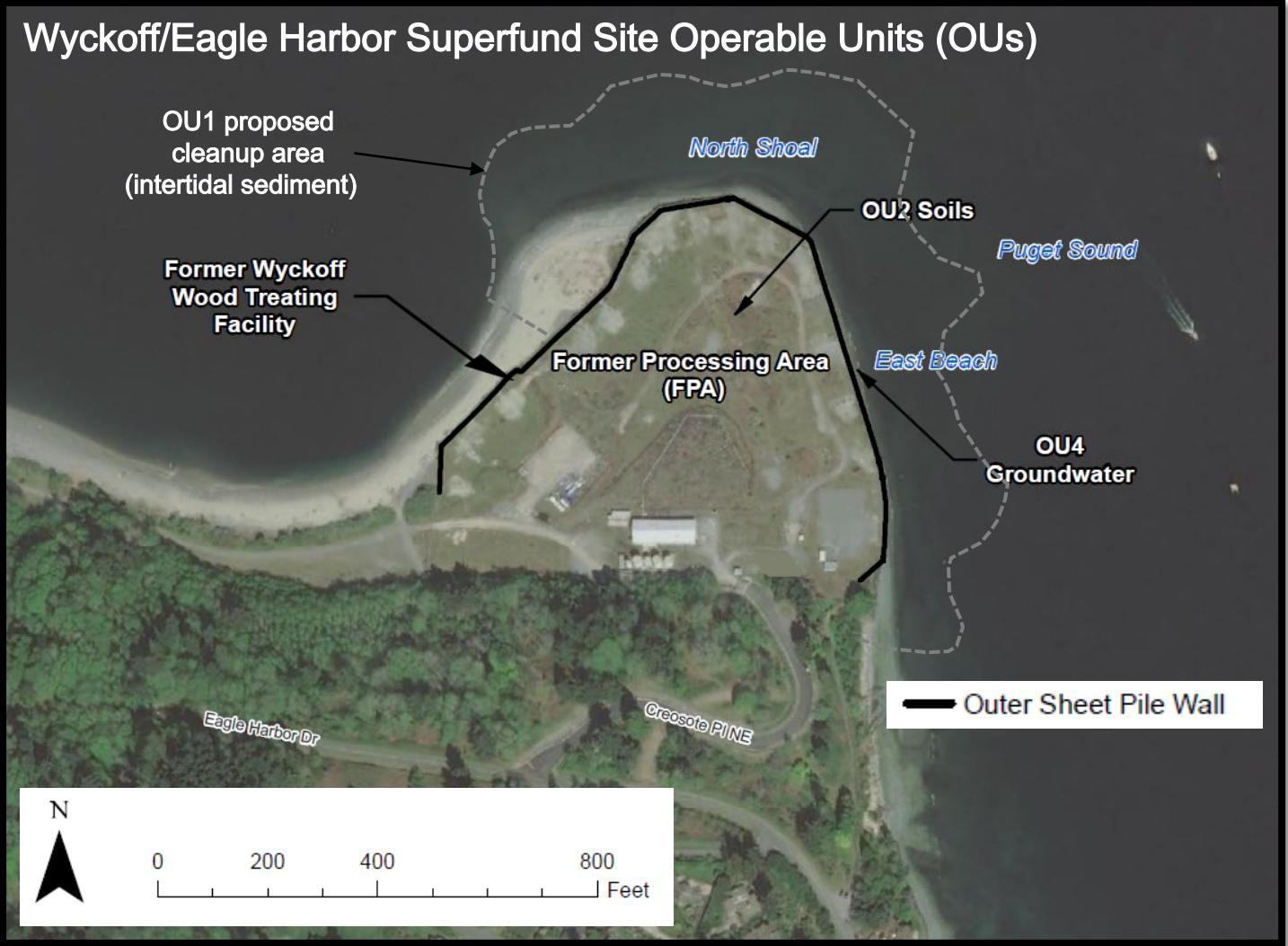
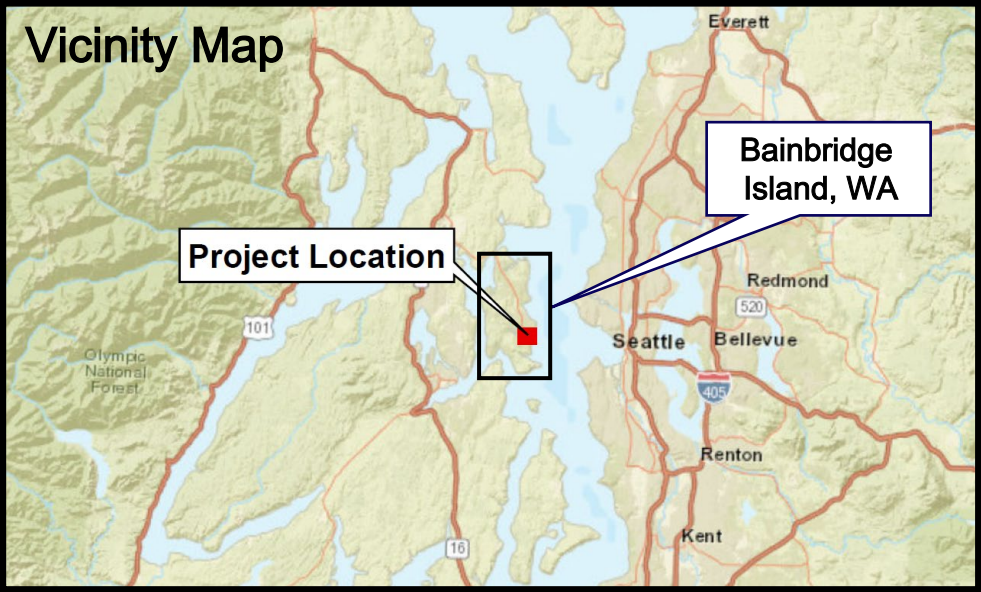


Quantifying Specific Discharge and Dissolved-Phased PAH Mass Flux Using Sediment Bed Passive Flux Meters to Optimize Sediment Cap Design for Intertidal Sediments

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***Sediment Management Work Group (SMWG)
Fall Sponsor Forum (Philadelphia, PA)
October 21, 2025***

Wyckoff/Eagle Harbor Superfund Site



Sediment Cap Predesign Investigation

■ Study Area:

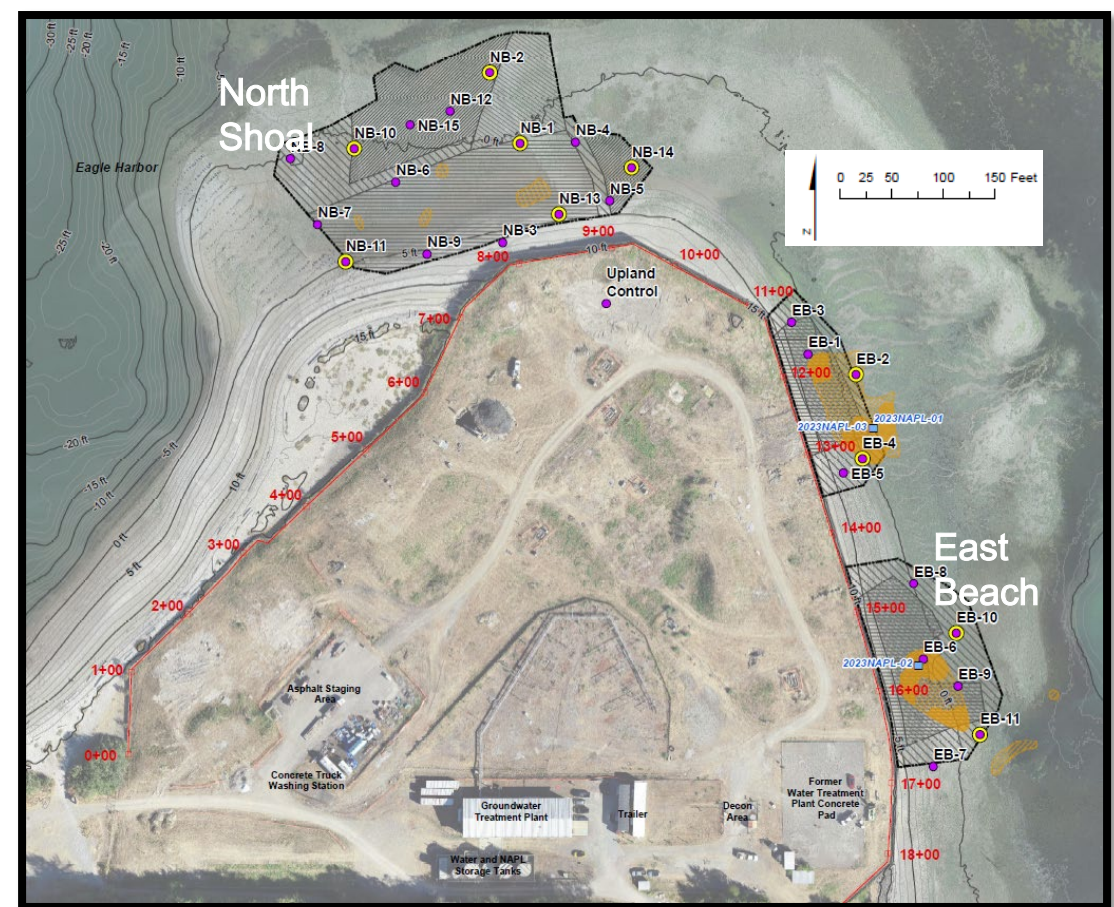
- East Beach and North Shoal (intertidal sediment)
- Migration of non-aqueous phase liquid (NAPL)
- Dredging and capping selected as remedy for NAPL
- Previous GW flow modeling predicted areas of discharge and range of specific discharges
- Existing but limited passive sample pore water dissolved-phase PAH data suggested non-issue?

■ Objectives:

- Determine if dissolved-phase PAH discharges also need to be treated by sediment cap
- Obtain inputs for dissolved contaminant transport modeling for cap design

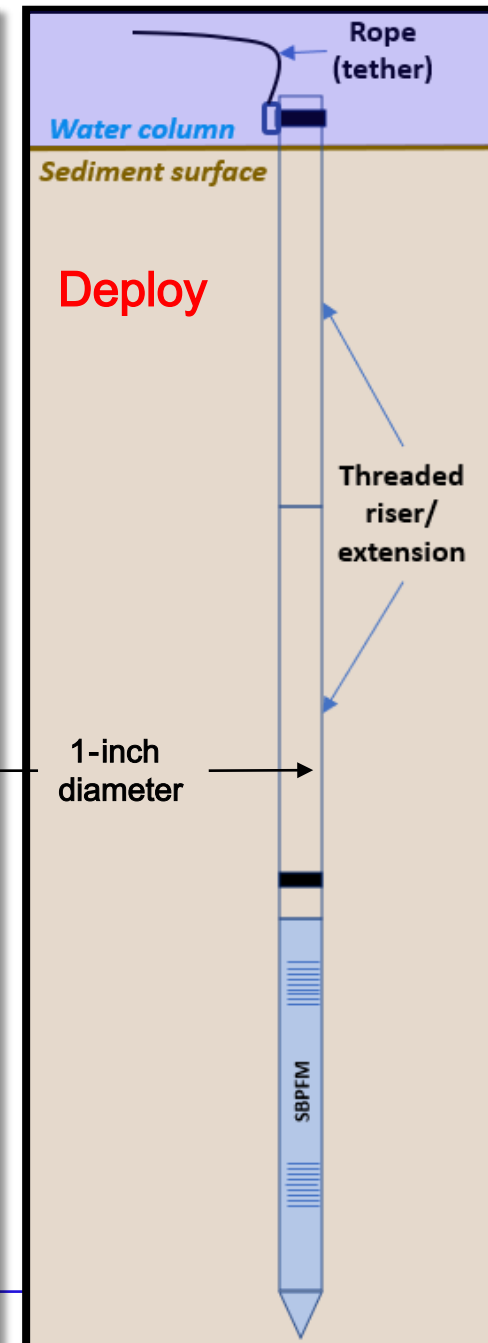
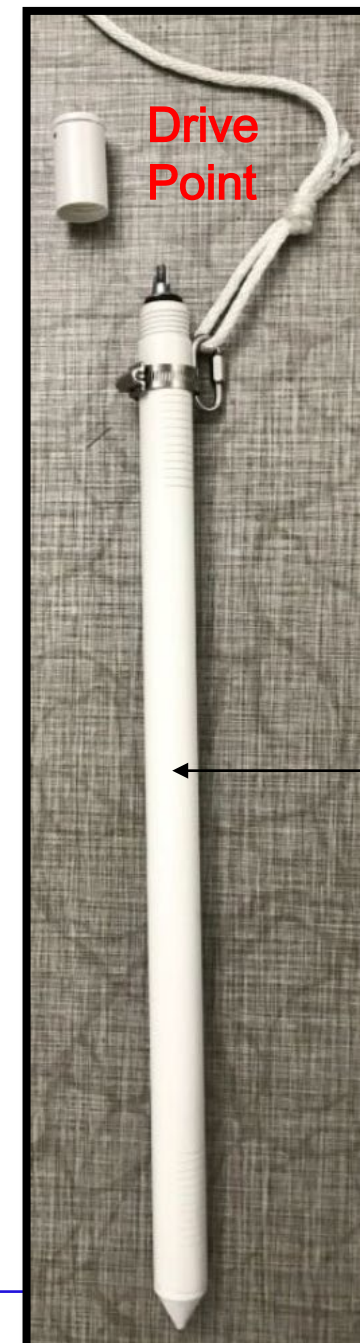
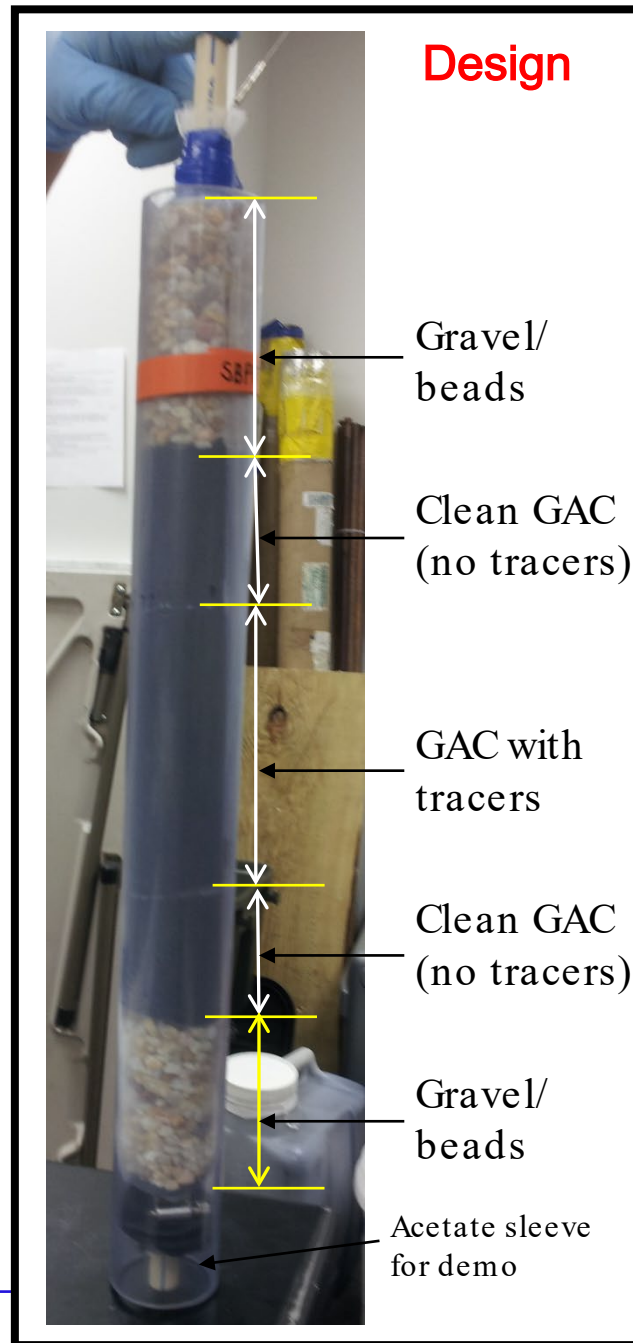
■ Approach:

- Deploy sediment bed passive flux meters (SBPFMs) within the groundwater-surface water transition zone at the base of the proposed cap (subsurface sediment)
- Confirm dissolved-phase PAH discharges
- Quantify dissolved-phased PAH concentrations and rates of discharge

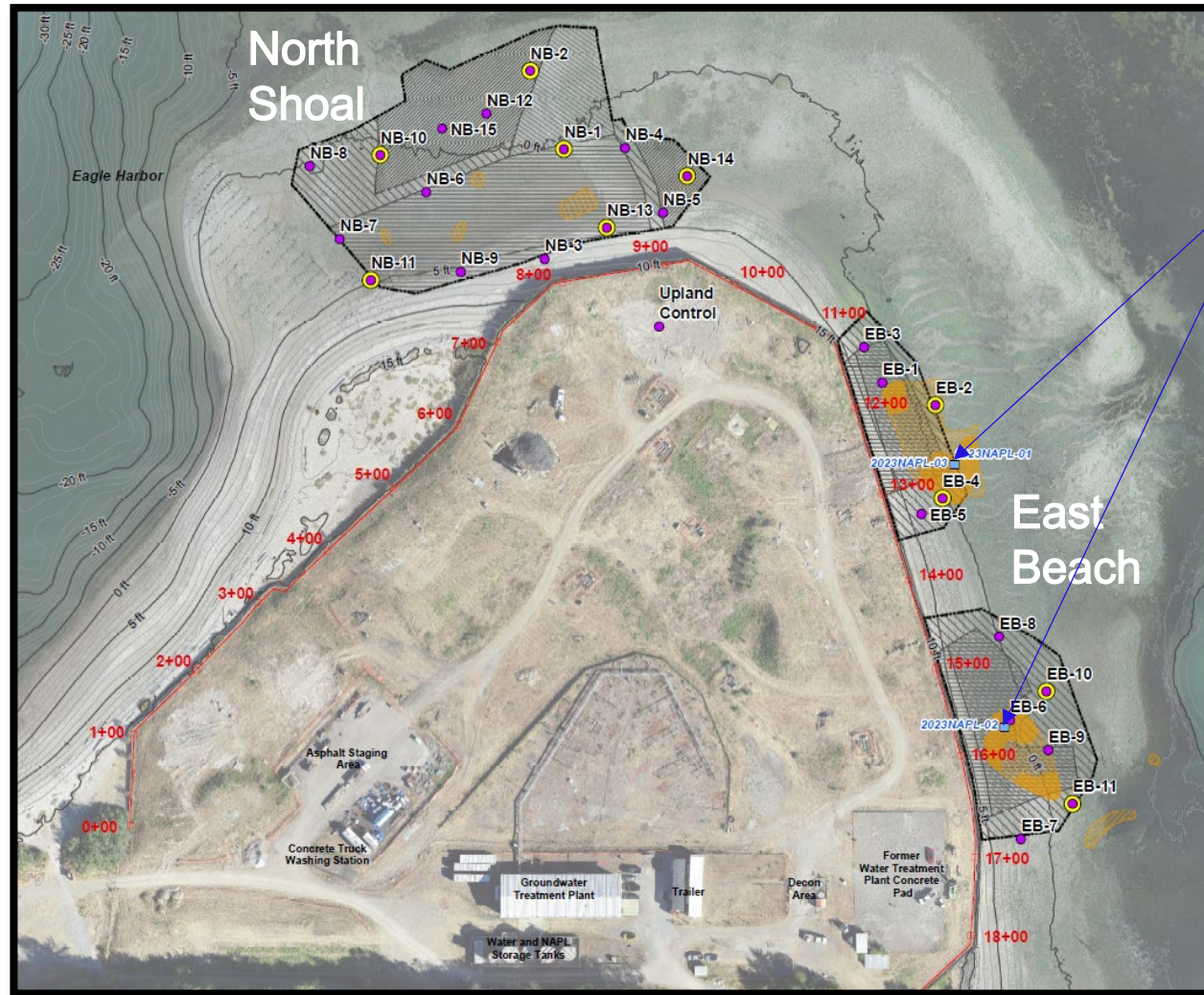


SBPFM Description

- Self-contained permeable unit
- Added to drive points
- Intercepts vertical GW flow (transition zone) through screens – up or down
- Internal function:
 - Matrix of permeable sorbents
 - Retains dissolved contaminants
 - Known amounts of soluble resident tracers (leach at rates proportional to water flux)
- Sampling and analyses:
 - Quantification of specific discharge
 - Mass flux of contaminant
 - Time-weighted average (2 weeks)
 - Correction for location-specific natural hydraulic conductivity (K-value)

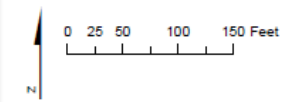


Sediment Cap Predesign Investigation Study Area

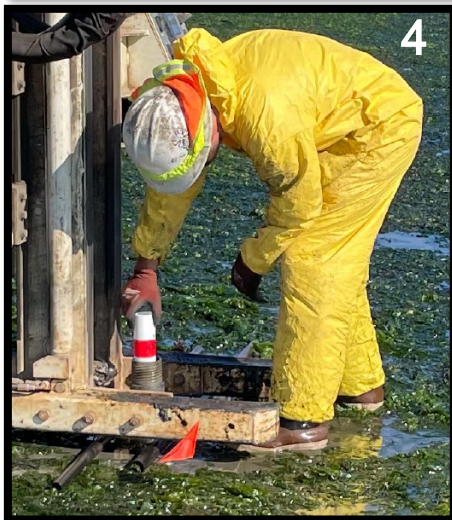
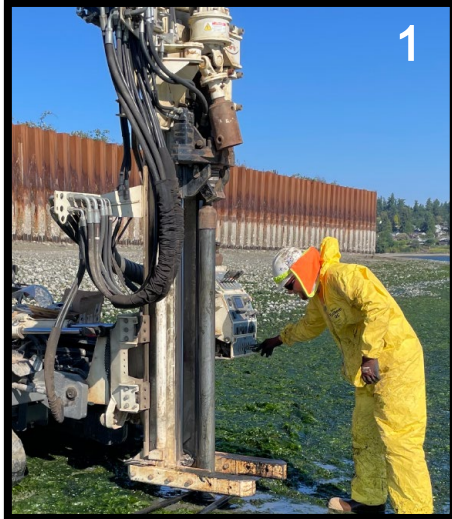


- SBPFM and Porewater Sample
 - SBPFM Location
 - NAPL Seep Sample
 - Historical Seeps**
 - Product (NAPL)
 - Sheen
 - Dredging and Capping Limits (as presented in 30% Design Report)
- No observable NAPL on the surface of the North Shoal

- NAPL equilibration testing:
- Lab-based testing
 - Site-specific seawater-to-NAPL ratio of 90:10
 - 7-day tumble at 30 revolutions per minute
 - Filtered equilibrated water analyzed for PAHs
 - Results provided effective solubility estimates for NAPL-associated PAHs
 - Benchmark for maximum undiluted *dissolved* PAH in porewater for NAPL-impacted sediments



SBPFM Deployment



- Installed 1-inch diameter SBPFMs with 5-foot threaded riser
 - 26 locations for 2 weeks
 - 2-2.5 to 4-4.5 feet below sediment surface (below cap base)
- Track-mounted Geoprobe 7280T direct-push drill rig:
 - 4.25-inch diameter drill casing with expendable drive point
 - SBPFM placed inside casing
 - Casing withdrawn allowing sediment collapse around SBPFM
 - Capped and tethered for retrieval

- Porewater grabs:
 - By PushPoint at 10 locations for comparison
 - Point-in-time during the ebb tide
 - Collected just prior retrieval
- Retrieval at 2 weeks
 - Shipping canister on ice to Enviroflux

Specific Discharge and Total PAHs Flux from SBPFMs

North Shoal Station	Specific Discharge (cm/d)		Upward PAH Concentrations (µg/L)		
	Upward	Downward	LPAH	HPAH	Total PAHs
NB-1	0.87	0.48	2,279.57	199.70	3,128.27
NB-2	0.12	0.12	7.65	25.12	32.78
NB-3	0.17	0.10	184.28	18.05	222.59
NB-4	0.16	0.08	21.71	ND	21.71
NB-5	1.32	0.04	0.79	0.36	1.16
NB-6	0.82	0.18	2,959.27	13.16	2,991.49
NB-7*	0.71	1.10	155,010.87	366.53	162,957.95
NB-8	4.34	0.81	1,290.84	29.14	1,992.68
NB-9	0.18	0.33	19.96	16.81	36.77
NB-10	2.01	0.03	2,130.43	9.66	2,282.92
NB-11	0.13	0.11	19.74	12.57	32.31
NB-12	0.24	0.16	79.87	10.18	105.39
NB-13	0.01	5.86	435.31	193.92	629.23
NB-14	0.49	0.03	2.77	2.38	5.15
NB-15	0.29	0.21	4.91	6.90	19.95

East Beach Station	Specific Discharge (cm/d)		Upward PAHs Concentrations (µg/L)		
	Upward	Downward	LPAH	HPAH	Total PAHs
EB-1*	1.88	0.10	32,841.40	2,024.58	42,791.32
EB-2	1.21	0.07	12.18	38.31	50.49
EB-3	0.38	0.45	171.55	26.96	224.74
EB-4*	0.81	0.13	1,238.54	1,386.70	3,013.40
EB-5	0.24	0.26	ND	115.66	115.66
EB-6	0.44	0.02	472.85	315.39	2,293.83
EB-7	0.80	0.17	1.71	8.26	9.97
EB-8*	1.15	0.05	890.68	1,806.18	3,361.53
EB-9	0.21	0.20	10.30	16.84	27.14
EB-10	0.38	0.21	2.26	2.24	4.50
EB-11	0.44	0.25	ND	ND	ND

*NAPL affected (exceeds effective solubility estimates)

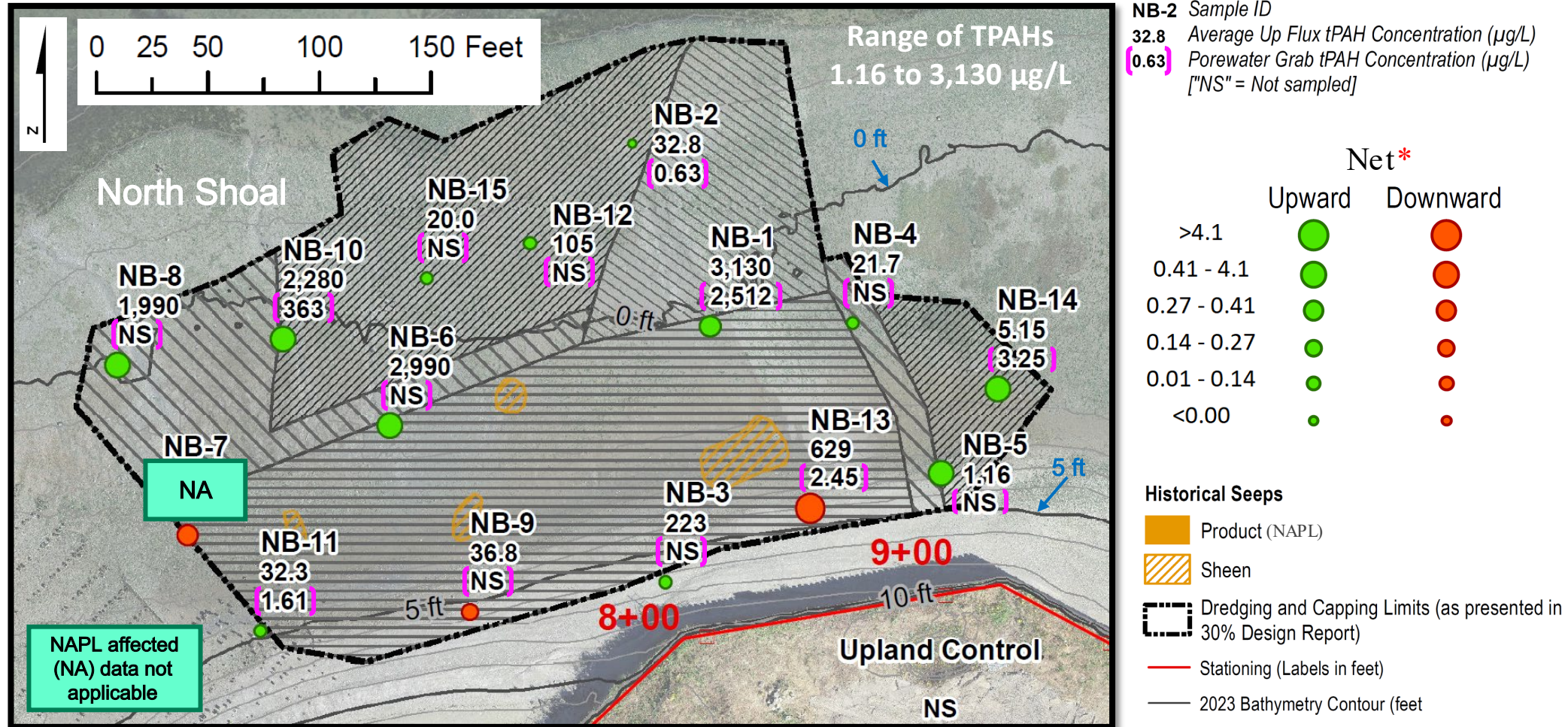
LPAH = low molecular weight PAHs

HPAH = high molecular weight PAHs

ND = not detected

- Range of upward specific discharges consistent with those predicted by groundwater flow model






Specific Discharge and Total PAHs– North Shoal
















* Net discharge = upward minus downward discharge

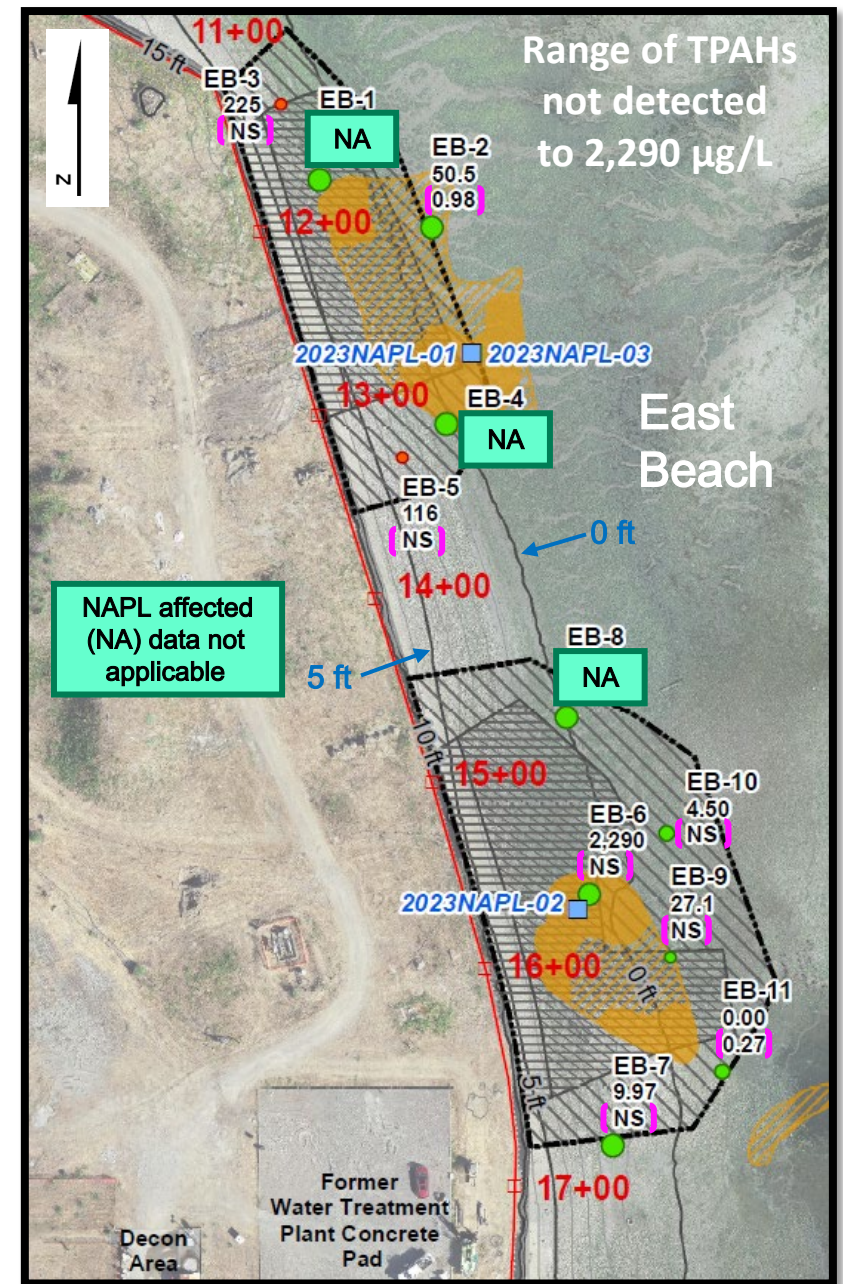
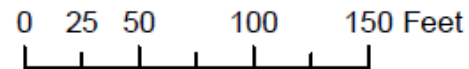
Specific Discharge and Total PAH Concentrations - East Beach

Historical Seeps

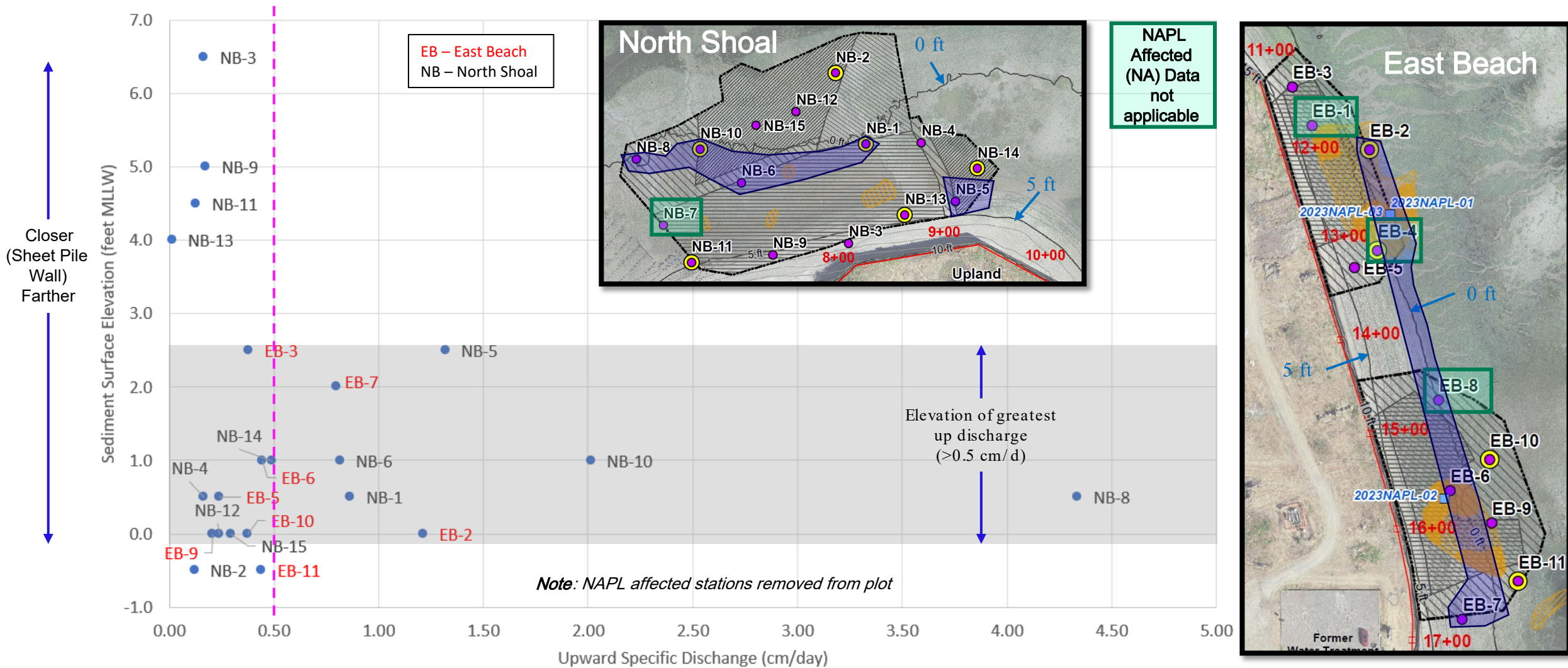
-  Product (NAPL)
-  Sheen
-  Dredging and Capping Limits (as presented in 30% Design Report)
-  Stationing (Labels in feet)
-  2023 Bathymetry Contour (feet)

- EB-2** Sample ID
- 32.8** Average Up Flux tPAH Concentration ($\mu\text{g/L}$)
- (0.63)** Porewater Grab tPAH Concentration ($\mu\text{g/L}$)
["NS" = Not sampled]
-  NAPL Seep Sample

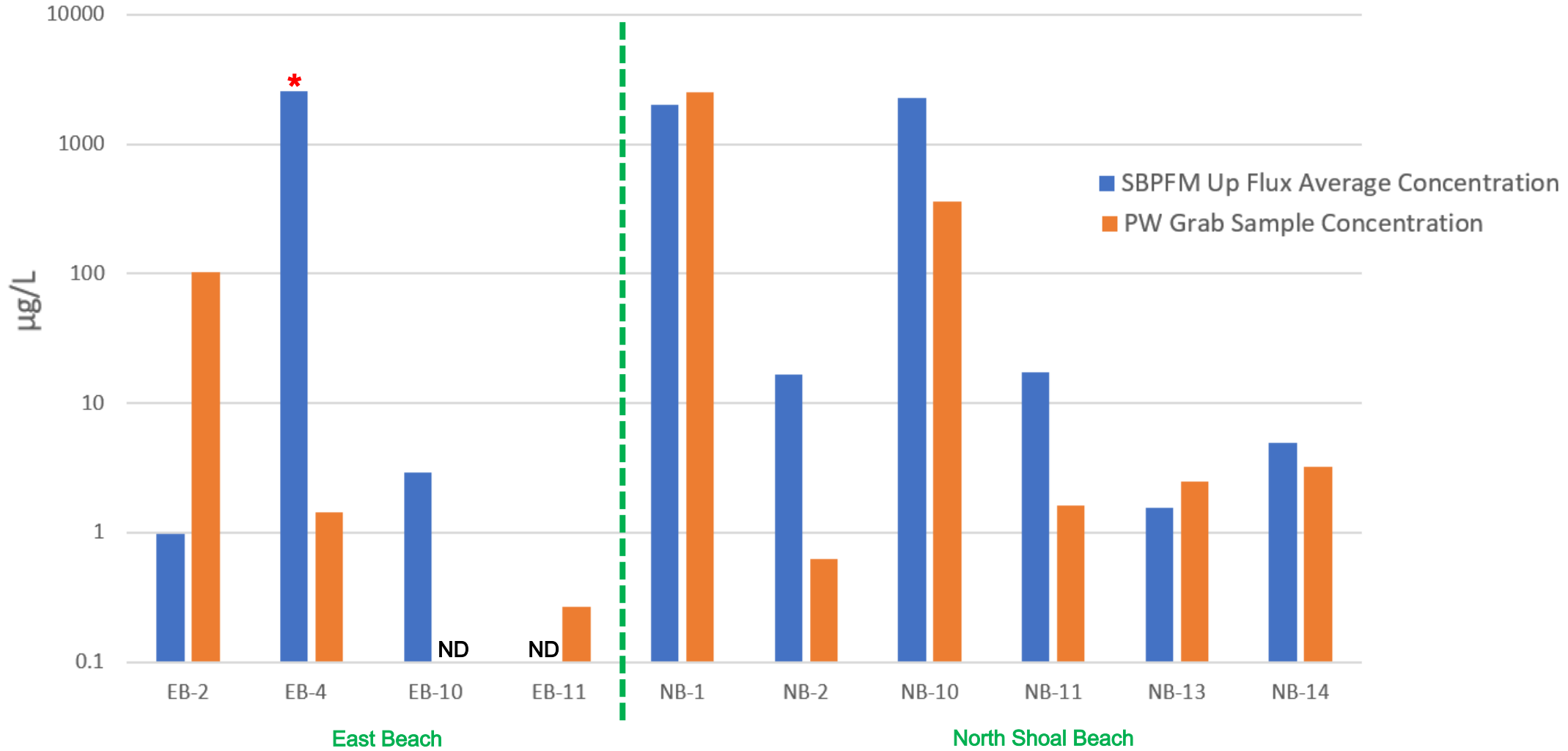
	Net*	
	Upward	Downward
>4.1		
0.41 - 4.1		
0.27 - 0.41		
0.14 - 0.27		
0.01 - 0.14		
<0.00		



Upward Specific Discharges Relative to Sediment Surface Elevation



Comparison of SBPFM Up Flux and Pore Water Grab Total PAH Concentrations



* NAPL affected

ND = not detected

Conclusions/Closing

- SBPFM results confirmed CSM by verifying primary areas of discharge and range of specific discharges as predicted by the groundwater flow model
- Excluding NAPL-affected results, SBPFM results provided range of time-weighted average transition zone concentrations that will inform dissolved contaminant transport modeling for cap design in both East Beach and North Shoal areas
- Transition zone (pore water) grab sample results generally agreed with SBPFM concentrations, providing additional confidence in the SBPFM data set when differences between the methods were considered
- Study makes apparent the need for renewed and updated modeling for cap design
- Uncertainties –
 - Methods for estimating location-specific hydraulic conductivity (K-value) - **important**
 - Affect of entrained sediment (particulate in the SBPFMs influencing results)
 - Importance of validation: pore water grab sampling needed? Method and frequency?

Thank You

For questions:

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Reinventing tomorrow.



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