

Development of Sediment Anthropogenic Background for the East Waterway Using Upstream Suspended Sediments

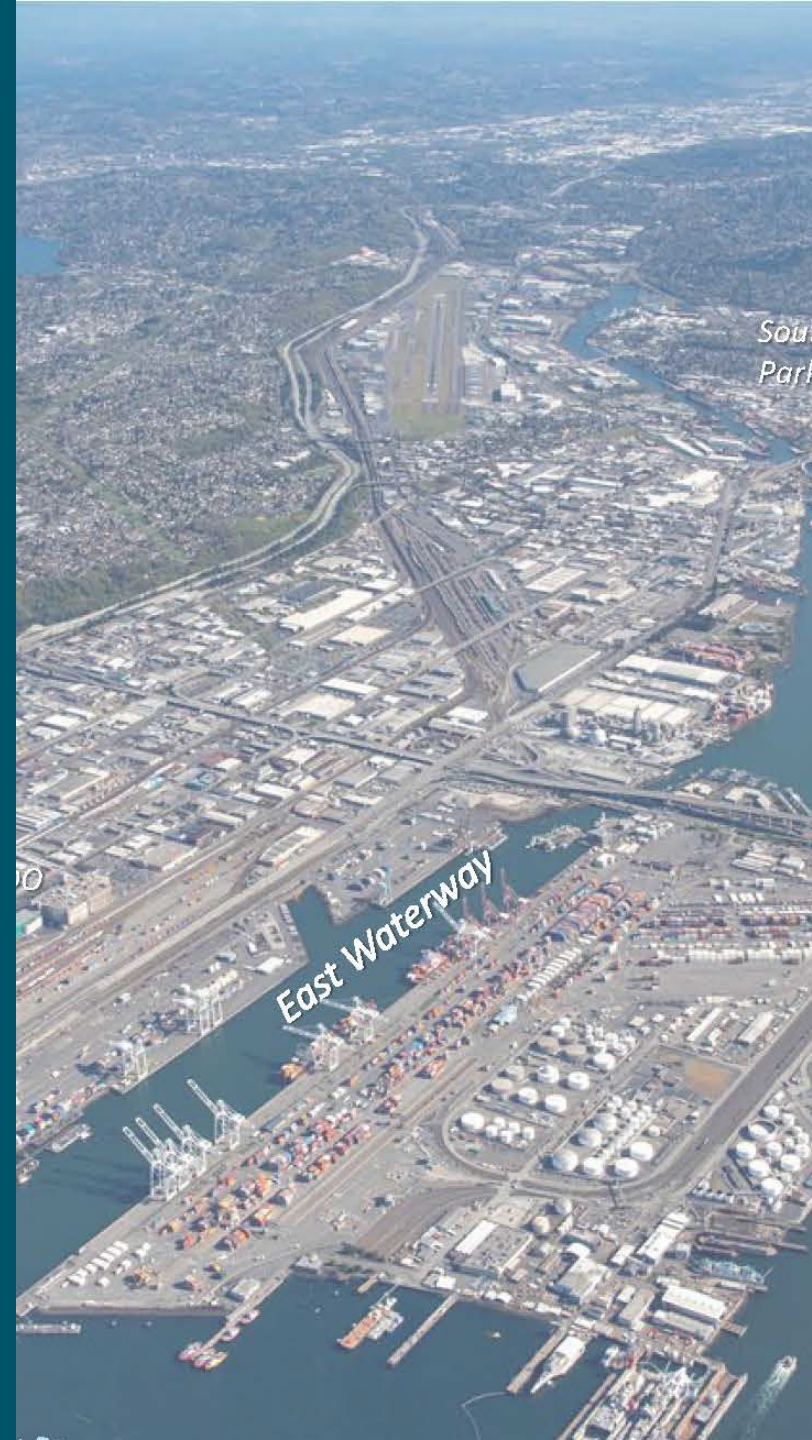
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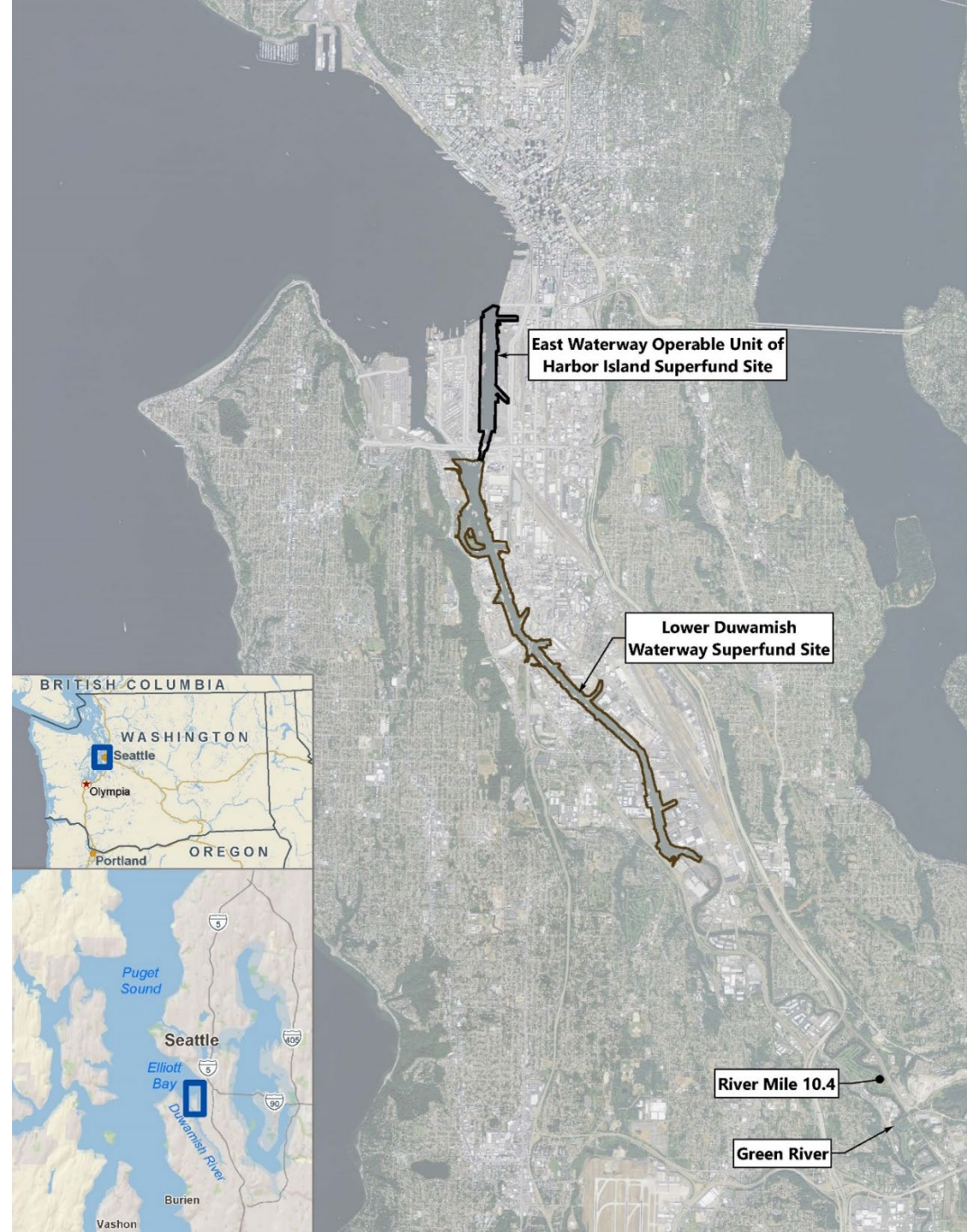
Debra Williston and Jeff Stern, King County;

Pete Rude and Allison Crowley, City of Seattle

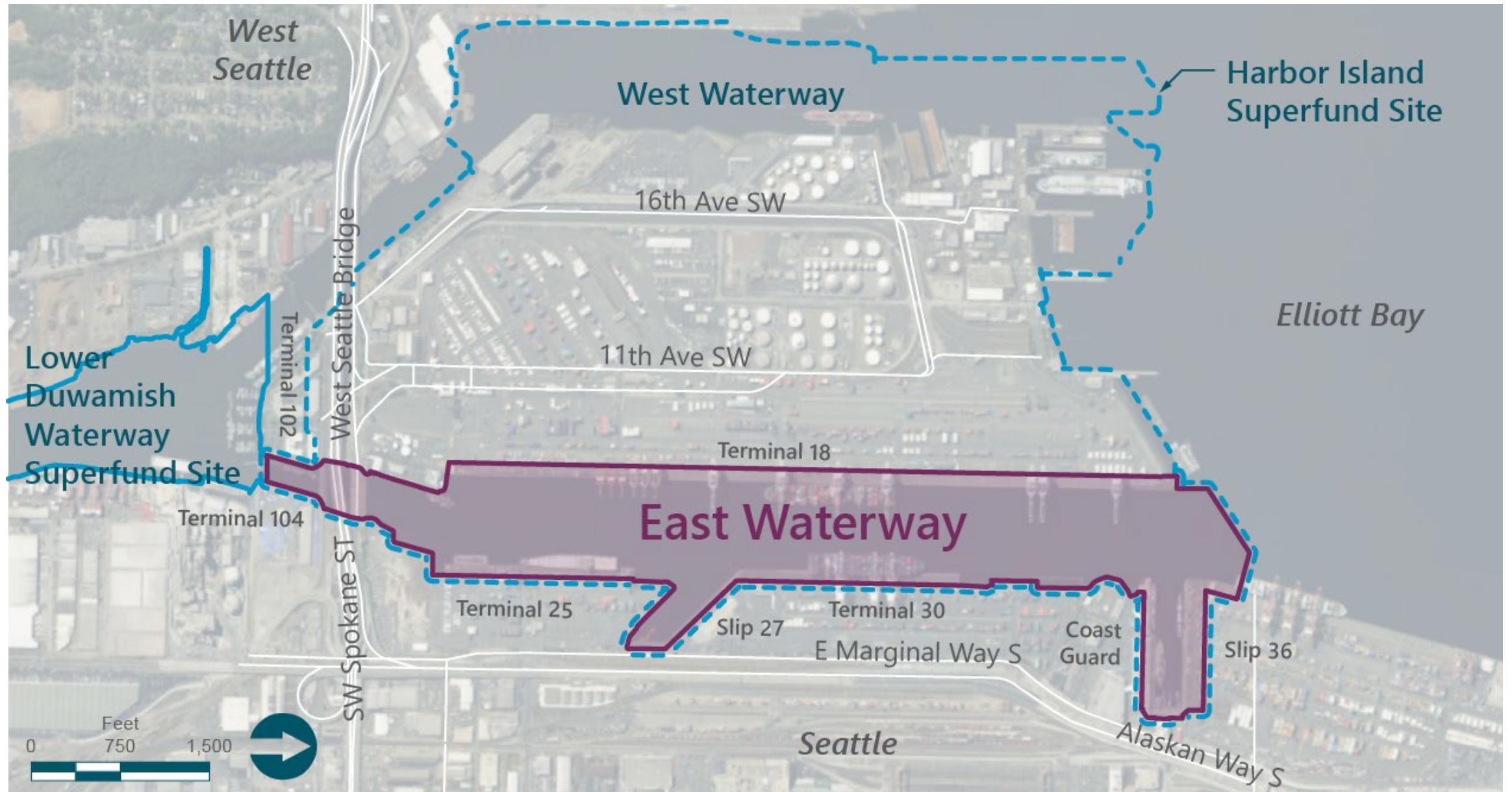


East Waterway Operable Unit (EW)

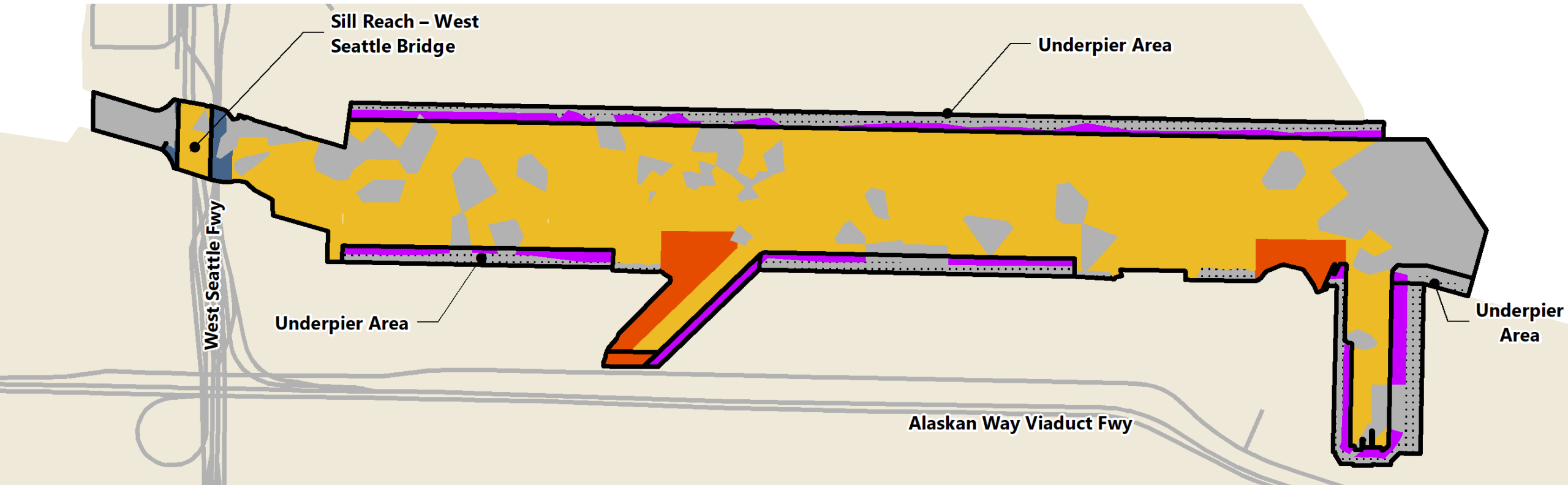
- Located in Seattle, Washington
- 1.5 miles long
- -51 feet mean lower low water
- 157 acres of sediment
- Outlet of Duwamish Waterway and Green River



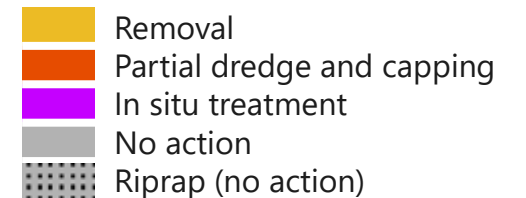
East Waterway Operable Unit of Harbor Island Superfund Site



Example Remedial Alternative



- 121 to 132 acres of active cleanup
- Dredging 810,000 to 1,080,000 cubic yards
- Remedial action levels developed to achieve natural background



Feasibility Study Predictions

- Natural background PRGs are unattainable due to the urban setting and sediment inputs from upstream of the LDW
- Accumulating sediment concentrations not related to EW site sources are higher than natural background
 - Green River suspended sediments
 - General urban runoff



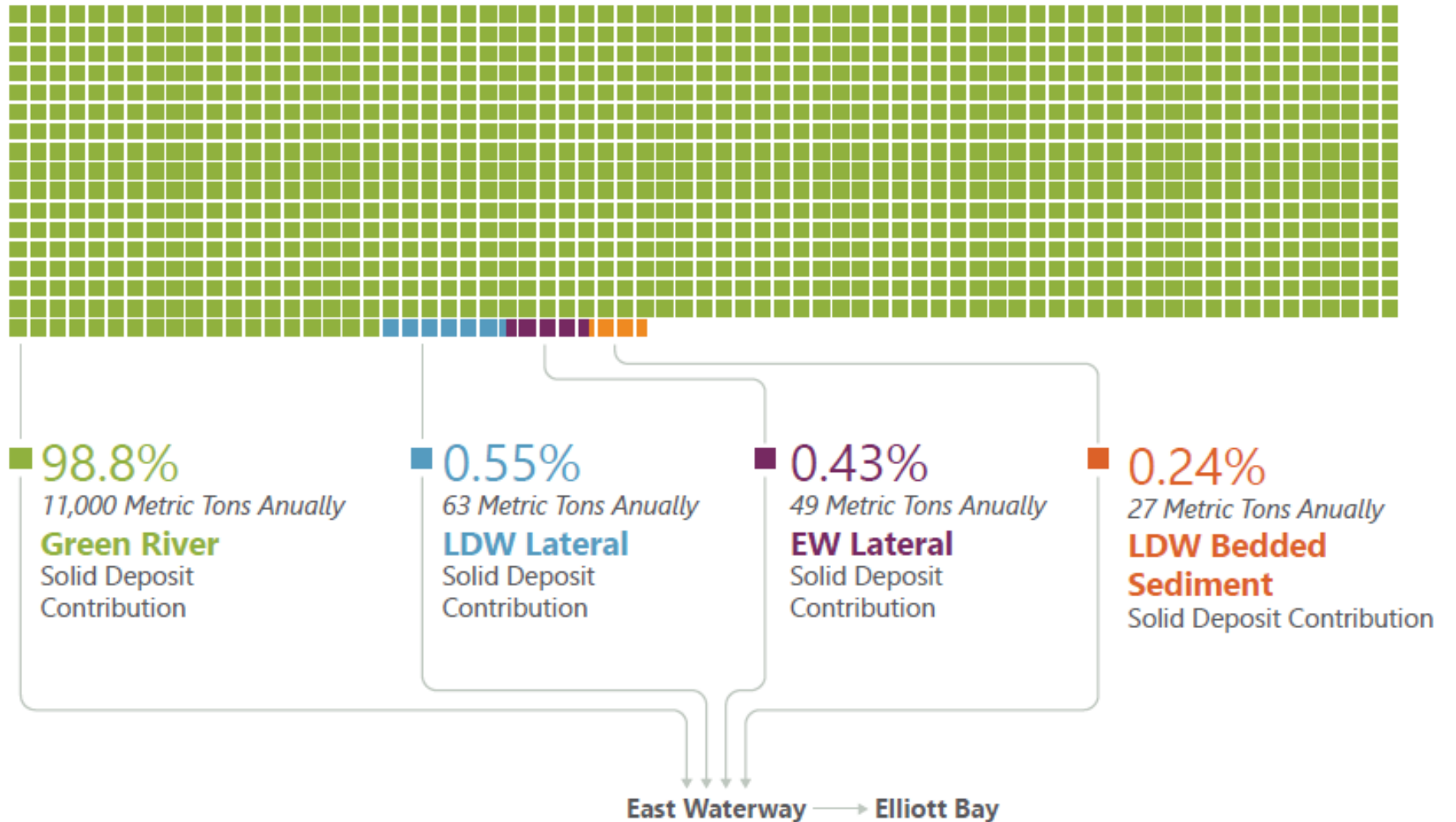
Estimating Anthropogenic Background (AB)

- Anthropogenic background: “Natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question)” (EPA 1989)
- EPA and East Waterway Group Working Group
 - Assemble and evaluate existing data
 - If sufficient data, develop AB estimates for PCBs, dioxins/furans, and arsenic

Annual Solids Inputs to the East Waterway

Total Deposits in East Waterway (11,112 Metric Tons Annually)

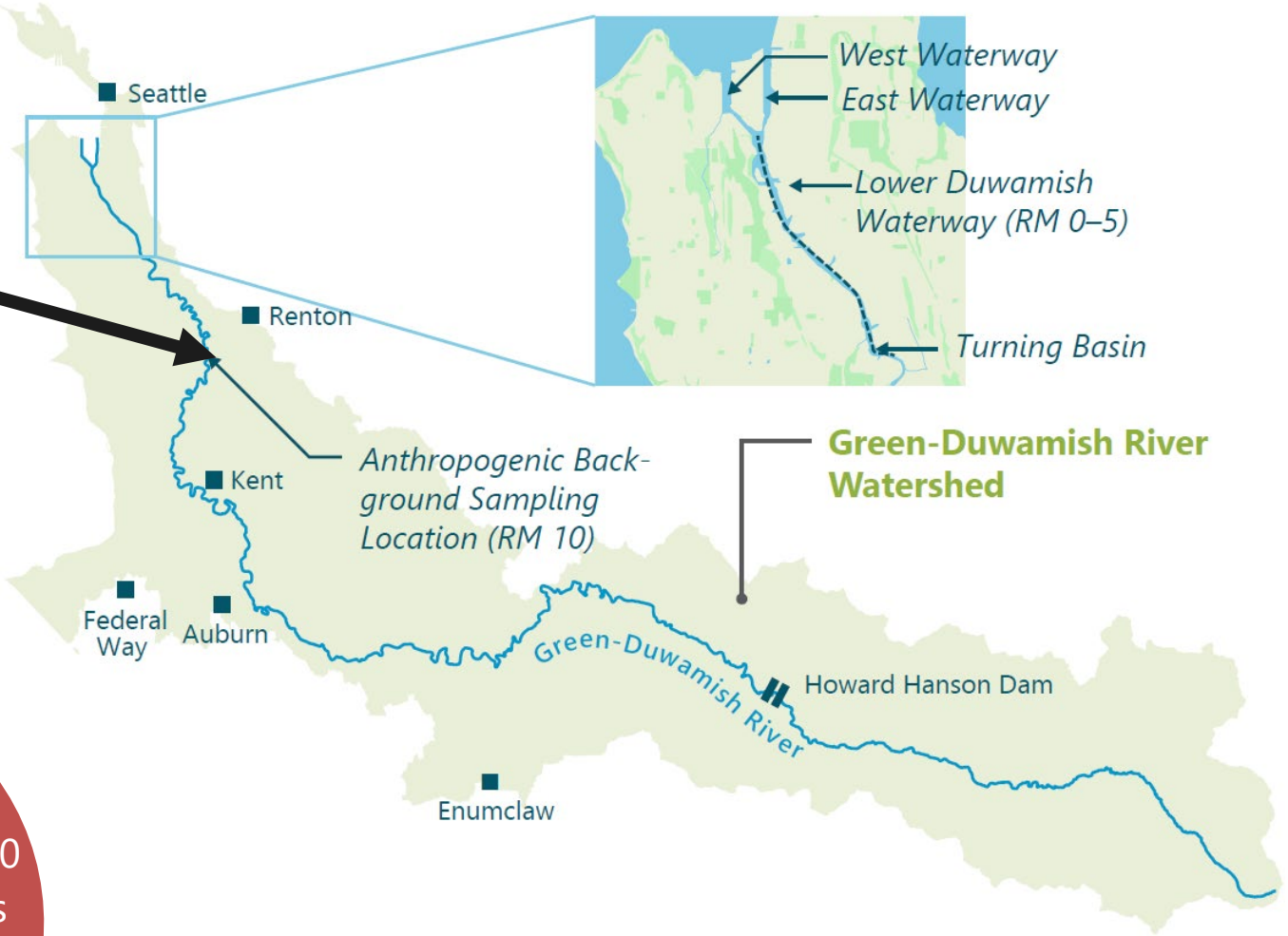
■ Each block represents 10 metric tons



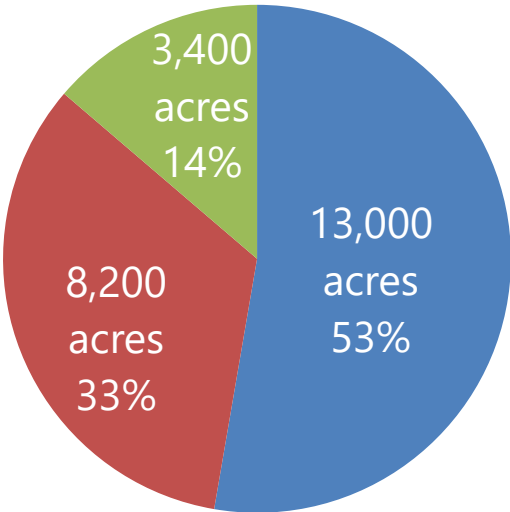
Notes:

Based on FS Table J-1

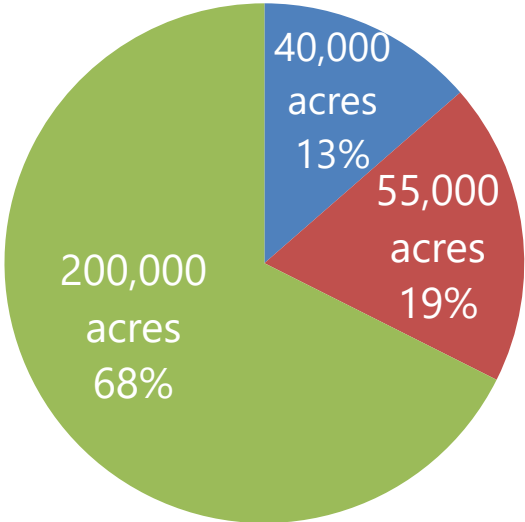
Green River Sampling Location



**Land Use
Downstream of RM 10**



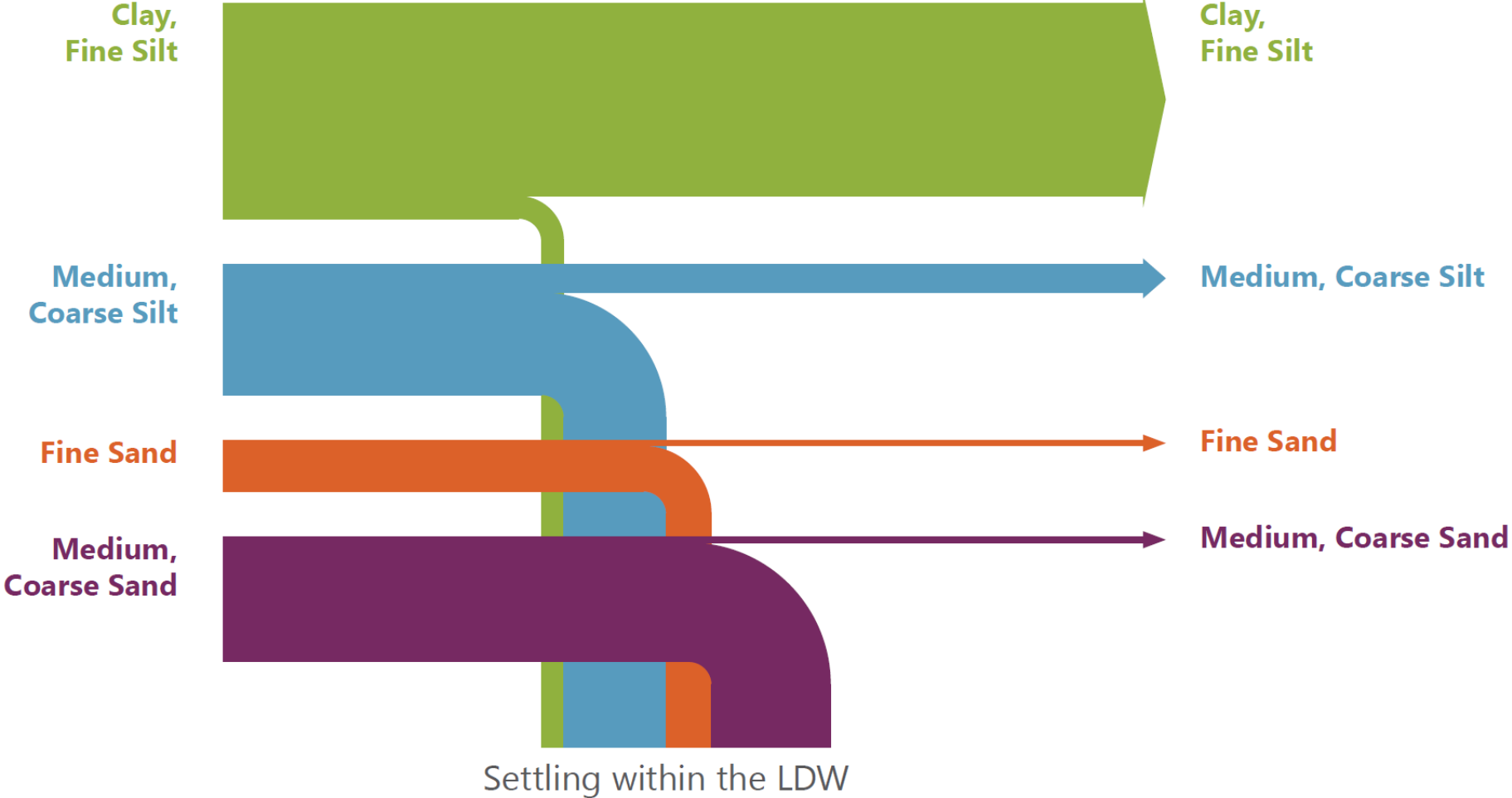
**Land Use
Upstream of RM 10**



- Natural resources, park, agriculture, and open space
- Residential areas and schools
- Commercial and industrial areas and Rights of Way

Green and Duwamish River Sediment Transport

Exiting the Green River → Transport and Settling within the LDW → Exiting the LDW (Entering the East and West Waterways)



Suspended Solids Sampling Methods

- 44 samples by centrifugation (included)
- 12 samples by filtration (included)
- 9 samples by baffle- or jar-style sediment trap (excluded)



Centrifuge



Filter solids



Baffle-style trap



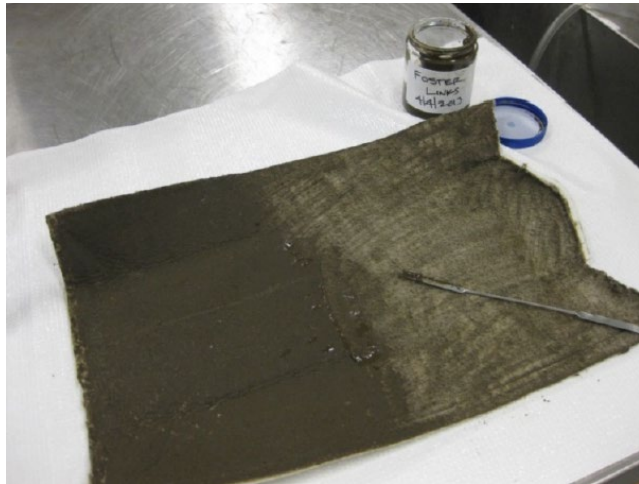
Jar-style trap

Suspended Solids Sampling Methods

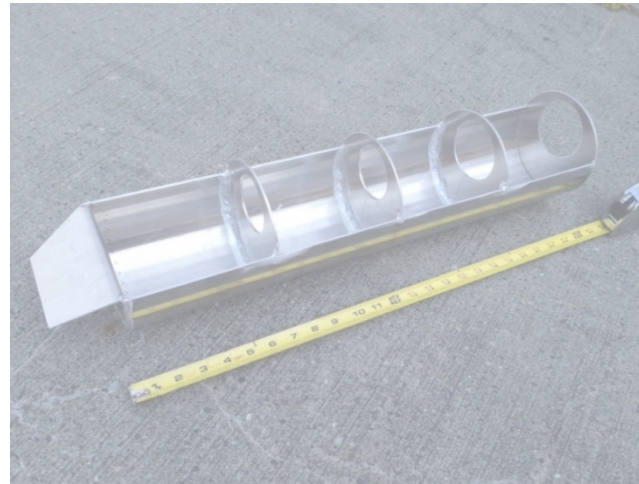
- 44 samples by centrifugation (included)
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Centrifuge



Filter solids



Baffle-style trap



Jar-style trap

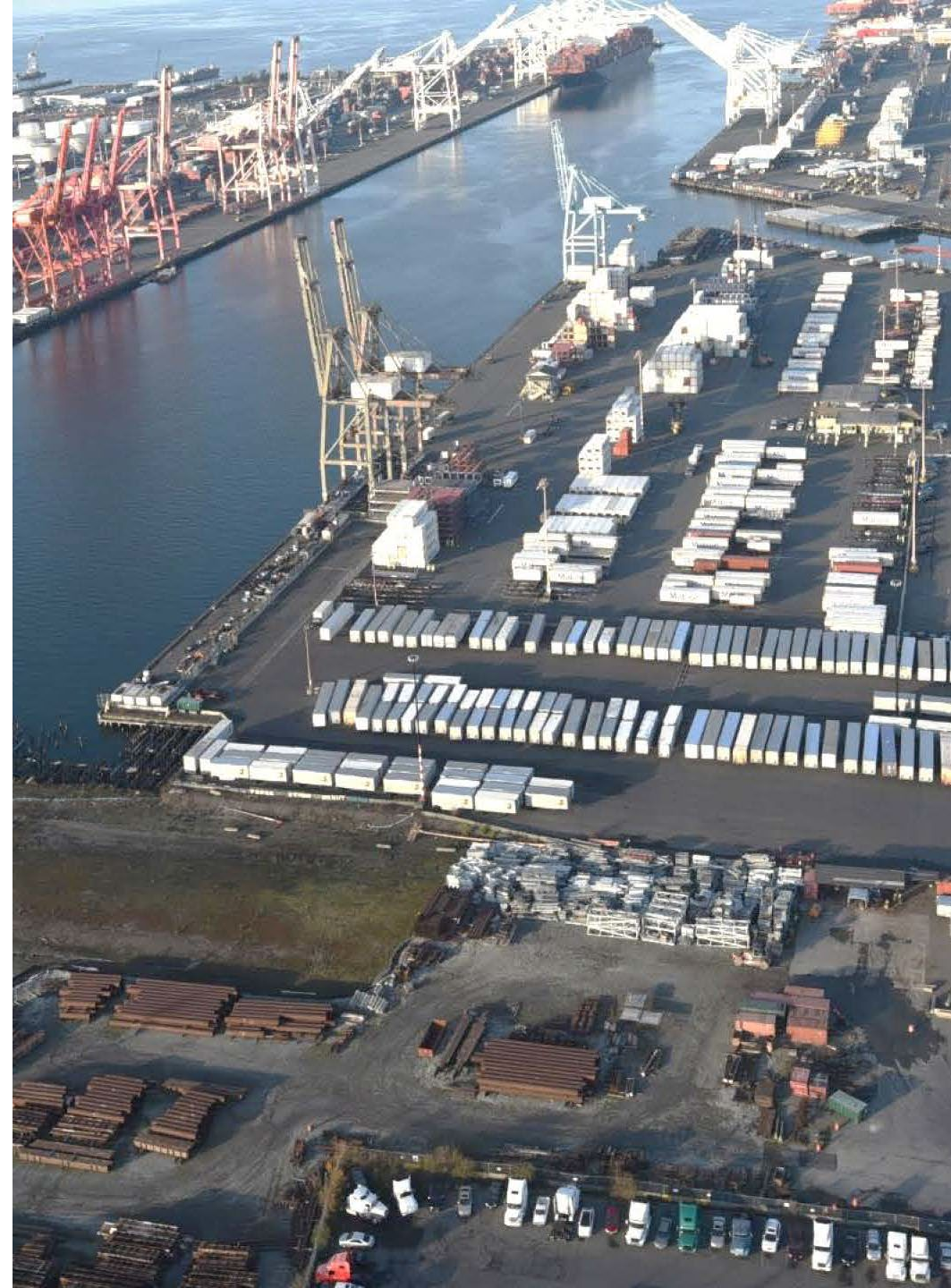
PCBs

- 37 centrifuge and 12 filter solids samples (2013 to 2017)
- 49 congener samples and 7 Aroclor samples
- Decision: exclude PCB Aroclors
- 4 Non-detect treatments evaluated: not sensitive

Data Subset	Total PCBs ($\mu\text{g}/\text{kg}$)			
	Count	Mean	Median	90th Pctl
Congeners	49	17	8.8	46
Aroclors (Ecology Samples)	7	14	7.5	32
Congeners + Ecology Aroclor Samples	56	17	8.6	48
All Aroclor Samples	24	18	13	45

Dioxins/Furans

- 44 centrifuge and 10 filter samples (2013 to 2017)
- EPA prefers congener-specific AB values
- 4 congeners were primary contributors to risk from seafood consumption (86%)
 - 2,3,7,8-TCDD
 - 2,3,7,8-TCDF
 - 1,2,3,7,8-PeCDD
 - 2,3,4,7,8-PeCDF
- TEQ also presented to support risk communication



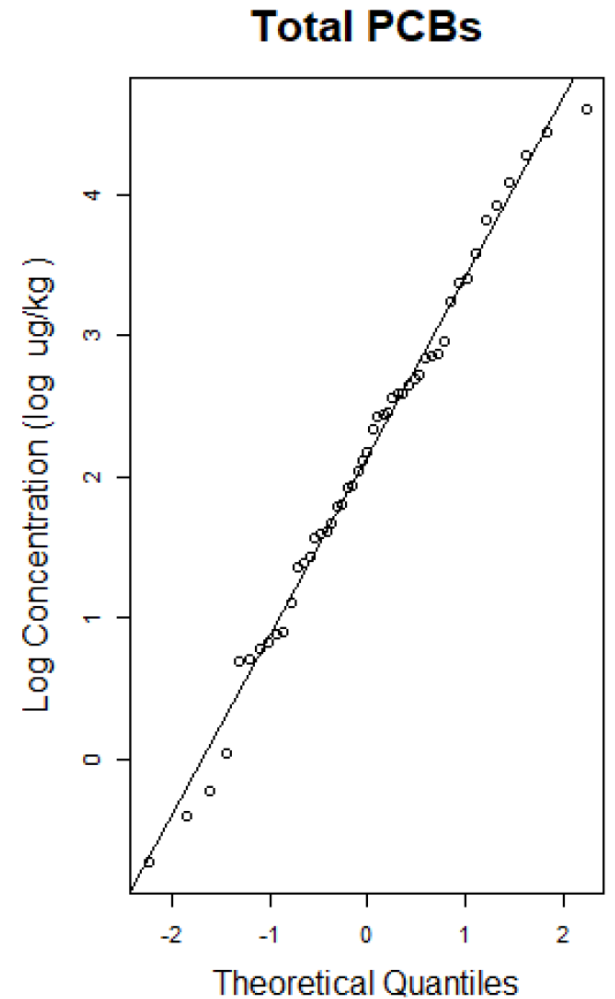
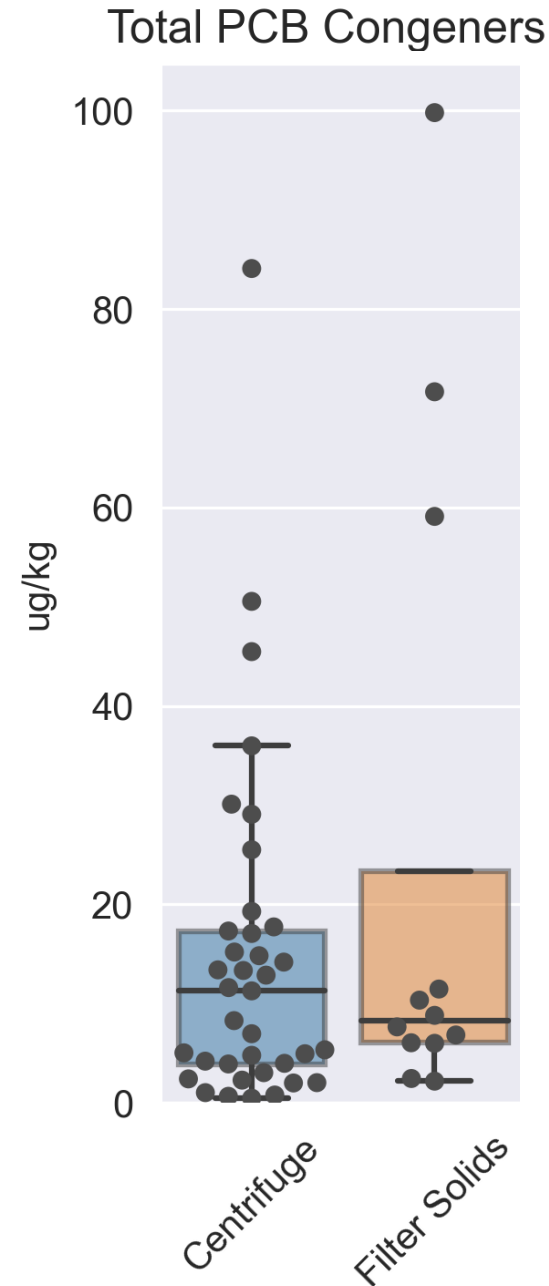
Arsenic

- 46 centrifuge and 12 filter solids samples (2013 to 2017)
- Average bedded sediment concentrations in EW are lower than Green River suspended solids concentrations
- Biogeochemical reactions can result in the release of arsenic from anaerobic sediment following deposition
- Green River arsenic concentrations are influenced by natural geogenic sources
- Arsenic AB based on suspended solids but acknowledge a high bias in AB value

Location	Mean	N	Sample Year Range
Green River Suspended Solids	17.2	52	2008–2017
East Waterway Sediments	11.0	239	1995–2009

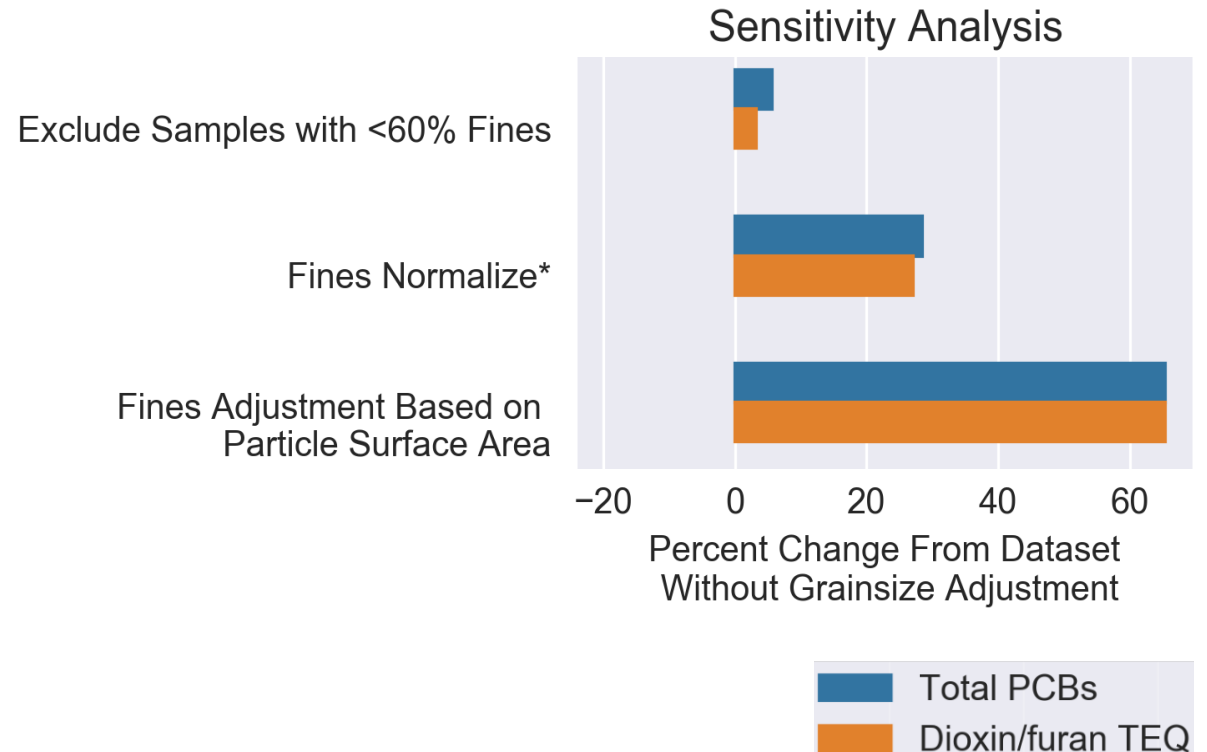
Outliers

- The suspended solids dataset was analyzed for potential outliers
- Concentrations fit a log-normal distribution (including highest)
- Highest concentrations were consistent with the Green River conceptual site model (river flow and precipitation conditions)
- No outliers were identified; all data were retained



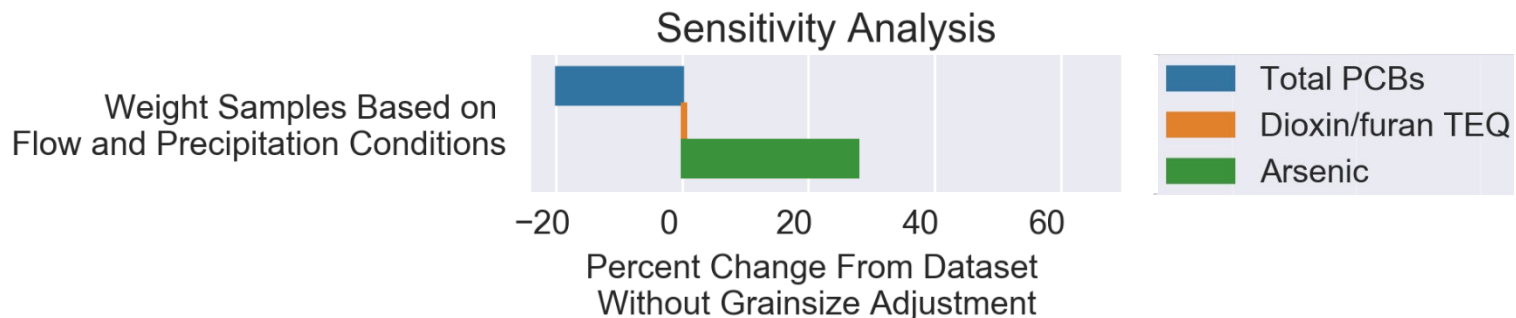
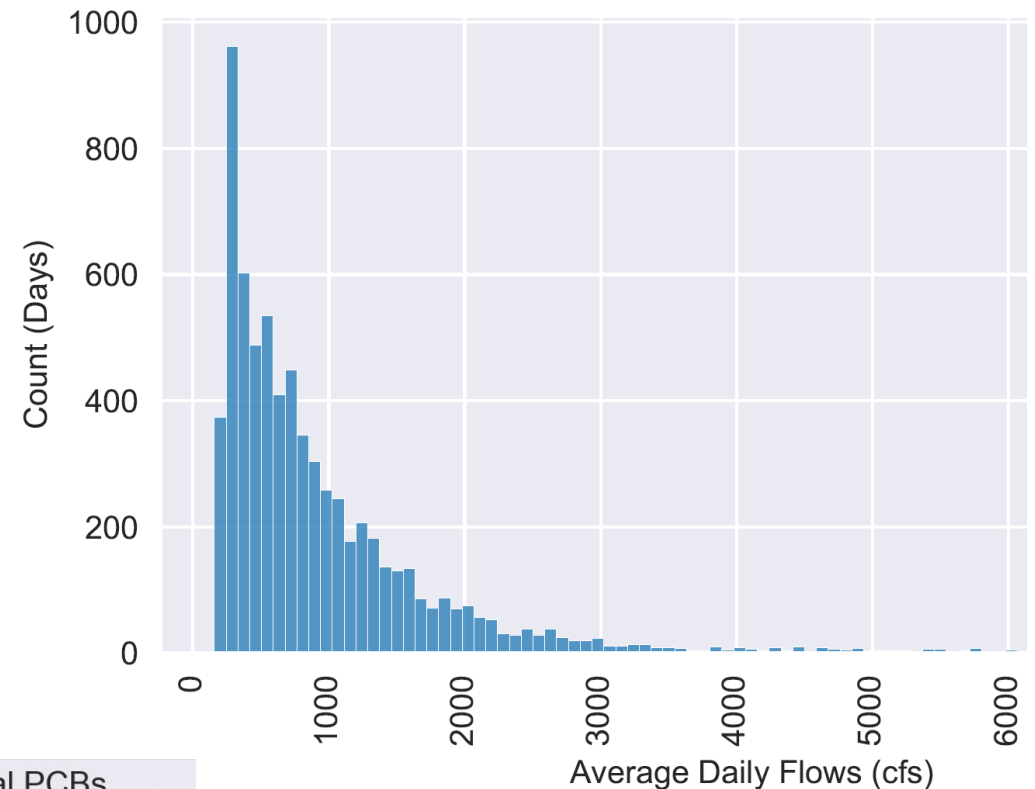
Grain Size Adjustments for Organics

- Organic contaminant concentrations correlate to grain size, consistent with Green River bedded sediment data
- Green River suspended solids have a higher percentage of sand compared to fine-grained sediment entering EW (low bias)
- Fines normalization selected for organic contaminants

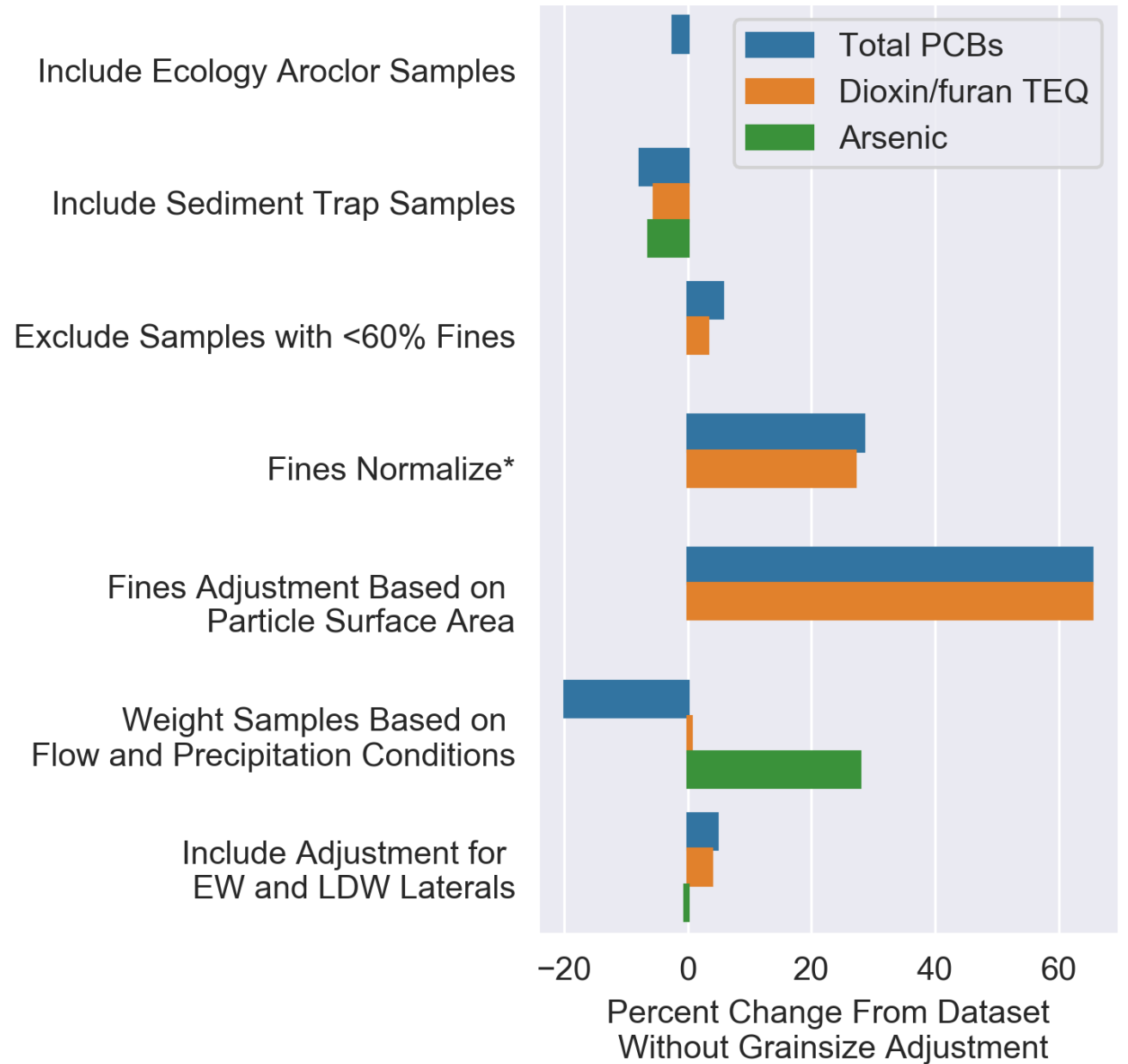


River Flow and Precipitation Weighting

- Suspended solids concentrations vary with river flow and precipitation conditions
- Flow and precipitation weighting explored to adjust for different river conditions
- Weighting not selected



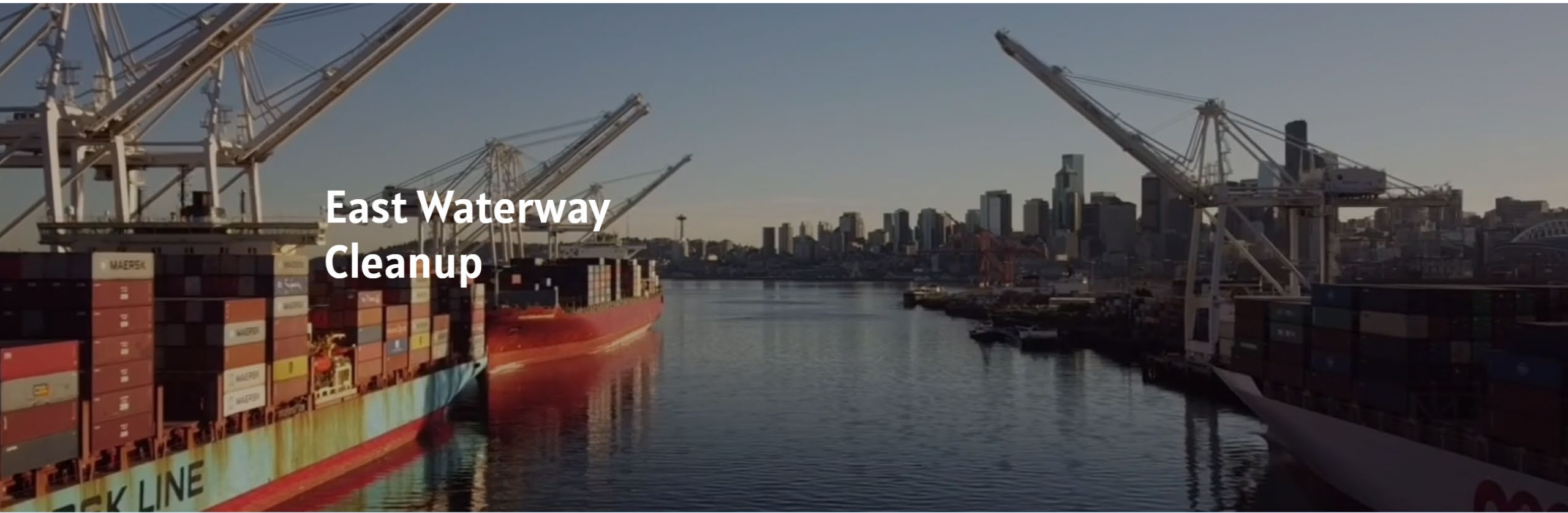
Sensitivity Analysis



EPA-Approved Anthropogenic Background Values for East Waterway

Chemical	Unit	Detect	Mean	95% Upper Confidence Limit
Total PCBs	µg/kg	49/49	22	31
Arsenic	mg/kg	52/52	17	20
1,2,3,7,8-PeCDD	ng/kg	46/54	1.7	2.1
2,3,4,7,8-PeCDF	ng/kg	45/54	0.9	1.1
2,3,7,8-TCDD	ng/kg	42/54	0.58	0.71
2,3,7,8-TCDF	ng/kg	46/54	0.91	1.2
Dioxins/Furans Toxic Equivalent (TEQ)	ng/kg	54/54	7.8	9.6

<https://eastwaterway.org>



East Waterway Cleanup

The East Waterway, located in Seattle, WA, is one of the most active commercial waterways in the Pacific Northwest, supporting shipping and water-based industries. Most vessel traffic consists of shipping container vessels and tugboats.

THANK YOU



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REFERENCES

Anchor QEA (Anchor QEA, LLC), 2019. *East Waterway Operable Unit Feasibility Study Technical Memorandum: Final Anthropogenic Background Evaluation*. July 2021. (Slide 7)

Anchor QEA, LLC, 2021. *East Waterway Operable Unit Supplemental Remedial Investigation/Feasibility Study Technical Memorandum: Final Anthropogenic Background Evaluation*. July 2021. (Slide 19)

EPA (U.S. Environmental Protection Agency), 1989. *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)*. Interim Final Report. EPA/540/1-89/002. December 1989. (Slide 6)

QEA (Quantitative Environmental Analysis, LLC), 2008. *Lower Duwamish Waterway Sediment Transport Modeling (STM) Report*. Final Report. Prepared for U.S. Environmental Protection Agency, Region 10, and the Washington State Department of Ecology. October 2008. (Slide 9)