

Installing an Activated Carbon Sediment Amendment at the Puget Sound Naval Shipyard & Intermediate Maintenance Facility, Bremerton, WA



Presentation for Seventh International Conference on Remediation of Contaminated
Sediments. February 4-7, 2013, Dallas, TX

Installing an Activated Carbon Sediment Amendment at the Puget Sound Naval Shipyard & Intermediate Maintenance Facility, Bremerton, WA

Robert K. Johnston (johnston@spawar.navy.mil), Victoria Kirtay, D. Bart Chadwick, Gunther Rosen, and Joel Guerrero (Space and Naval Warfare Systems Center Pacific, San Diego, CA); John Collins and Craig Ortega (AquaBlok Ltd, Toledo, Ohio); Robert Webb and Richard May (Dalton Olmsted & Fuglevand, Inc., Poulsbo, WA); Joe Germano, David Browning, and Ezra Beaver (Germano and Associates, Bellevue, WA); Mark Wicklein, John Pittz, and Dwight Leisle¹ (Naval Facilities Engineering Command Northwest, Bangor, WA); Lesley Doyle and Larry Hsu (Puget Sound Naval Shipyard & Intermediate Maintenance Facility, Bremerton, WA)

ACKNOWLEDGEMENTS

PSNS&IMF Divers; Naval Base Kitsap Port Ops; Brad Helland – Hart Crowser Inc.; Skip Simpson and crew of tug MARGARET MARY and barge ABERDEEN – Quigg Bros Inc.; Dr. Richard G. Luthy - Stanford University; and Dr. Jason Conder - ENVIRON International, Corp. Major funding was provided by the Environmental Security Technology Certification Program (ESTCP) and the Navy's Environmental Sustainability Development to Integration (NESDI) Program.

¹ Current affiliation Port of Portland, Portland, OR

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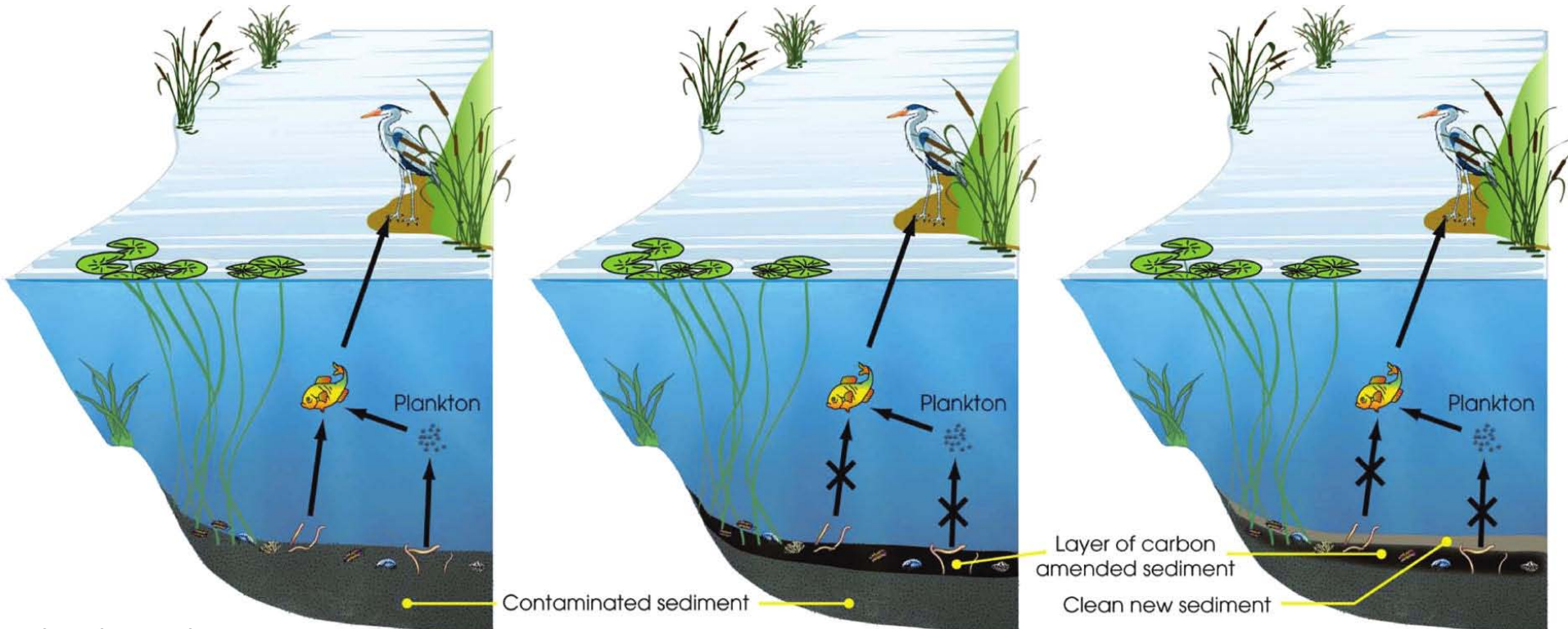
Outline of Talk

- Background/Purpose
- Site Description
- Technical Approach
- Placement Description
- Monitoring and Verification
- Costs
- Summary

Why Amend with Activated Carbon?

- Less obtrusive than dredging/capping
- Focused on reducing bioavailability and mobility
- Shorten ecosystem recovery time
- Expand site management options
- Less costly and more expedient

Need Large Scale Demonstrations to Gain Acceptance





Pacific Ocean

Sinclair and
Dyes Inlets

You Are 2,246 miles
in this direction



Bremerton, Washington

Naval Base Kitsap Bremerton, Puget Sound Naval Shipyard & IMF (Bremerton Naval Complex)



Pier 7

Google earth

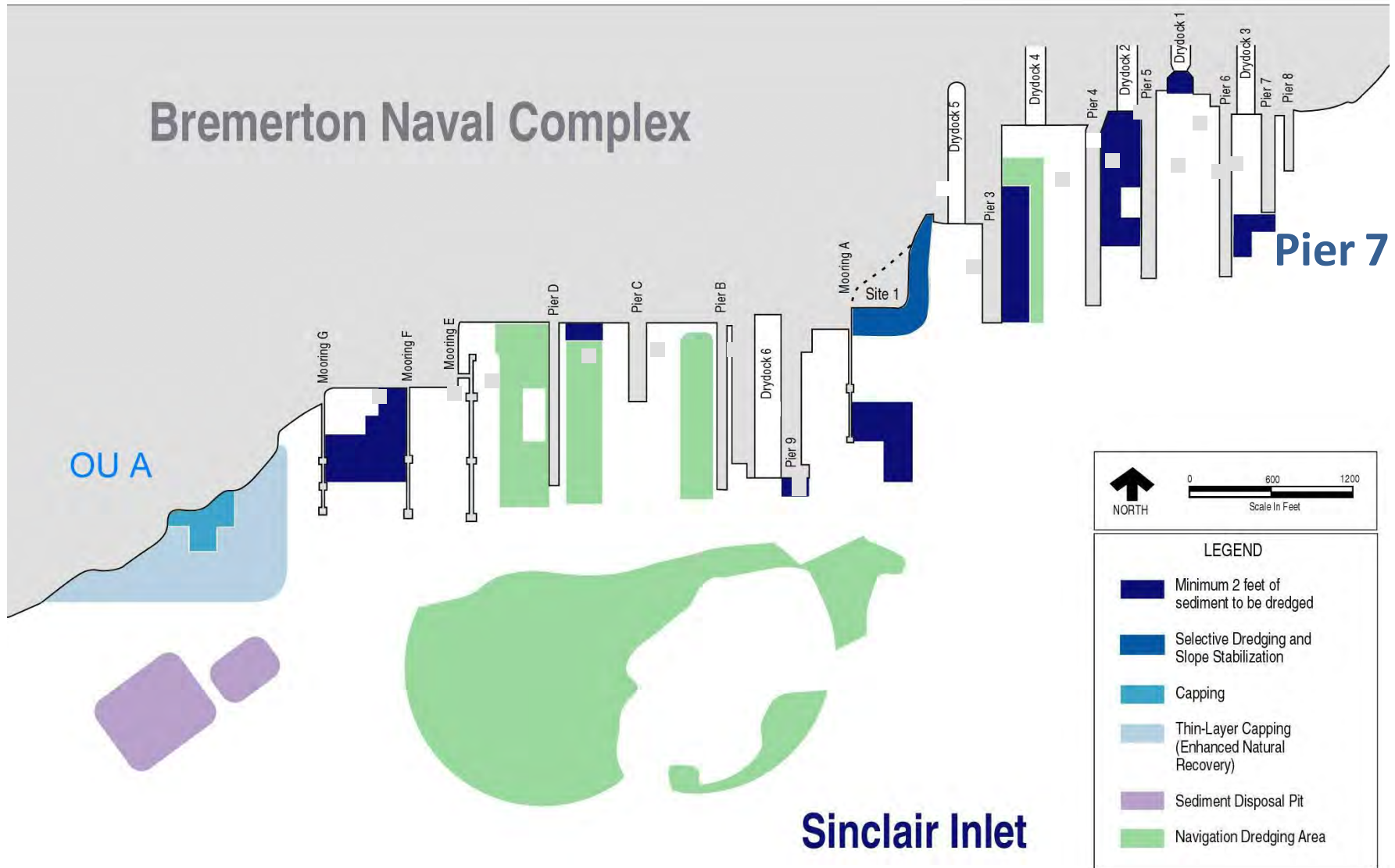
Eye alt 3.02 km

683 m

Imagery Date: 8/19/2011

lat 47.555445° lon -122.638788° elev 0 m

Sediment Remediation for Operable Unit B (OU B) Marine Conducted 2000-2001



Pier 7 Site Location

Elevated sediment contamination found during a fender pile replacement project in 2010

Pier 7

Google earth

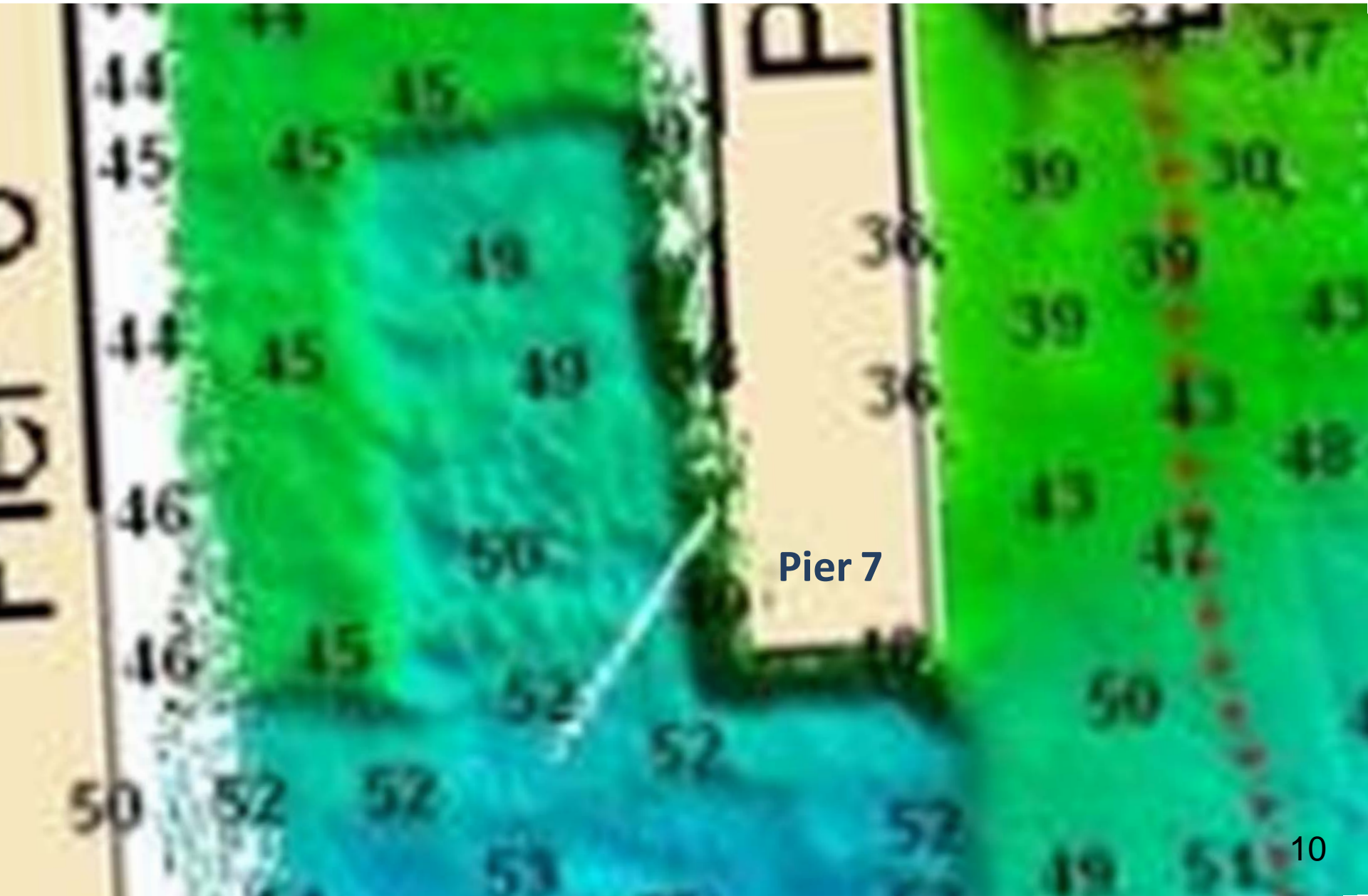
Eye alt 156 m

lat 47.558833° lon -122.628929° elev 0 m

36 m

Imagery Date: 8/19/2011

Bathymetry in the vicinity of Pier 7



Pier 7 Screening Analysis - Methods

Diver Collected Samples
10 cm surface cores
Rapid Screening
 PCBs, PAHs
 - ImmunoAssay
 Cu, Pb, Zn
 - XRF
Lab Analysis
 Hg - CVAA
 Grain Size Distribution

	C1	C2	C3	C4	C5	C6
T1						
T2						
T3						
T4						
T5						
T6						
T7						
T8						
T9						
T10						

Method Detection Limit	
PCB (Aroclor 1254) RaPID™ Assay, Statagic Diagnostics Inc.	53.5 ng/g
PAHs (Total) Immunoassay EPA 4035	980 ng/g
Cu XRF	48 ug/g
Zn XRF	43 ug/g
Pb XRF	50 ug/g
Hg CVAA	0.005 ug/g

Pier 7 Screening Grids Sediment PCB ng/g (ppb)

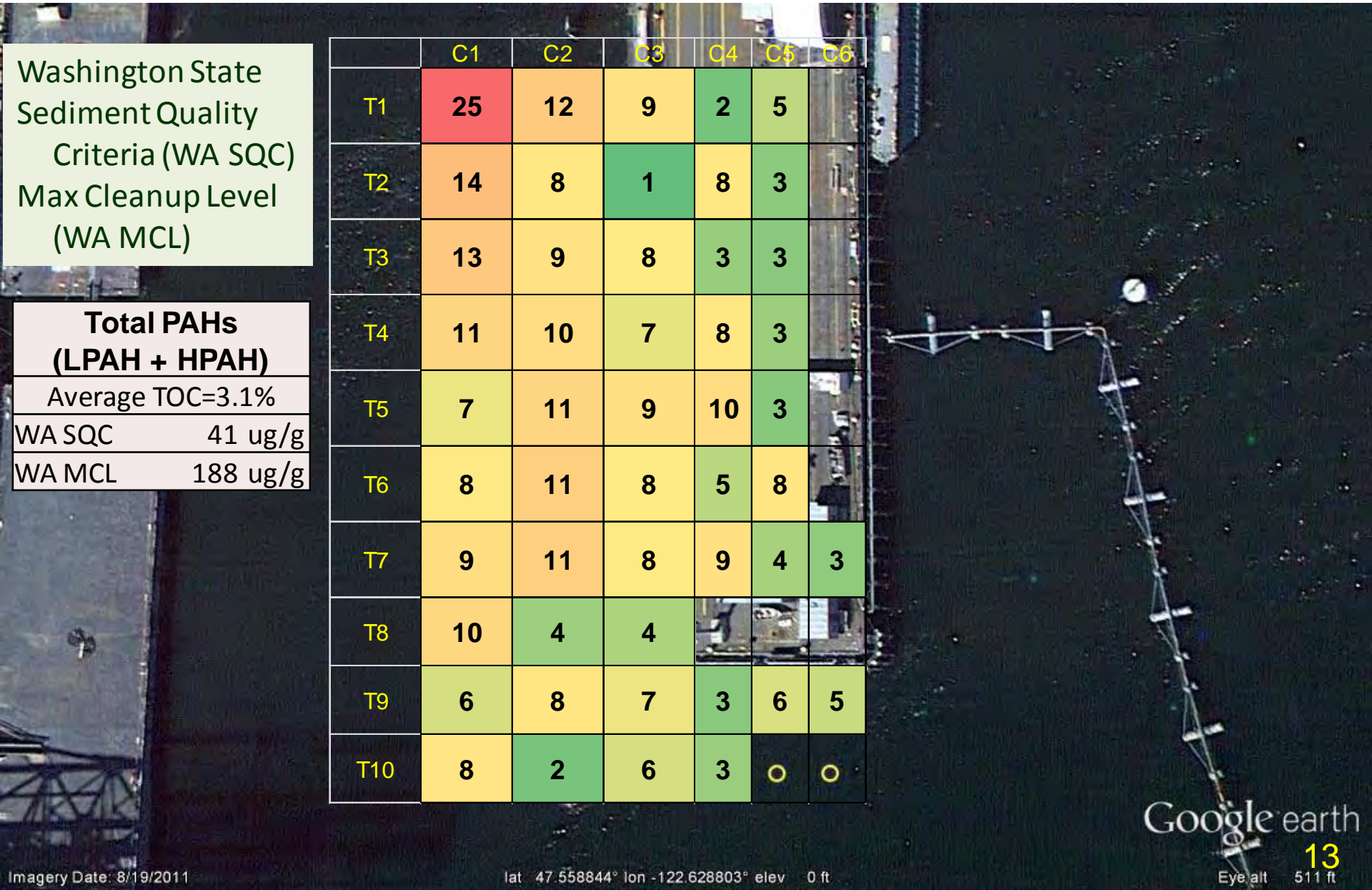
Washington State
Sediment Quality
Criteria (WA SQC)
Max Cleanup Level
(WA MCL)

Total PCBs	
Average TOC=3.1%	
WA SQC	372 ng/g
WA MCL	2015 ng/g

	C1	C2	C3	C4	C5	C6
T1	234	192	91	46	152	
T2	176	151	28	261	58	
T3	170	96	285	74	48	
T4	341	140	113	133	11	
T5	111	594	159	150	74	
T6	243	262	6650	305	439	
T7	224	261	129	655	193	105
T8	227	129	163			
T9	91	74	74	73	84	80
T10	161	24	126	92	134	115

Bulk Sediment
Sample Obtained
for Laboratory
Evaluation

Pier 7 Screening Grids Sediment PAHs ug/g (ppm)



Pier 7 Screening Grids Sediment Hg ug/g (ppm)

Washington State
Sediment Quality
Criteria (WA SQC)
Max Cleanup Level
(WA MCL)

Hg	
WA SQC	0.41 ug/g
WA MCL	0.59 ug/g

	C1	C2	C3	C4	C5	C6
T1	0.64	0.40	0.24	0.62		
T2	0.52	0.20	0.70	0.17		
T3	0.43	0.11	0.73	0.19		
T4	1.19	0.29	0.45	0.57	0.21	
T5	0.21	0.83	0.69	0.44	0.49	
T6	0.56	0.49	0.90	0.36	0.60	
T7	0.33	0.85	0.14	0.69	0.34	0.26
T8	0.12	0.17	0.28			
T9	0.32	0.35	0.17	0.06	0.18	0.20
T10	0.67	0.06	0.44	0.81	0.92	1.00

Pier 7 Screening Grids Sediment Cu ug/g (ppm)

Washington State
Sediment Quality
Criteria (WA SQC)
Max Cleanup Level
(WA MCL)

Cu	
WA SQC	390 ug/g
WA MCL	390 ug/g



Pier 7 Screening Grids Sediment Zn ug/g (ppm)

Washington State
Sediment Quality
Criteria (WA SQC)
Max Cleanup Level
(WA MCL)

Zn	
WA SQC	410 ug/g
WA MCL	960 ug/g

	C1	C2	C3	C4	C5	C6
T1	228	374	156	496	179	
T2	211	194	43	399	75	
T3	190	364	226	123	122	
T4	84	159	265	174	184	
T5	279	845	413	154	112	
T6	340	187	272	163	161	
T7	177	169	156	237	143	117
T8	136	95	117			
T9	93	170	136	56	91	78
T10	182	81	139	106	223	79

Pier 7 Screening Grids Sediment Pb ug/g (ppm)

Washington State
Sediment Quality
Criteria (WA SQC)
Max Cleanup Level
(WA MCL)

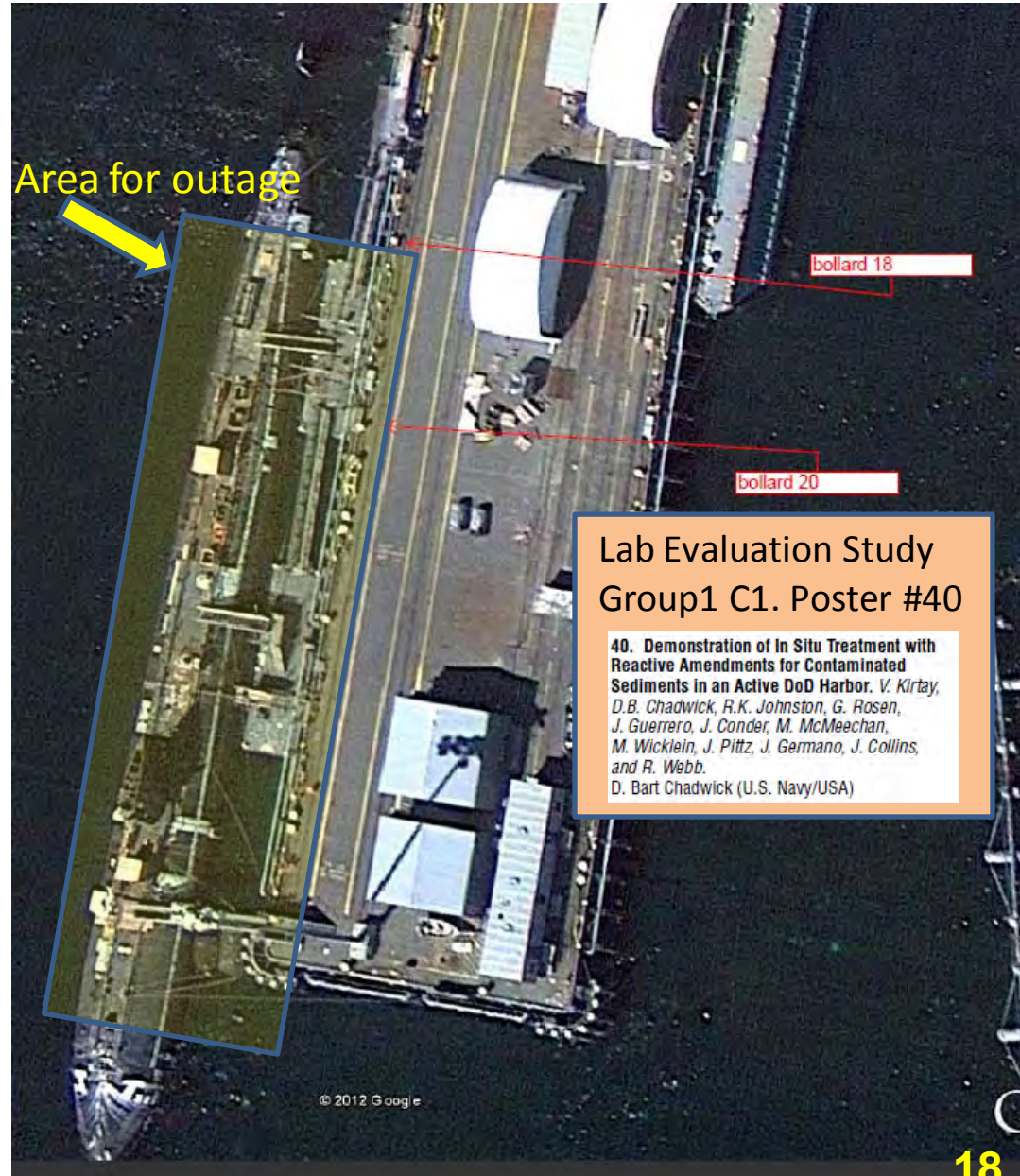
Pb	
WA SQC	450 ug/g
WA MCL	530 ug/g

	C1	C2	C3	C4	C5	C6
T1	86	121	50	224	83	
T2	77	50	50	138	50	
T3	91	58	104	62	50	
T4	50	78	106	88	59	
T5	60	415	85	60	38	
T6	147	75	107	138	57	
T7	115	73	52	109	50	51
T8	66	50	53			
T9	52	50	50	50	50	50
T10	64	50	52	50	50	50

Pier 7 Amended Cap Demonstration Project

Schedule

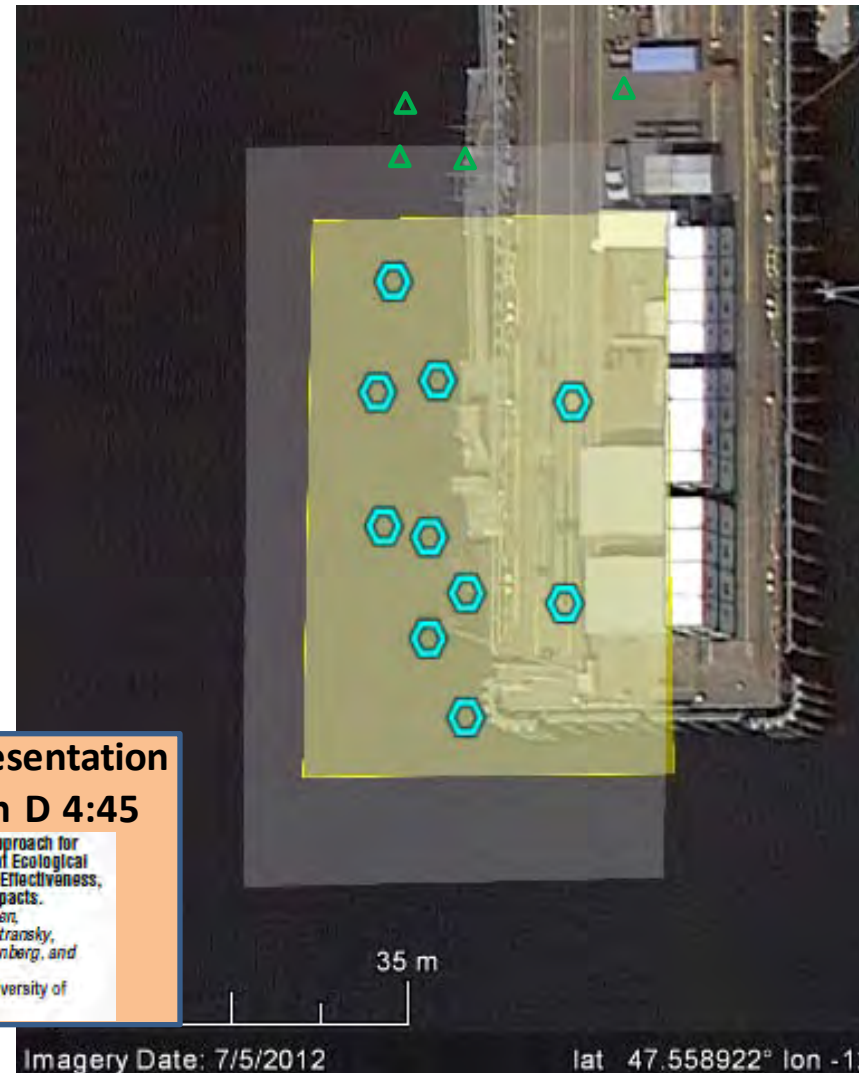
- 2011 Laboratory Evaluation Study Results Support **GO**
 - 2012:
 - May 8-9 Site Recon
 - Aug 1 Begin Outage
 - Aug 1-17 Pre-placement Monitoring
 - Oct 9 Received AquaGate Shipment
 - Oct 15-19 Placement
 - Oct 30-31 Placement Verification
 - Oct 31 End Outage
 - 2013
 - Jan (T=3 month) Monitoring
 - Apr (T=6 month) Monitoring
 - 2014
 - Apr (T=18 month) Monitoring
 - 2015
 - Sep (T=36 month) Monitoring
- Remedial Action under CERCLA**
Record of Decision for OU B Marine



Pre-Placement Monitoring

Establish Baseline

- SEA Ring Chambers Deployed at 10 stations for 14 Days
 - Bioaccumulation of PCBs and Hg
 - Clam – *Macoma nasuta*
 - Worm – *Neanthes arenaceodentata*
 - Passive Sampler – Diffusive Gradient in Thin films (DGT)
 - Toxicity
 - Amphipod – *Eohaustorius estuarius*
 - Physical, chemical and biological characterization (including TOC/Black Carbon)
- Sediment Profile Imaging (SPI) Camera at ~ 50 locations, extending beyond target footprint



SEA Ring Presentation

Tue Session D 4:45

Improved In Situ Approach for Assessing Sediment Ecological Risk, Remediation Effectiveness, and Stormwater Impacts.
G.A. Burton, G. Rosen, D.B. Chadwick, C. Stransky, H. Bailey, M.S. Greenberg, and J. Radford.
G. Allen Burton (University of Michigan/USA)

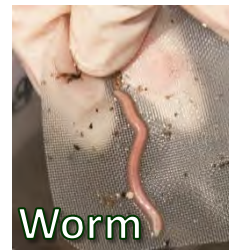
- Amendment Target Area
- SPI Monitoring
- SEA Ring Chamber
- Reference Site



SEA Ring chambers



Clam



Worm



Amphipod



Divers use syringe to "inject" worms

Sediment Ecotoxicity Assessment

SEA Ring



SEA Ring
chambers
penetrate
into sea floor



SEA Ring
chamber on
bottom



SEA Ring after retrieval

SEA Ring on Bottom

Diver inspecting SEA Ring prior to retrieval

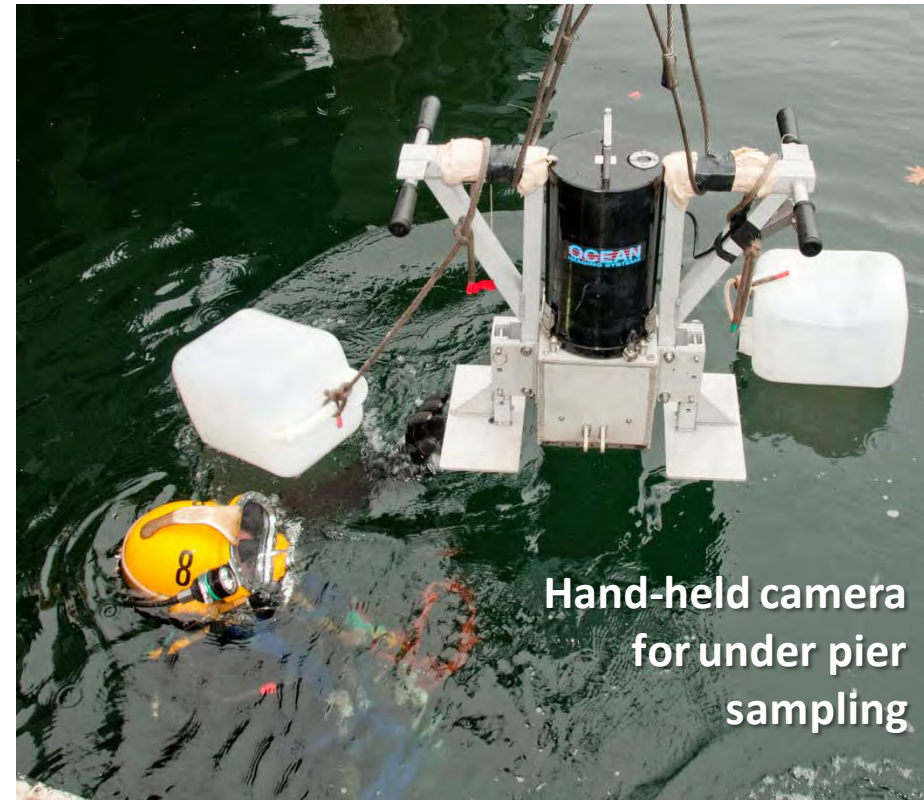
Flashing blue light indicates circulation pump OK

Chambers intact and covered with sea life



Pre-Placement Monitoring Cont.

Sediment Profile Imaging (SPI) Camera



Sediment Profile Images



AquaGate+PAC™ Composite Aggregate



Product Received
Note range of sizes

Dry State – Pre-Placement

Coating Layer



Aggregate Core:
Average Size
1/4 - 3/8"

Post-Placement



After Placement – Powder Activated
Carbon Falls off Core and Mixes
Naturally with Sediment

AquaGate Shipment to Port of Tacoma (Received 10/9/12)



“Super Sacks”
~2400 lbs/sack
~1 ton/sack



Product Staging and Placement

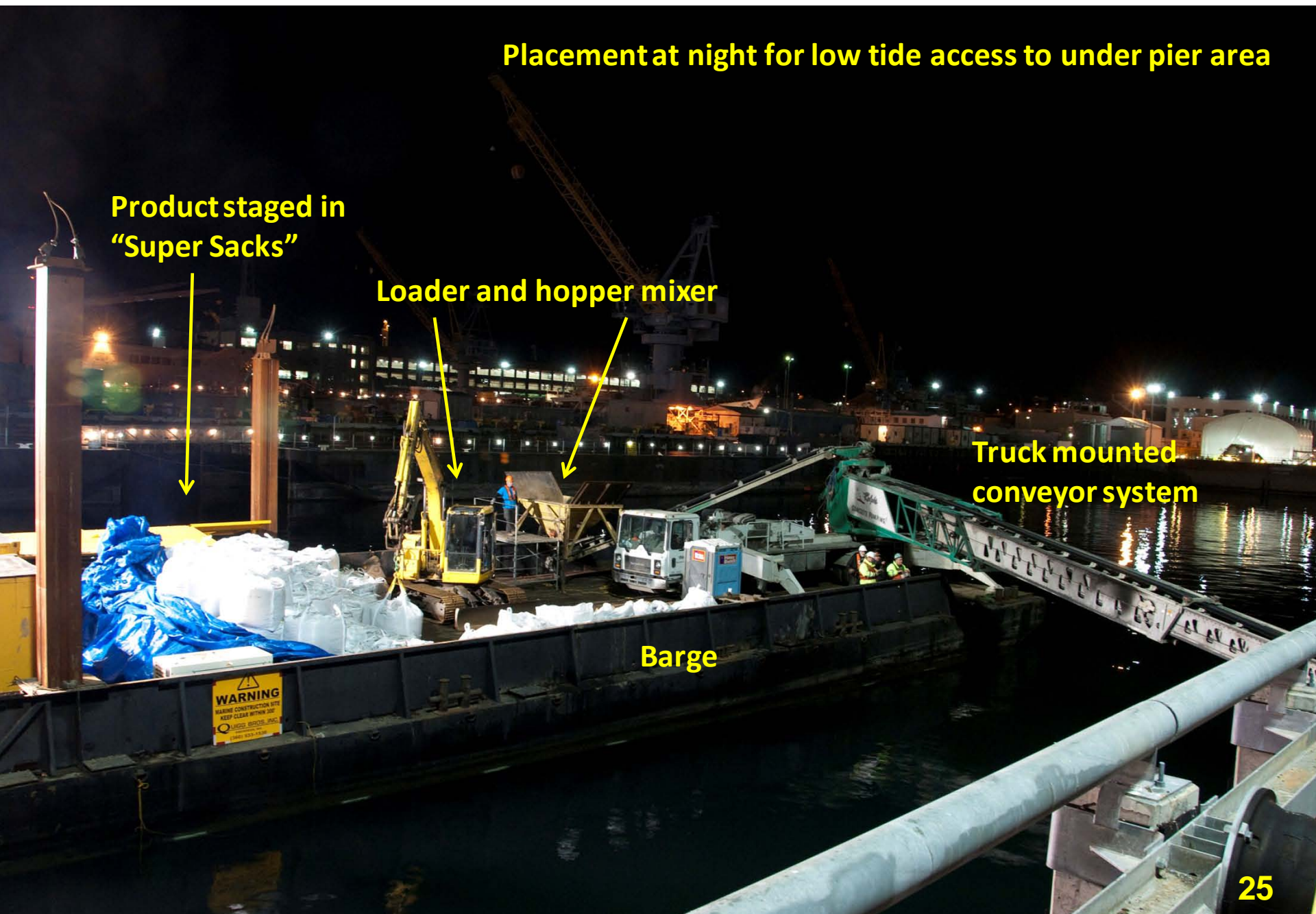
Placement at night for low tide access to under pier area

Product staged in
"Super Sacks"

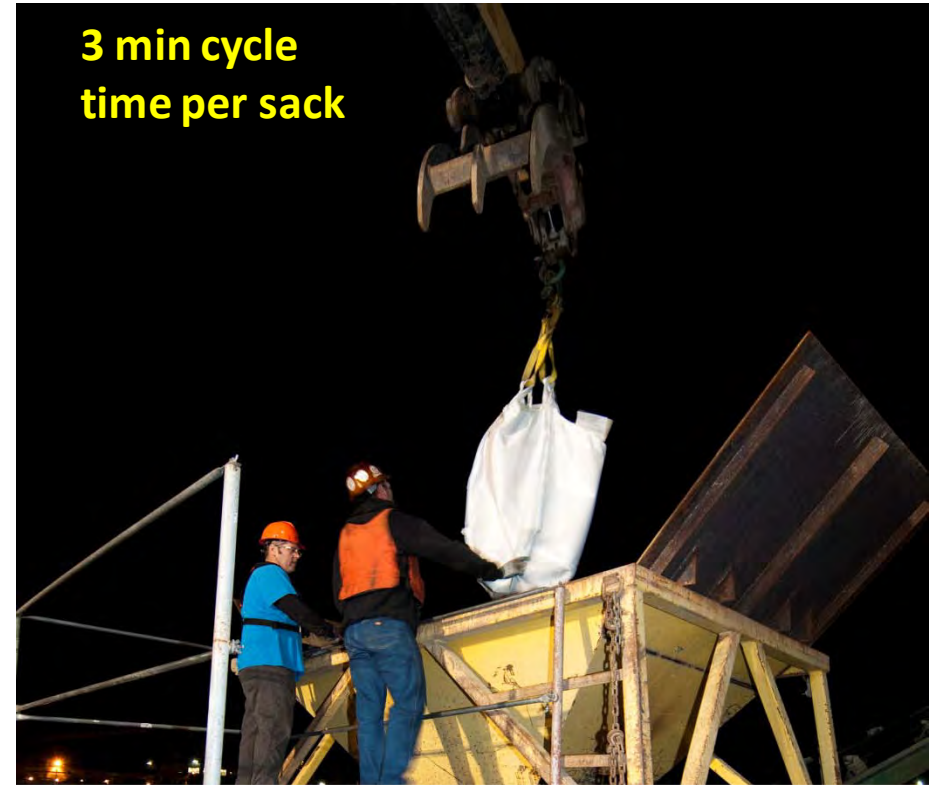
Loader and hopper mixer

Truck mounted
conveyor system

Barge



Product Handling on Barge



Telebelt Placement System



**Conveyor system
distributing in berthing area**

Under Pier Placement with Telebelt System



Conveyor system
extending under pier



Distributing
under pier



Distributing
under pier

Product Placement

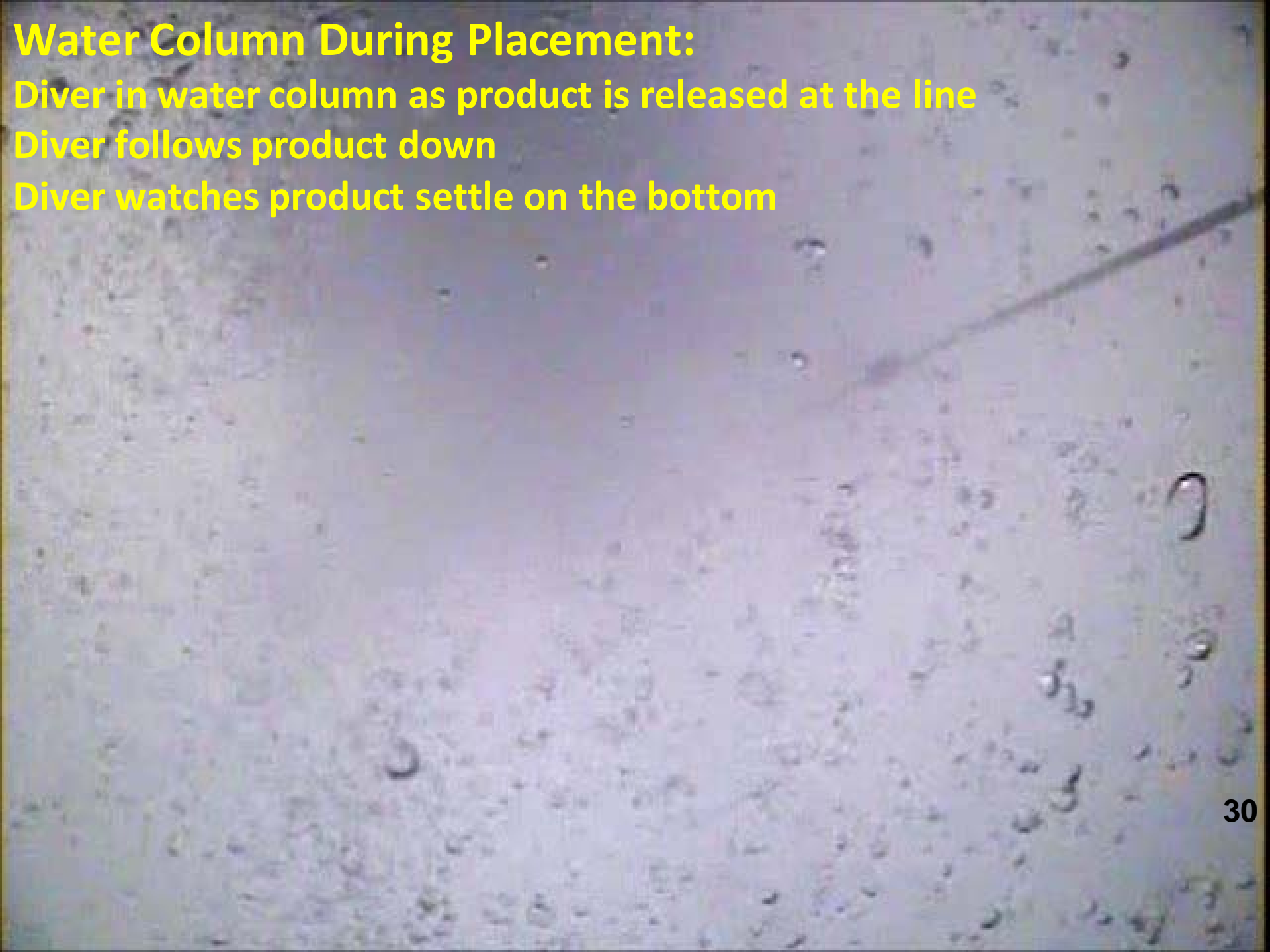


Water Column During Placement:

Diver in water column as product is released at the line

Diver follows product down

Diver watches product settle on the bottom



Bottom Following Placement

Diver surveys transect from area with no product

Through berthing area to under pier with product

Crabs, fish, other marine life, and sloping bathymetry visible



Typical Sediment Profile from SPI camera

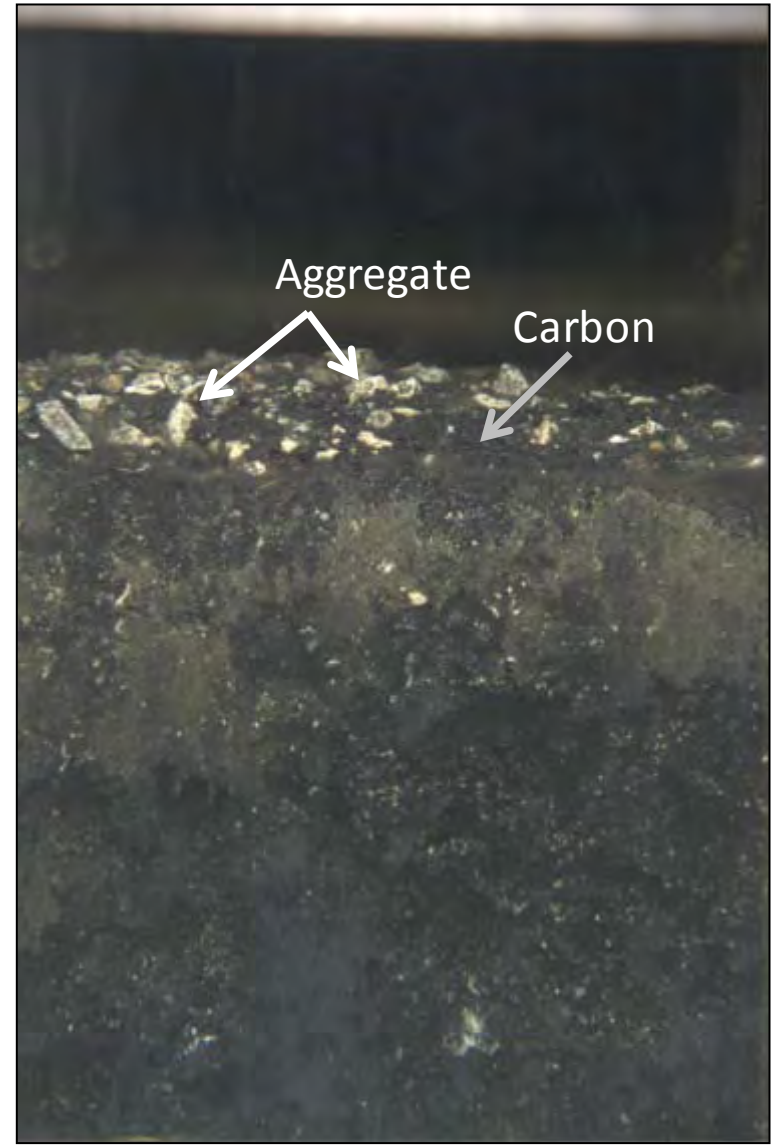
Before Placement

_DSC0101



After Placement

_DSC0225



Cost for Monitoring and Placement*

Monitoring (per event)		
Field Work	\$ 97,000	
Dive Support	\$ 27,000	
Laboratory Analysis	\$ 59,000	
Reporting	\$ 40,000	
	\$ 223,000	
Placement		cost/ton
Product (140 tons)	\$ 56,000	\$ 400
Shipment	\$ 42,000	\$ 300
Staging/Delivery	\$ 140,000	\$ 1,000
Verification	\$ 16,000	\$ 114
	\$ 254,000	\$ 1,814
Placement Unit Cost		
Area Treated	0.502	acre
Placement Cost/ft ²	\$ 11.62	

* Costs do not include management, oversight, and coordination.

Summary

- Conducted full scale demonstration of AC placement in active harbor
- Verified placement in berthing and under pier areas
- Established baseline to evaluate performance
- Post placement monitoring is on going

