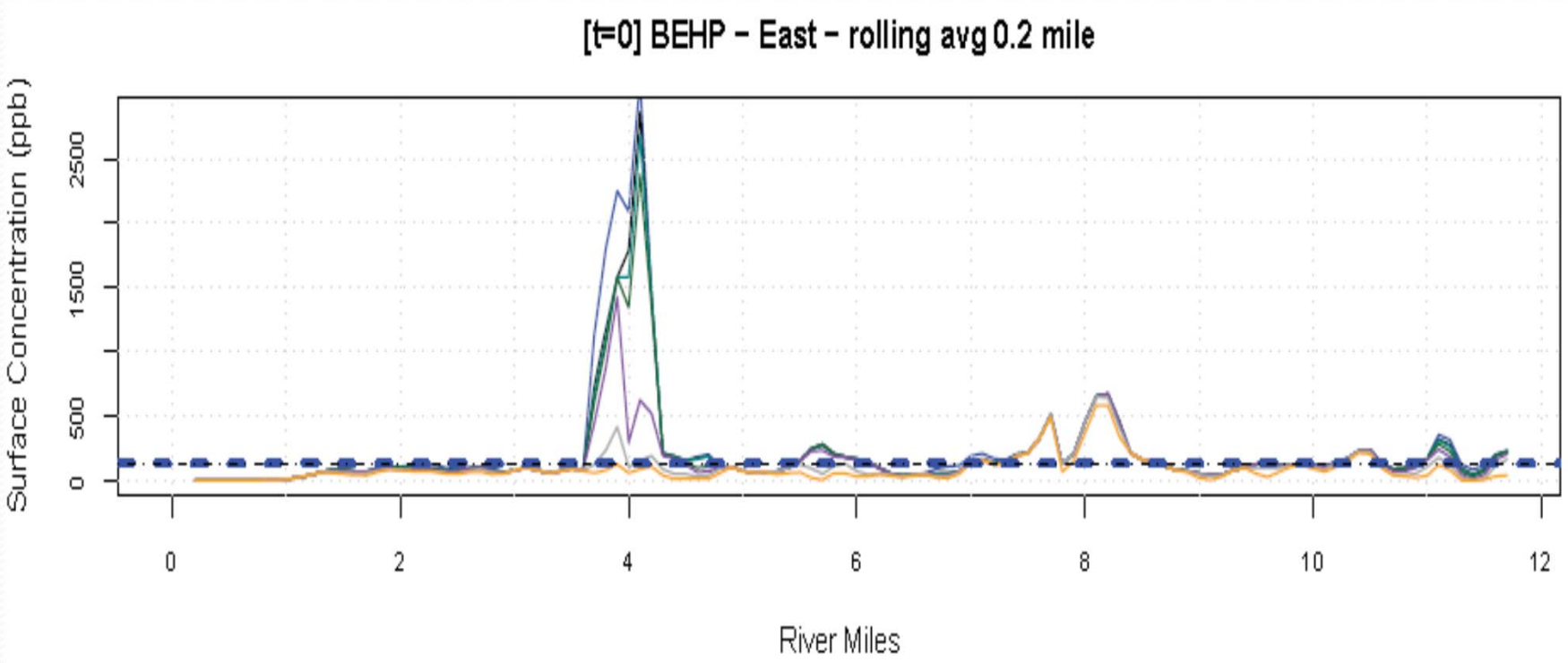
Example Receptors

- Sculpin
- Crayfish
- Benthic

Size

- Rolling 0.2 RM in River Zones

Example Rolling 0.2 RM



0.5 River Mile

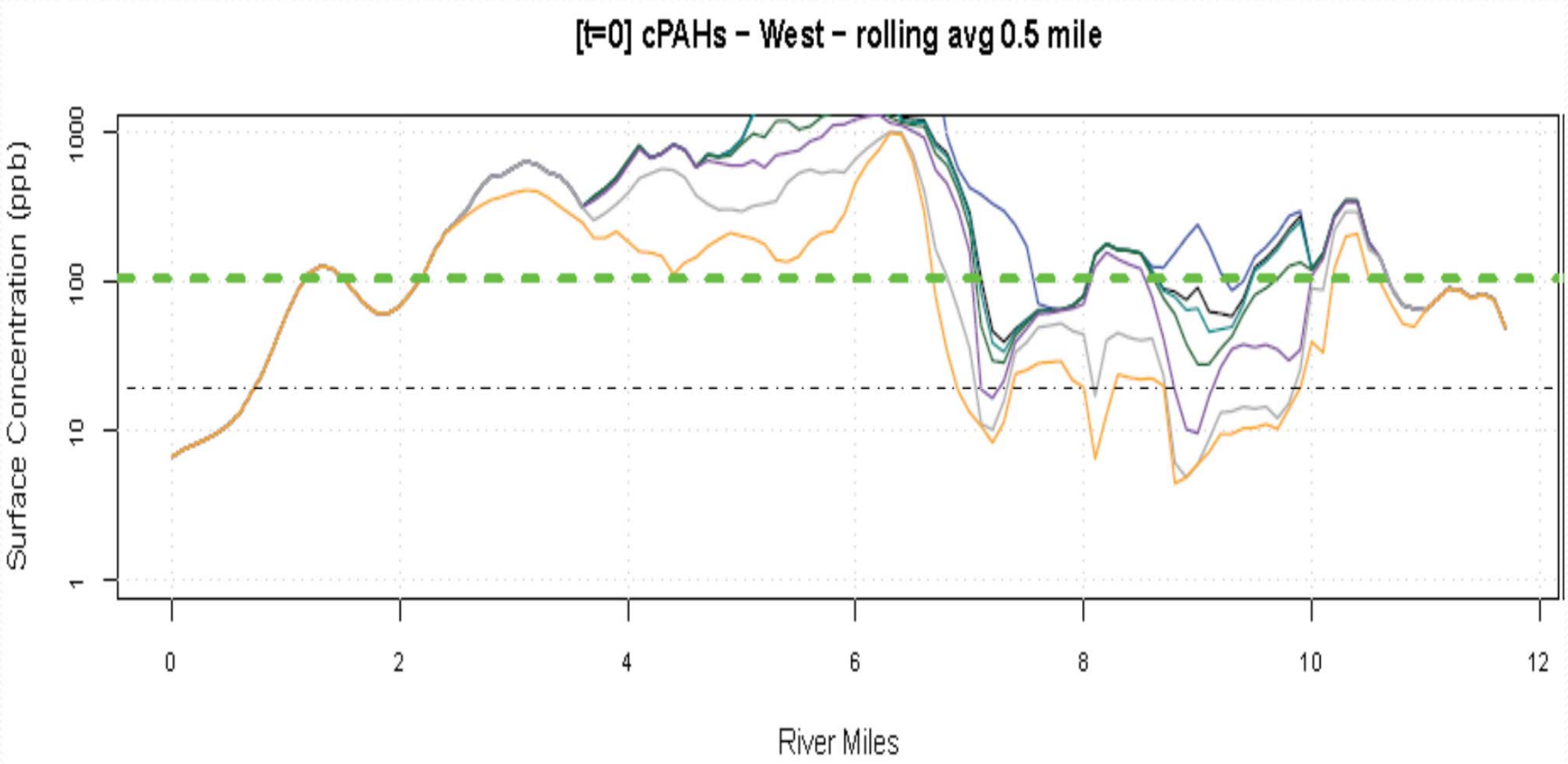
Example Receptors

- Human Direct Contact (nearshore only)

Size

- Rolling ½ RM in River Zones

Example Rolling 0.5 RM



1 River Mile

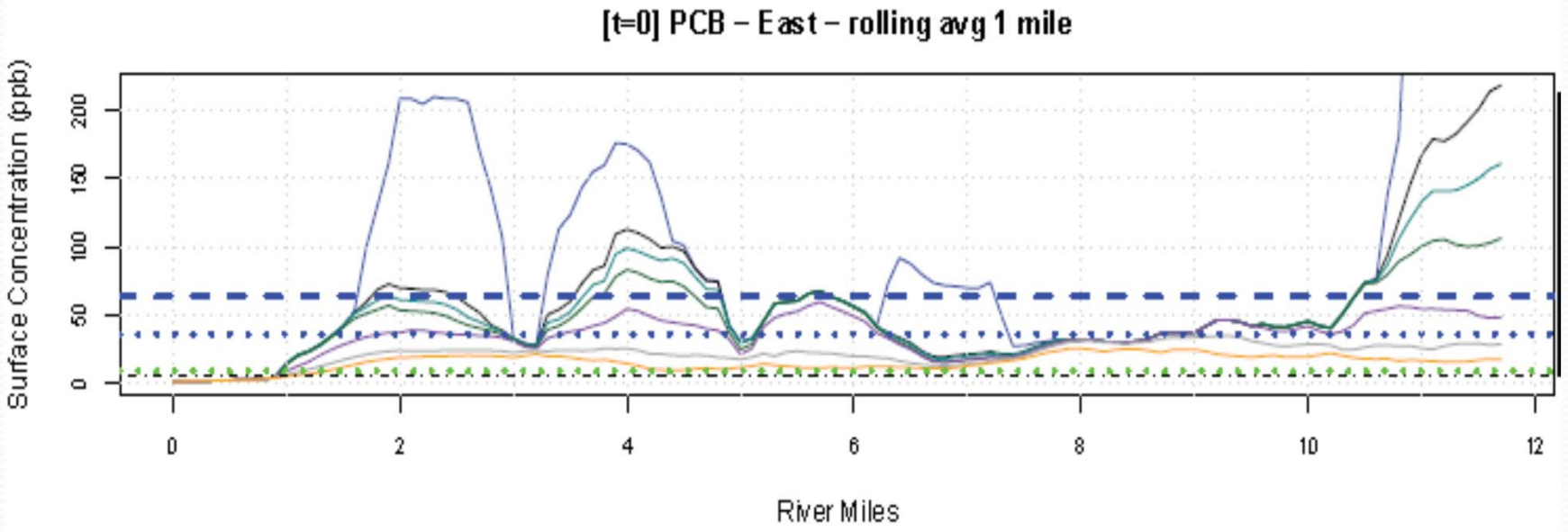
Example Receptors

- 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

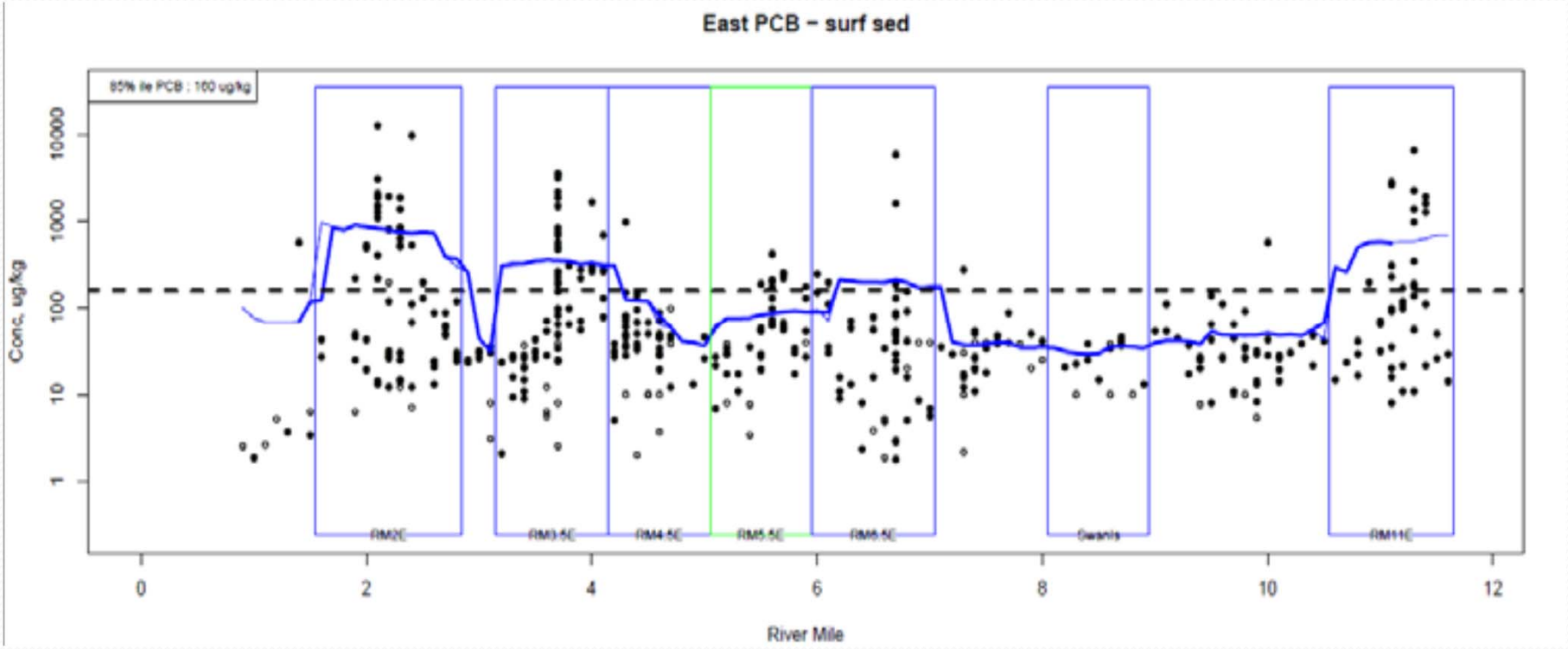
Goal

- Reproducible and spatially-based
- Evaluate highest risk reduction

SDU Approach

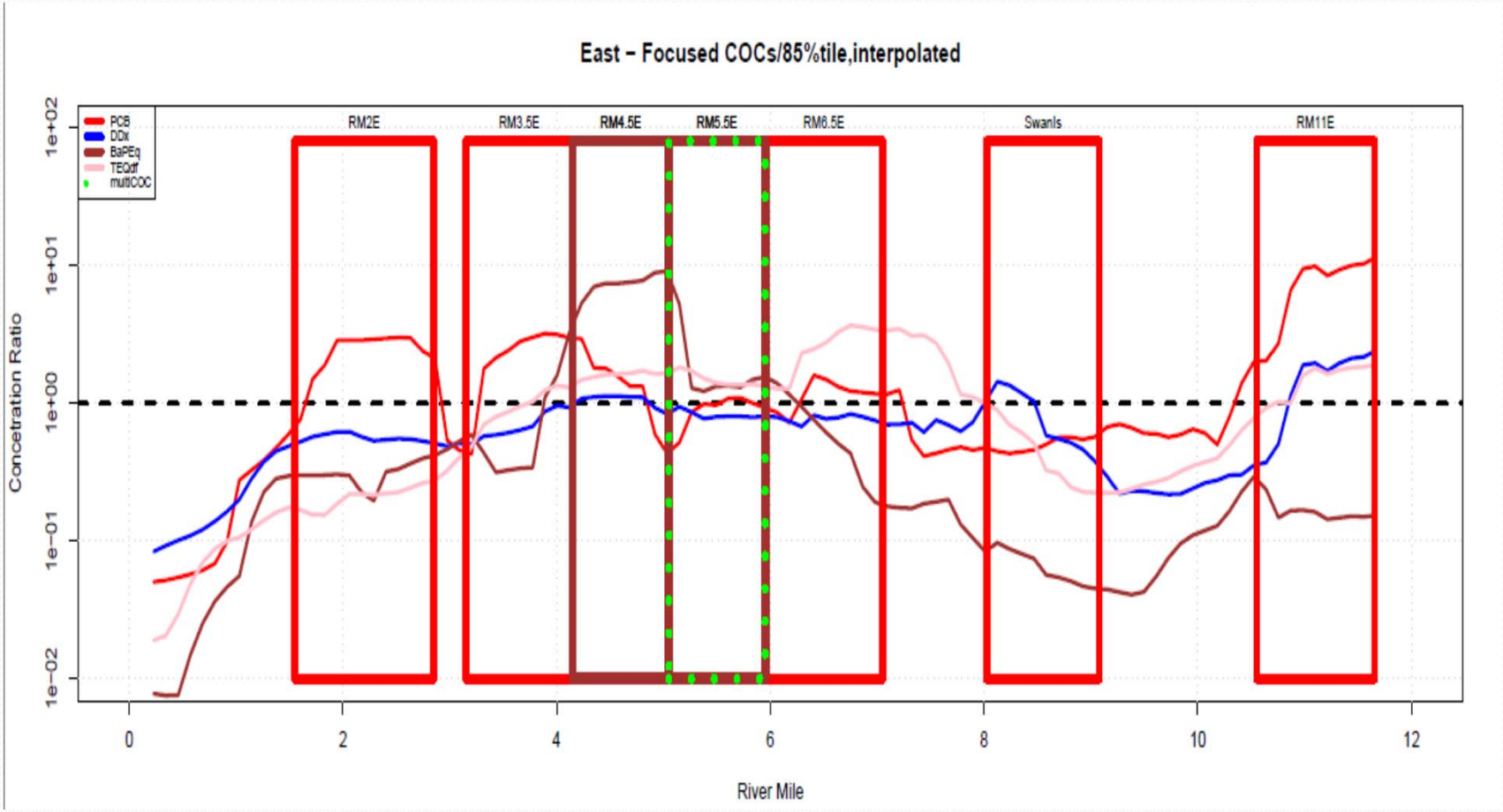
- Delineate highest concentration areas
- Based on river region
- Non-weighted surface sediment concentrations
  - Focused COCs
- Adjust SDU boundaries
  - interpolated concentration contours
- Other considerations
  - benthic risk
  - other COCs

Example Rolling RM



Note: All SDUs shown, not just PCB related ones

Example 85% Normalization



Resulting SDUs

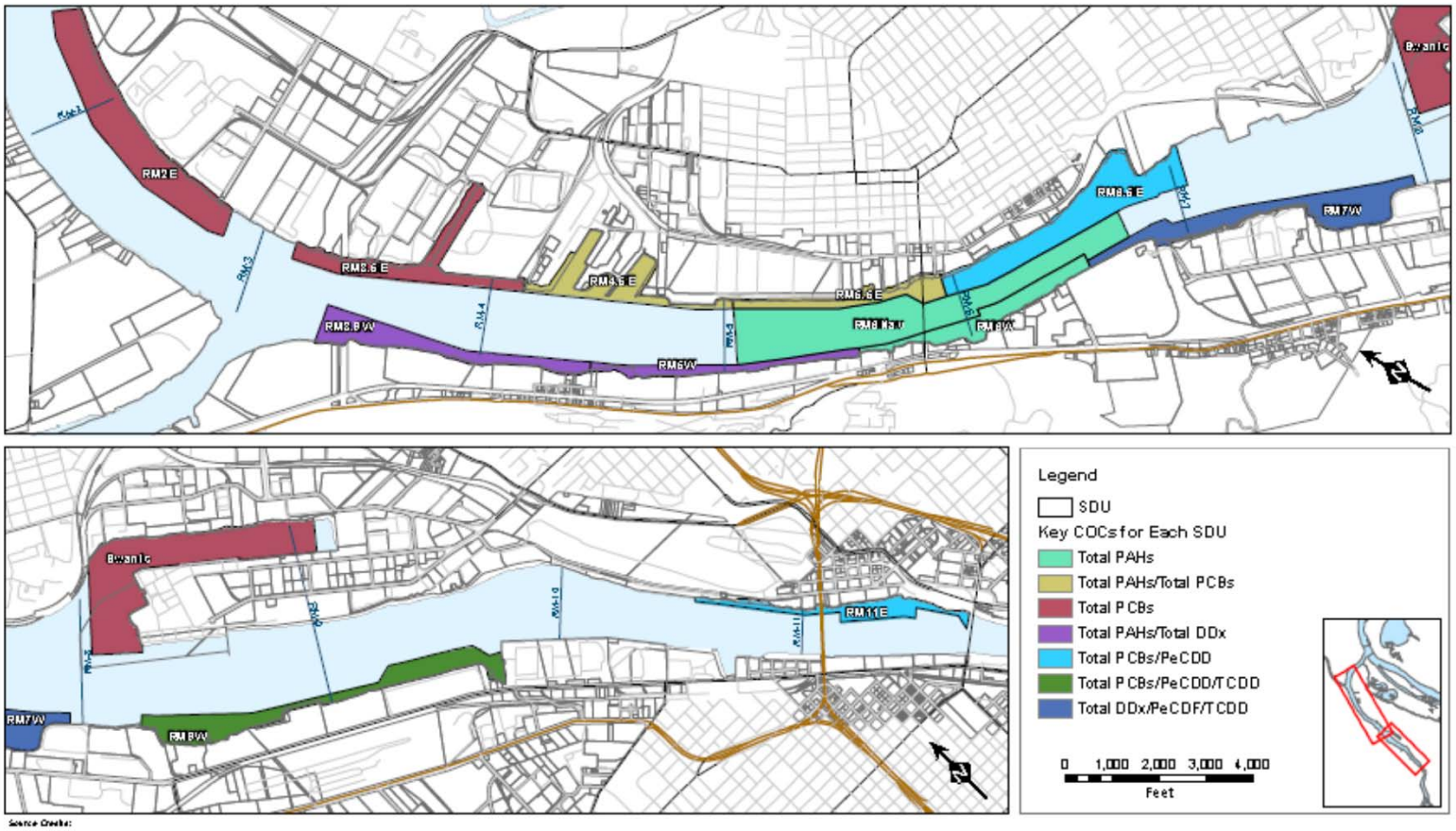


Figure 4.1-2. Sediment Decision Units and Key COCs

Overall Protection of Human Health and the Environment

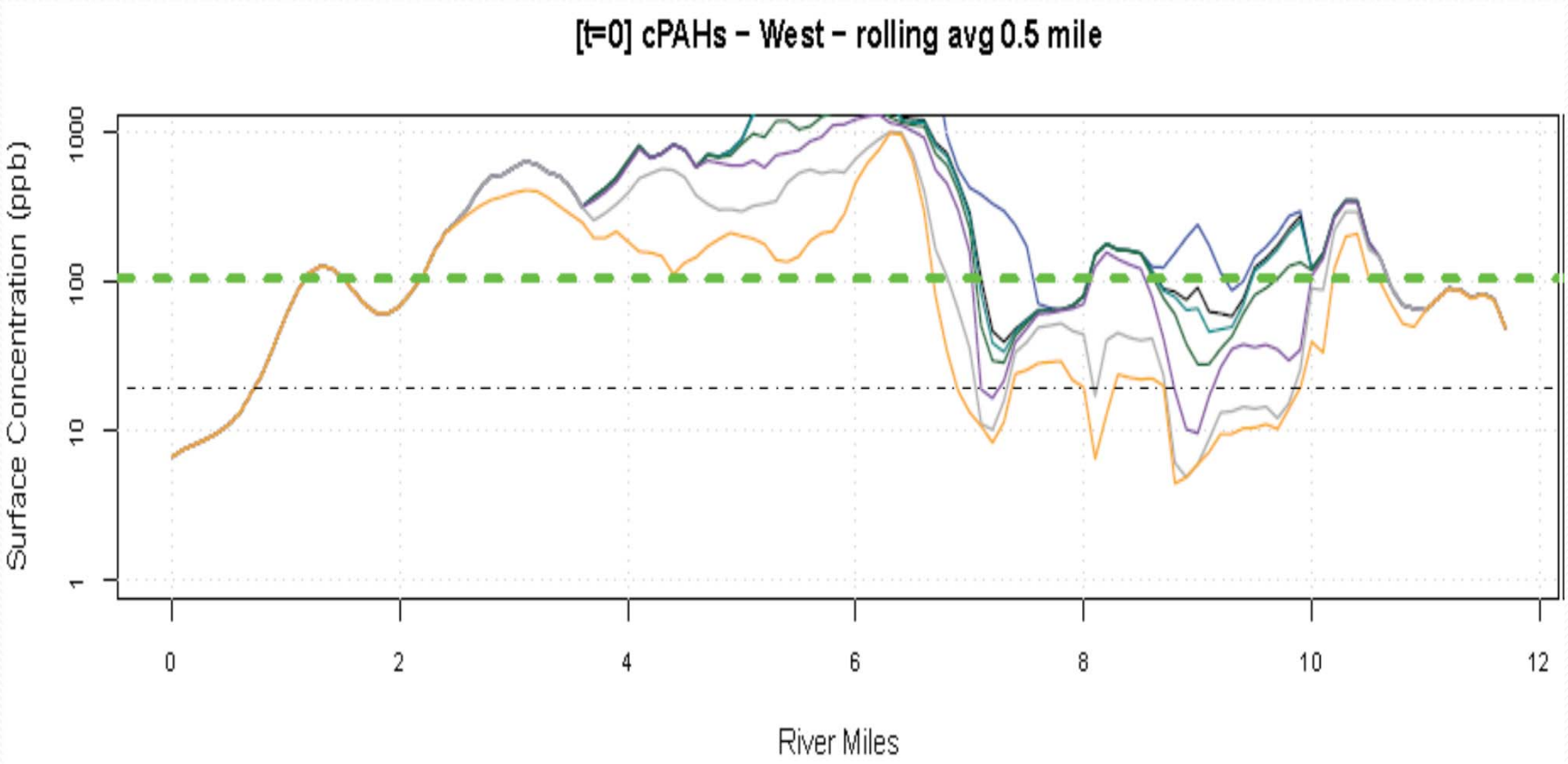
Human Health

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

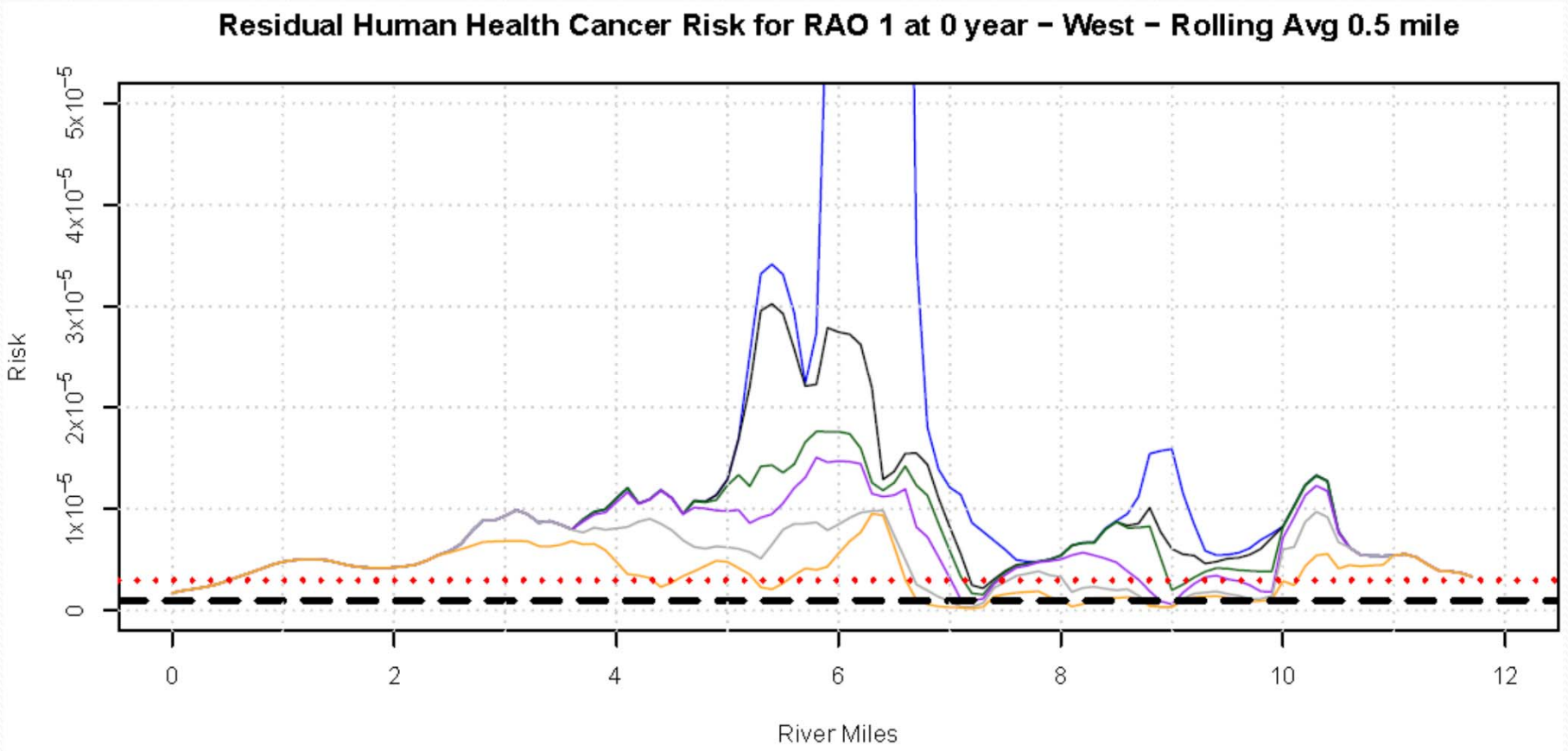
Ecological

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

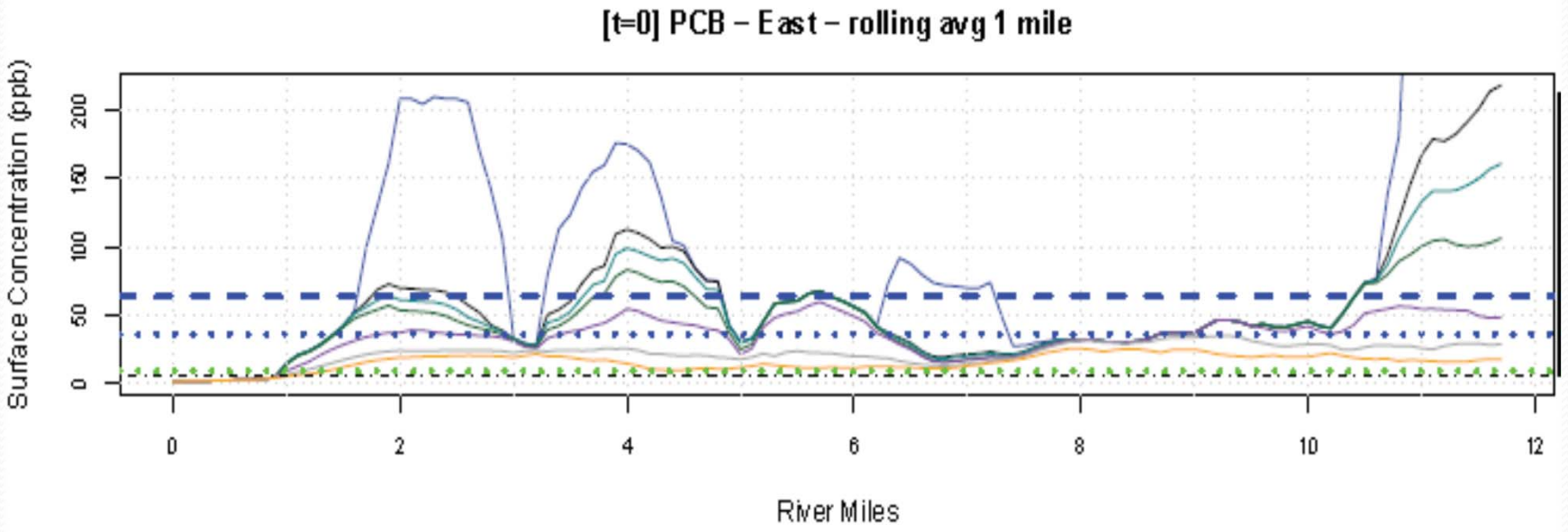
RAO 1 – Compare to PRG



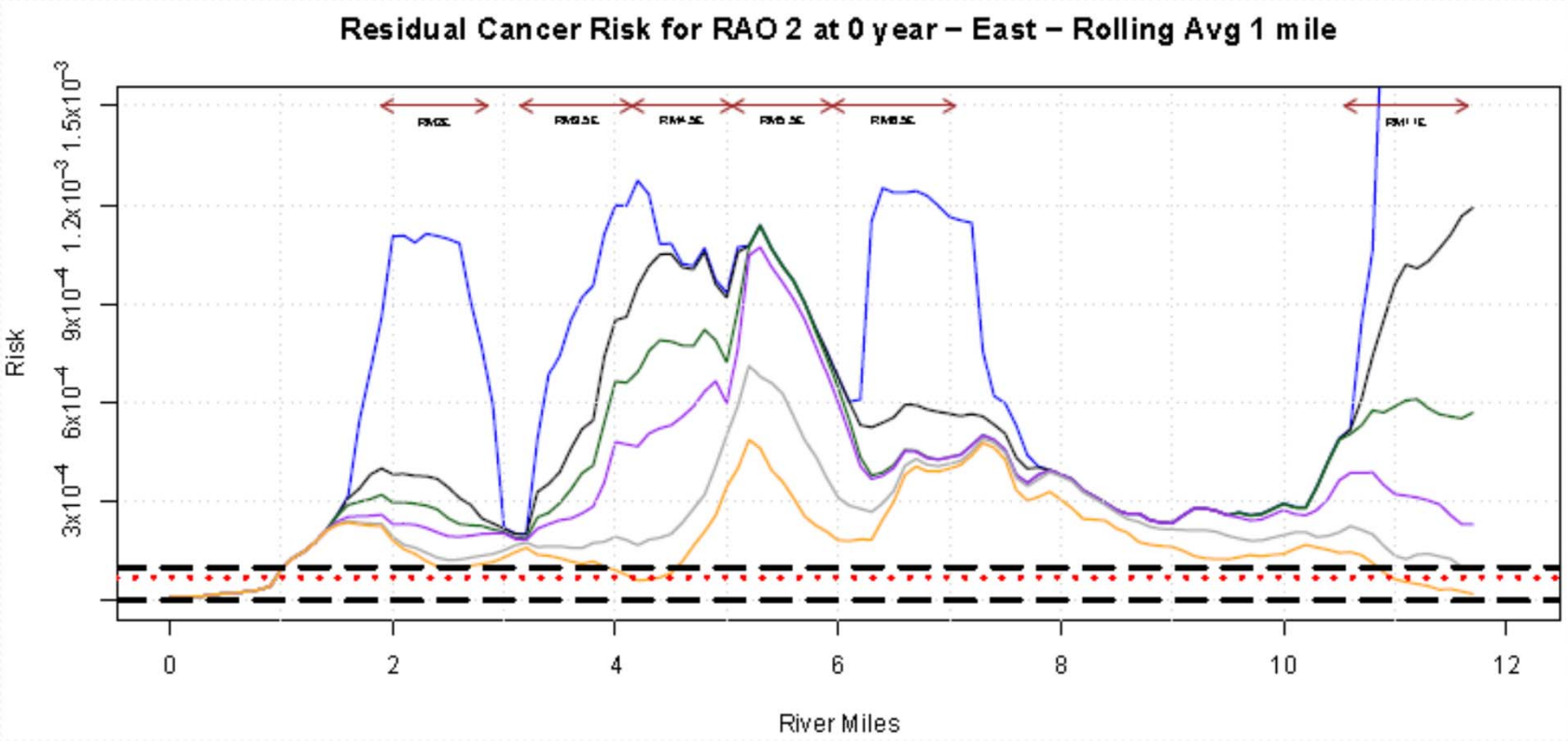
RAO 1 – Residual Risk (cancer)



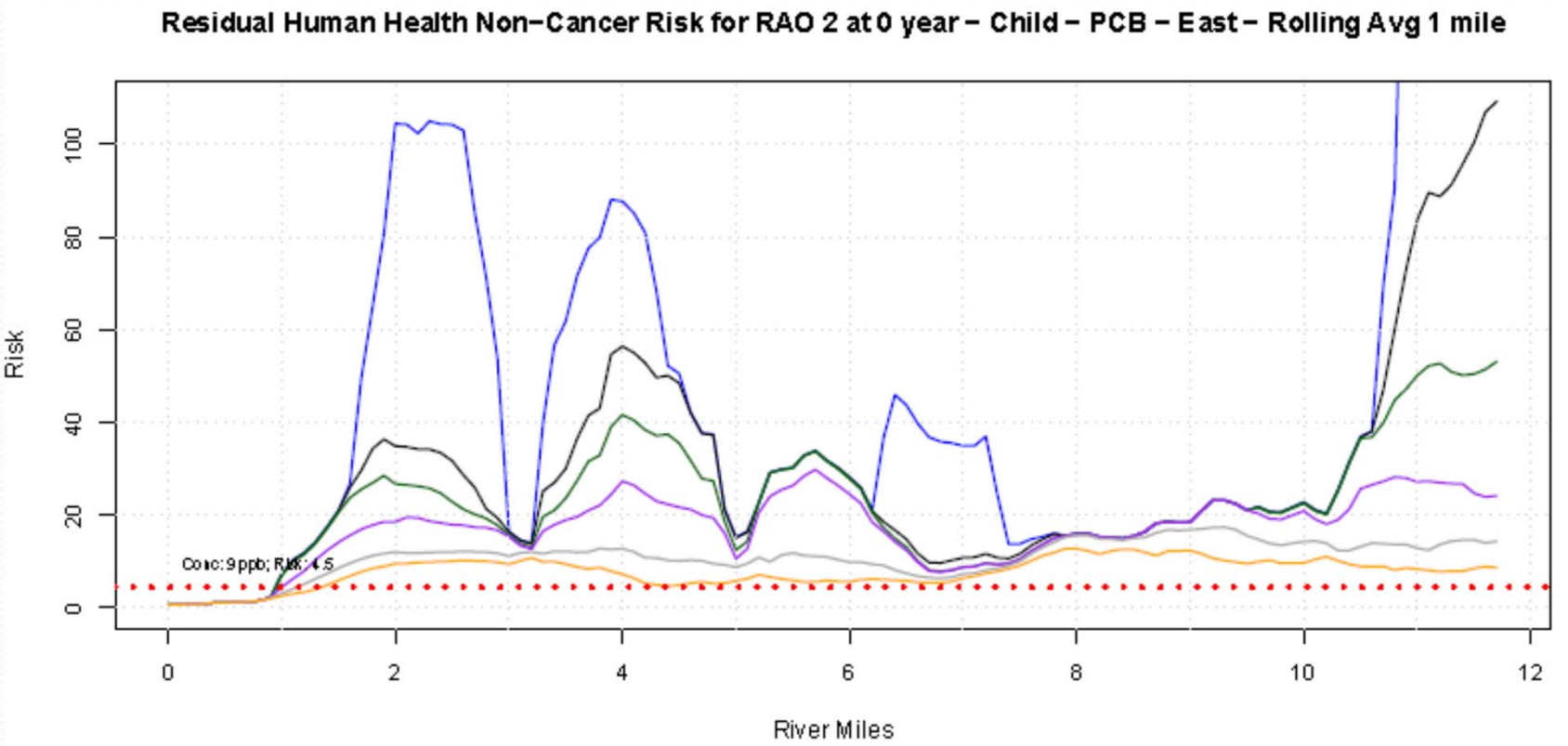
RAO 2 – Compare to PRG



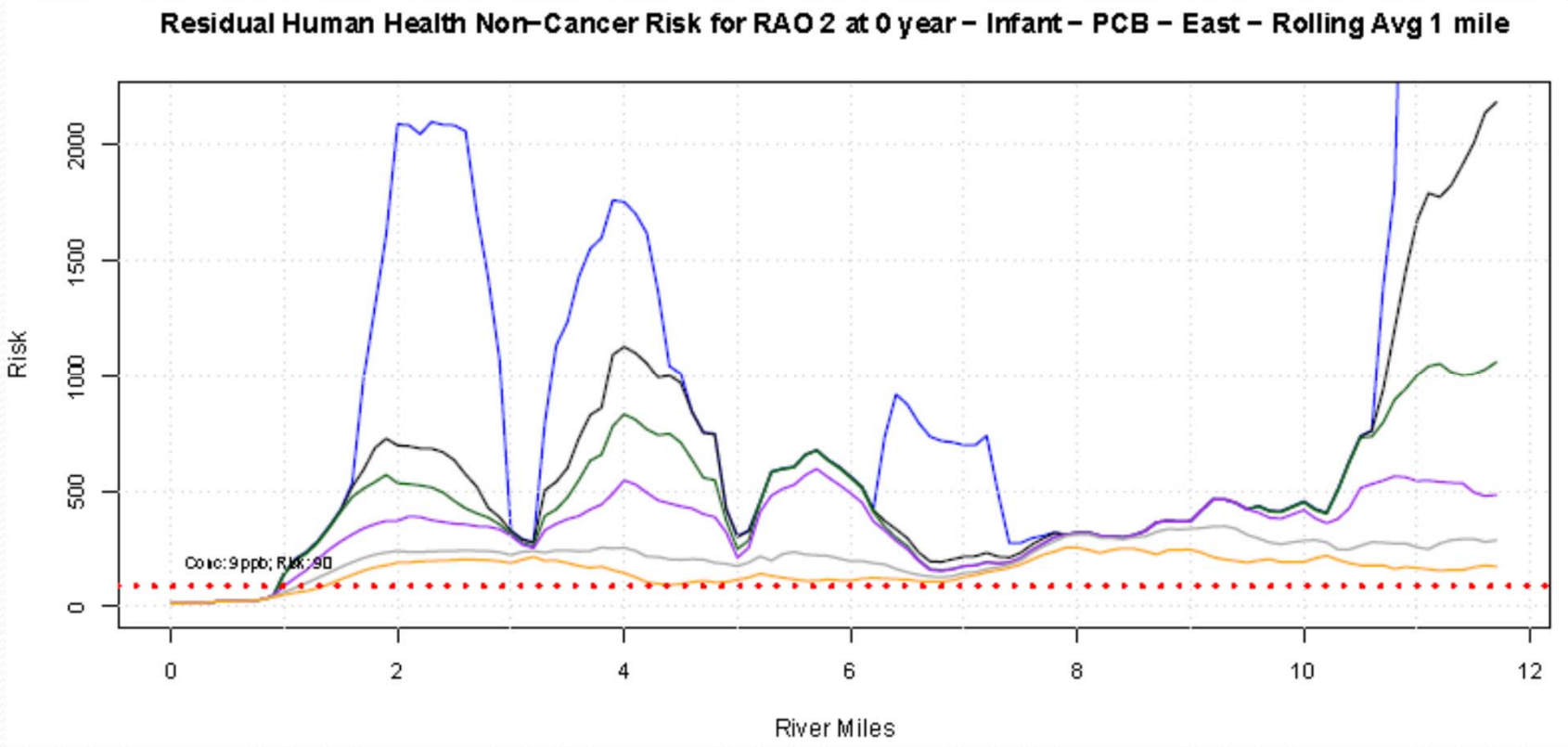
RAO 2 – Residual Risk (cancer)



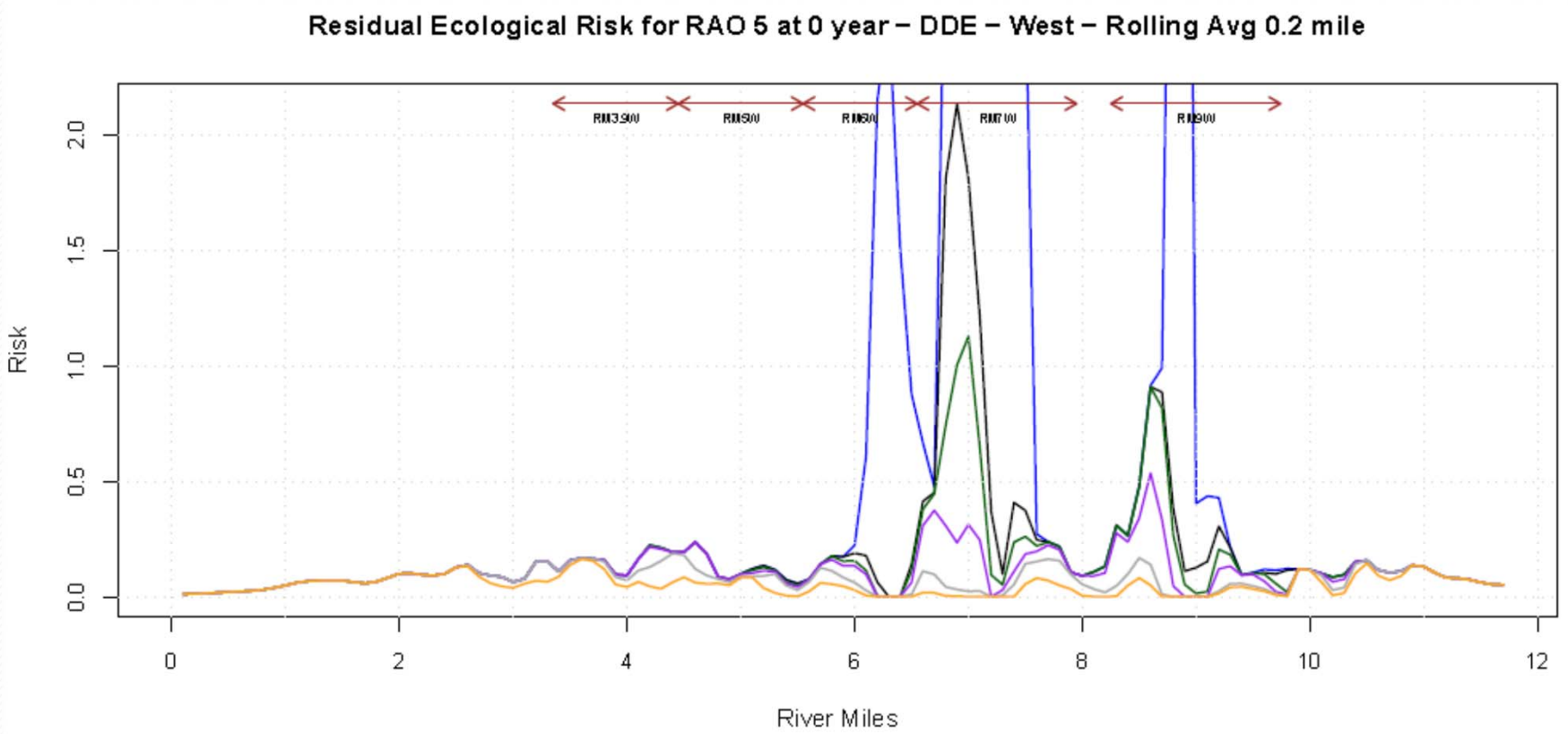
RAO 2 – Residual Risk (child)



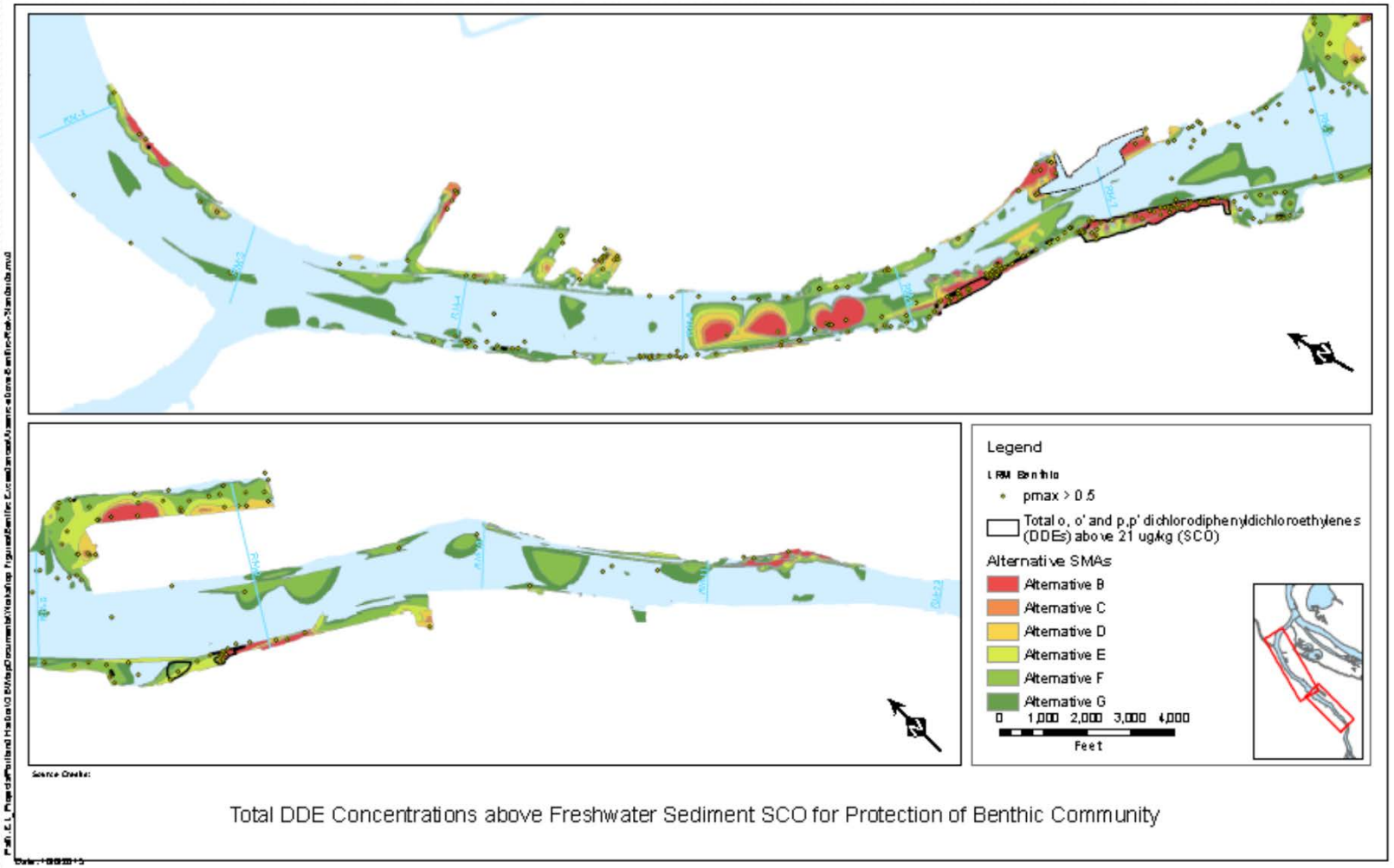
RAO 2 – Residual Risk (infant)



RAO 5 – Benthic Risk

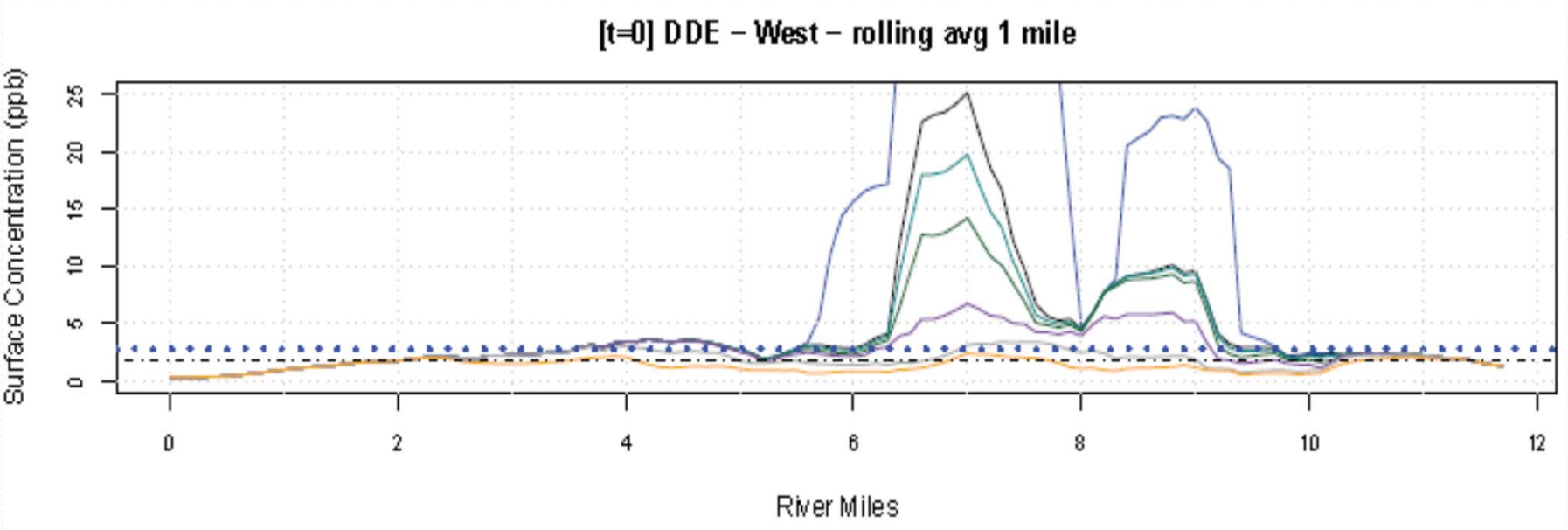


RAO 5 – Benthic Risk Areas (DDE)

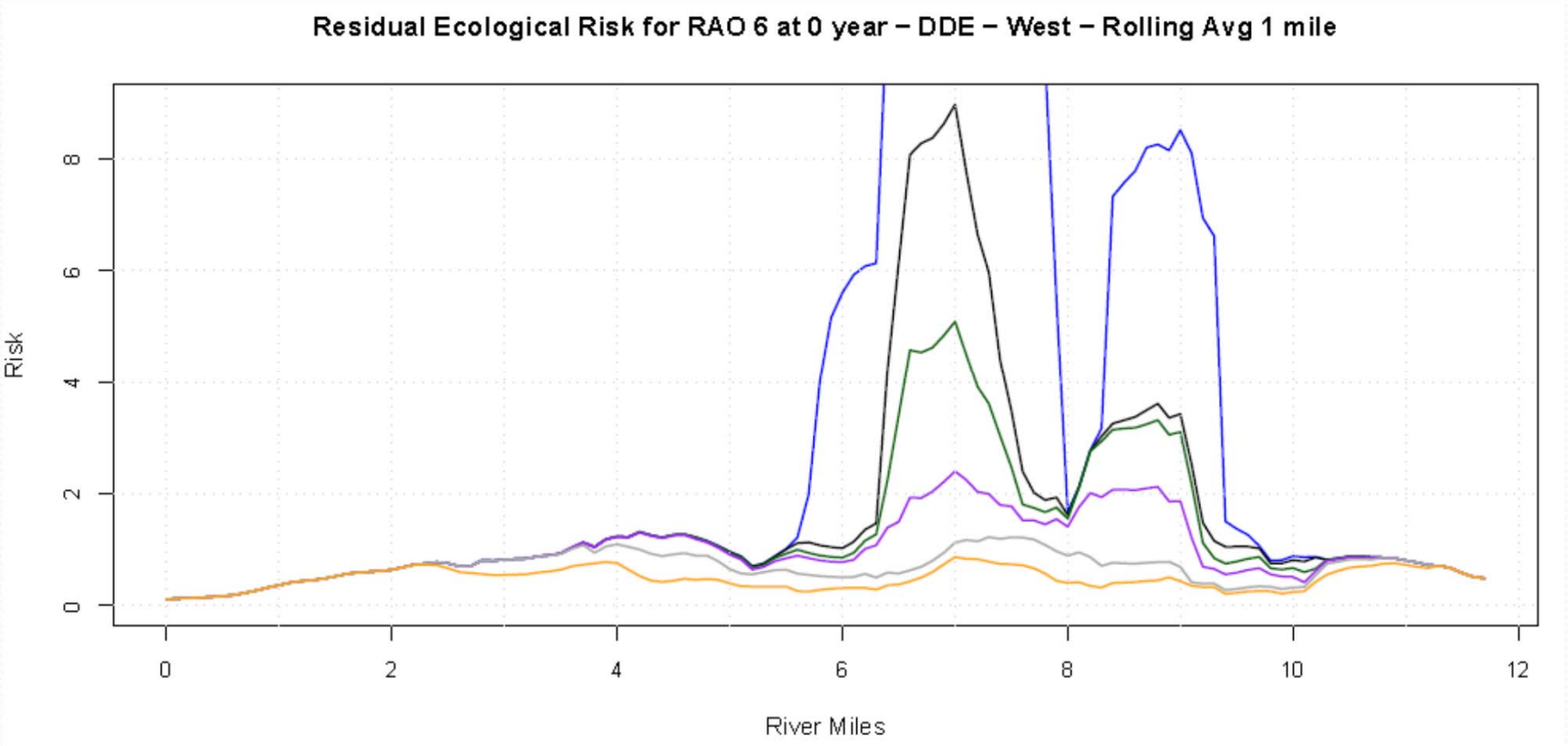


Total DDE Concentrations above Freshwater Sediment SCO for Protection of Benthic Community

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 Dredge/Cap 3 acres; EMNR 103 acres MNR 2,250 acres; In-situ 7 acres Ex-situ 321,120 cy; Disposal 892,000 cy	+	+	○	◔	◔	●	$
D	Dredge 161 acres; Contain 7 acres Dredge/Cap 6 acres; EMNR 88 acres MNR 2,185acres; In-situ 3 acres Ex-situ 395,060 cy; Disposal 1,766,000 cy	+	+	◔	◑	◔	◕	$
E	Dredge 249 acres; Contain 10 acres Dredge/Cap 10 acres; EMNR 60 acres MNR 2,121 acres; In-situ 0 acres Ex-situ 431,560 cy; Disposal 3,100,000 cy	+	+	◑	◕	●	◑	$$
F	Dredge 479 acres; Contain 18 acres Dredge/Cap 17 acres; EMNR 24 acres MNR 1,913 acres; In-situ 0 acres Ex-situ 495,830 cy; Disposal 7,115,000 cy	+	+	◕	●	◕	◔	$$$
G	Dredge 741 acres; Contain 22 acres Dredge/Cap 18 acres; EMNR 15 acres MNR 1,655 acres; In-situ 0 acres Ex-situ 518,010 cy; Disposal 11,722,000 cy	+	+	●	●	◑	○	$$$$

Portland Harbor

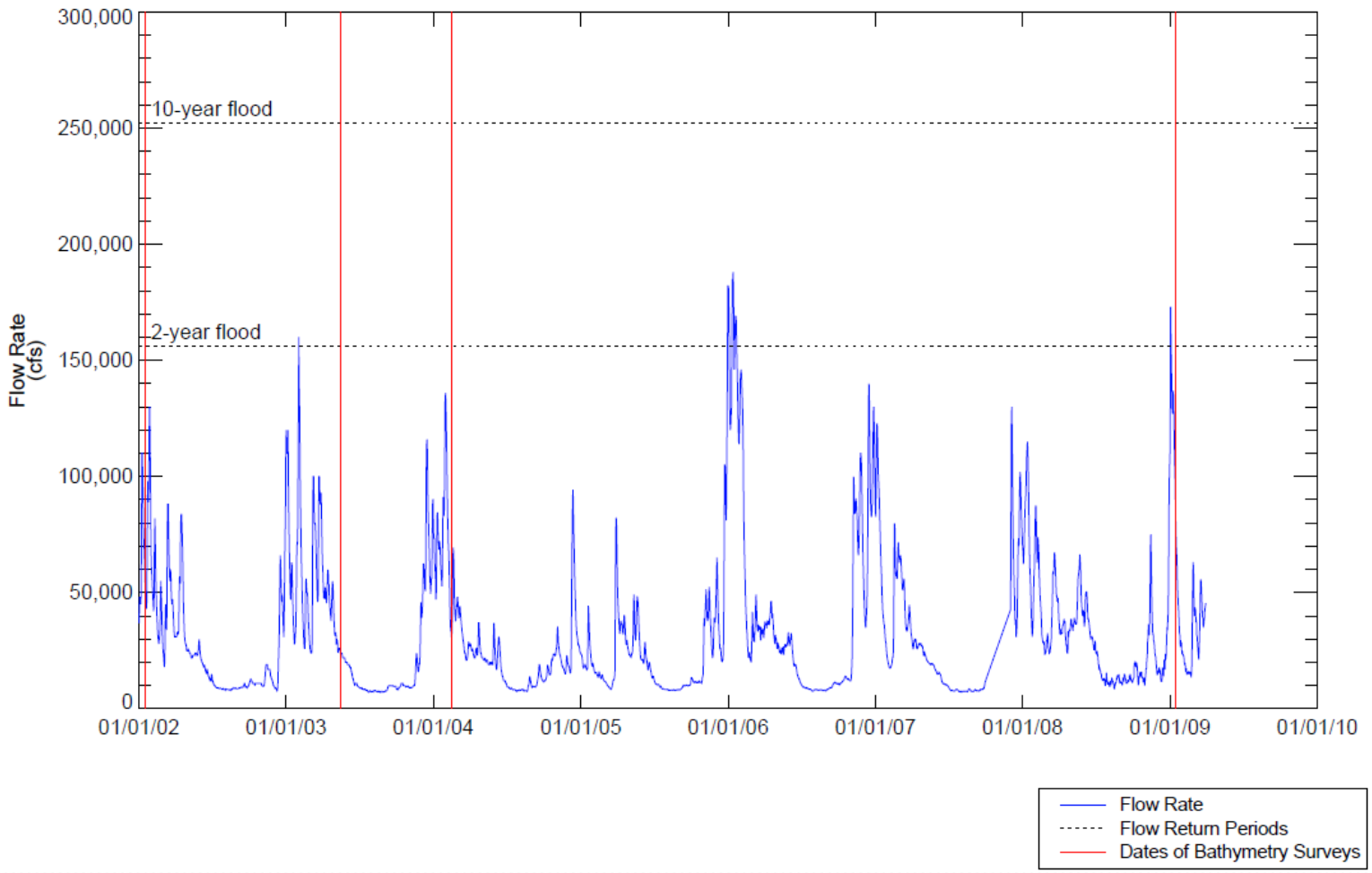
Modeling MNR

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

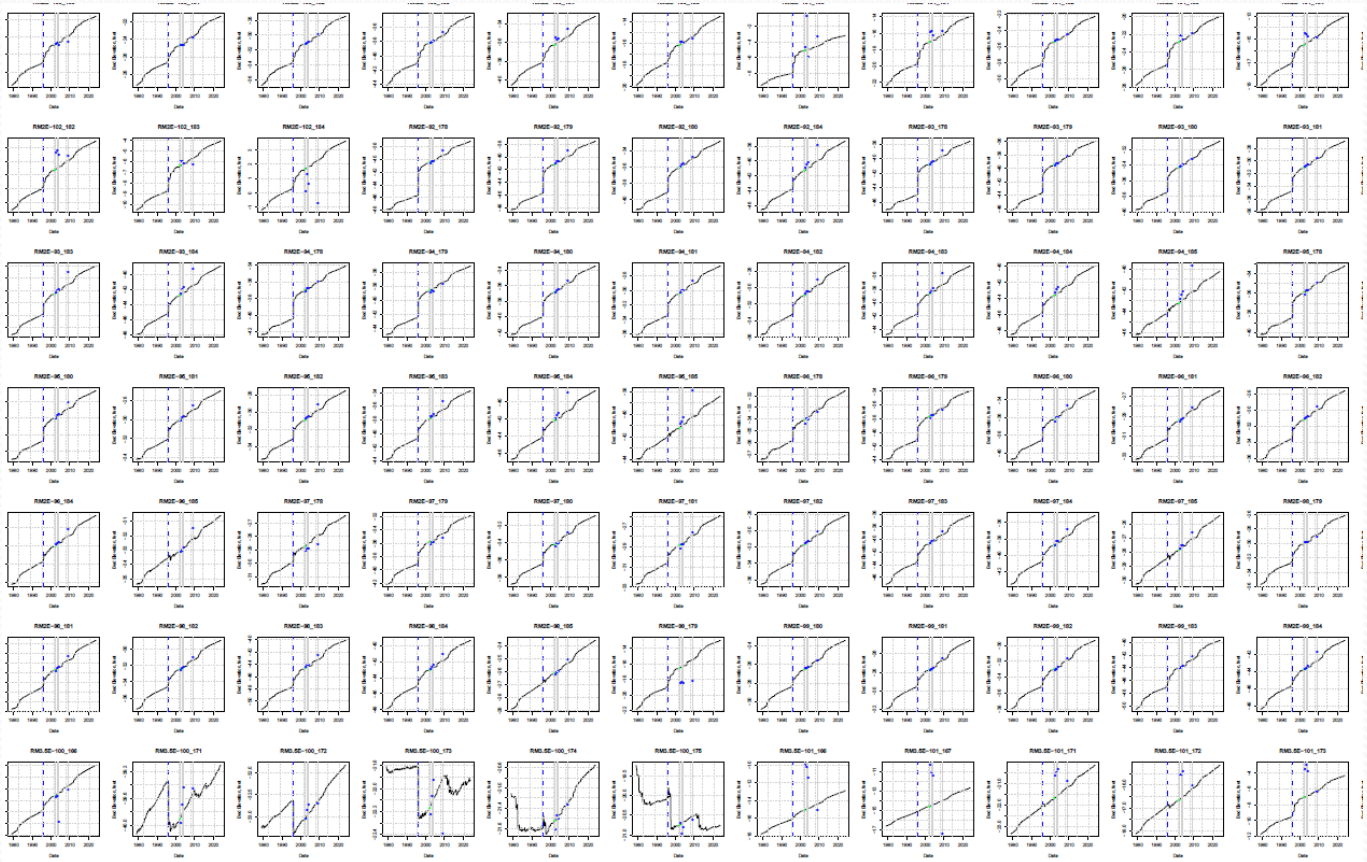
Model Grid Cells Example

Bathymetric Surveys



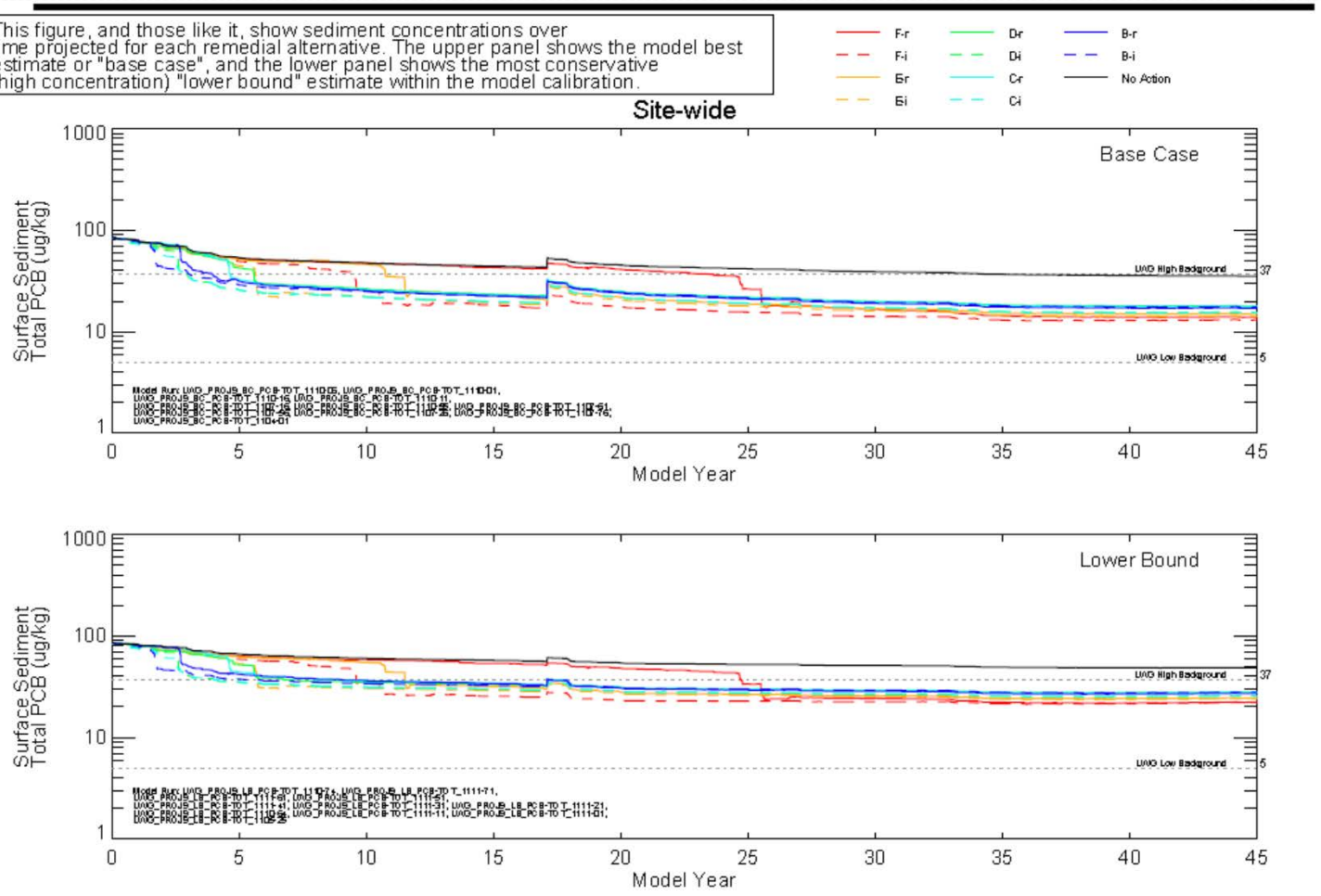
t>0 discussion

- LWG Model performance vs. Bathymetry graphs



Example of LWG Model Prediction

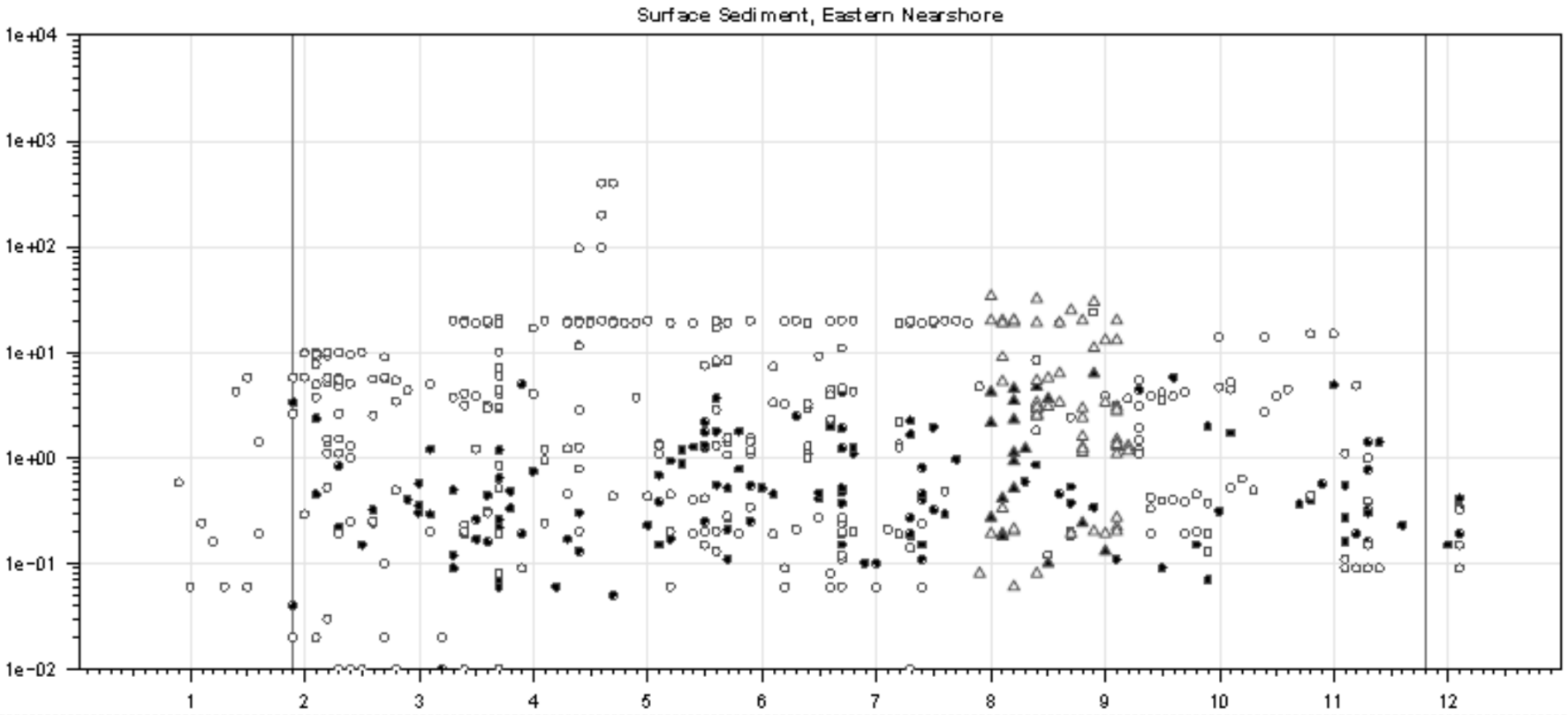
This figure, and those like it, show sediment concentrations over time projected for each remedial alternative. The upper panel shows the model best estimate or "base case", and the lower panel shows the most conservative (high concentration) "lower bound" estimate within the model calibration.



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.

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)

Portland Harbor

High-biasing Non-detects in Data Set

Example of High-biasing ND Hexachlorobenzene