Remedial Dredging Methods to Reduce or Eliminate Residuals

WODCON XXI

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WORLD DREDGING CONGRESS – WODCON XXI
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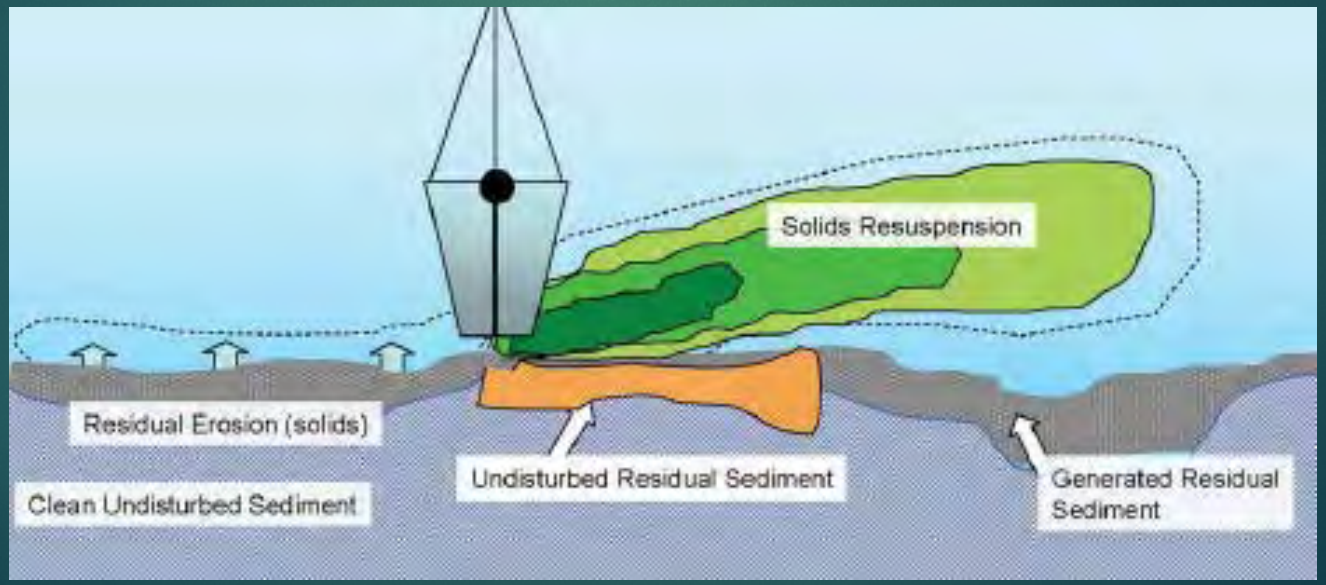
Method Development & Implementation

- Head of Hylebos – 2004-2006
- Duwamish Waterway Early Action Area – 2012-2015

- Specific client risk drivers and objectives for both projects
  - Once and Done
  - Reduce Risks
    - Residuals
    - Releases - Down stream losses
    - Volume uncertainty
    - Eliminate Sheetpile wall

Residuals, Resuspension & Release

- Defined as contaminated sediment found at the post-dredging surface of the sediment profile
- Classified as either:
  - Undisturbed residuals
  - Generated residuals
- Resuspension & Releases = Downstream Risk



Resuspension Sources

Action	Importance
Removal Actions	High
Erosion of Residual Sediment from Previous Passes	High
Cut-face Collapse	Low
Dredge Movement	
• *Spuds*	Low
• *Anchors*	Low
• *Resetting*	Low
Barge Overflow	High
Tender Vessels	Varies

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Source: Dredging Resuspension Processes and Modeling, Paul R. Schroeder, PhD, PE, Presented at SMWG Vicksburg, Mississippi May 2016

Head of Hylebos Sediment Remediation 2004 - 2006 Tacoma, Washington

Presented at WODCON 2007

- PCBs, PAHs, metals
- 310,000 M^3 (405,000 cy) of in-situ material dredged
- 371,000 M^3 (485,000 cy) of dredged material to landfill (20% entrained water)

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Observations During Dredging

- Full time observer on dredge (DOF)
- Located in excavator cab next to operator
- Observe material types in bucket
- Generate electronic logs

Post-Dredging Residuals

Table 1. Summary of Type-2 and Type-3 (PCB) Post-Dredging Monitoring Data

	Initial Post-Dredge Data (1)	Final Post-Dredge Data (2)
Samples Pass SQO, % (3)	72%	99%
Avg. PCB Concentration	234 ug/kg	76 ug/kg
Avg. Residual Thickness	6 cm	4 cm

(1) Samples collected following completion of the planned two-pass dredging program.
(2) Samples representing all CDMAs following completion of additional dredging in areas not initially passing SQO criteria
(3) Final post-dredging data includes SQO failing results from 4 CDMAs capped because of groundwater influence

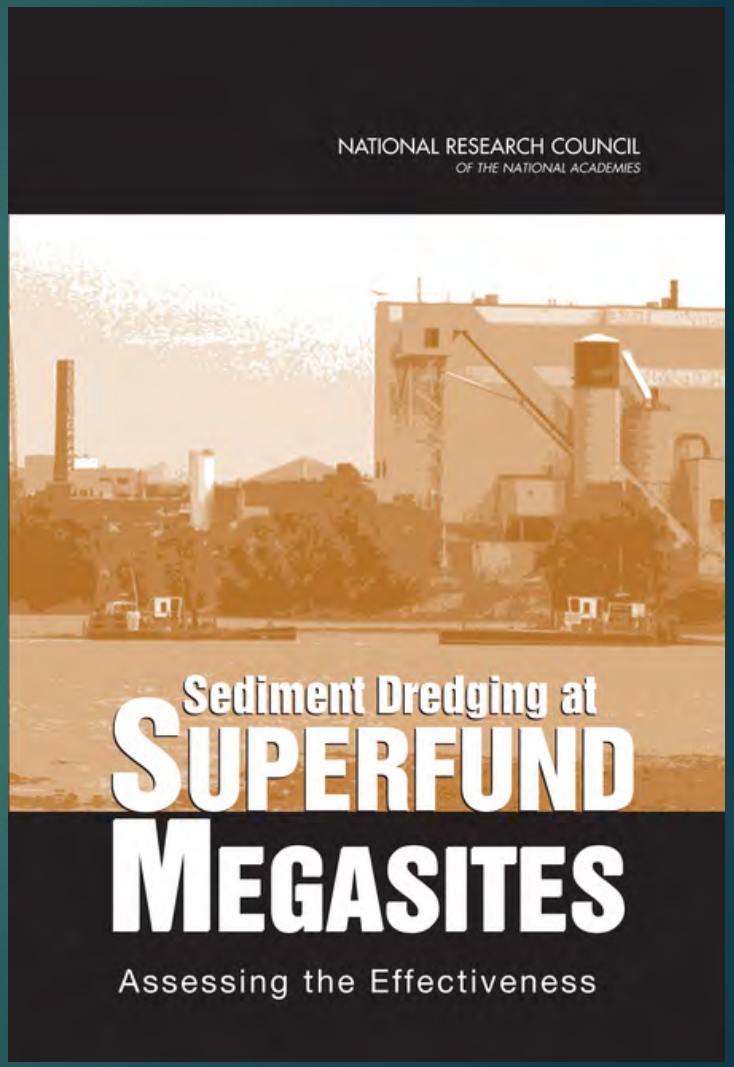
Head of Hylebos Waterway Tacoma, WA

Results

NRC Report Published 2007

- *"[Head of the Hylebos] remains one of the few sites where cleanup levels were obtained by dredging alone. The sediment remediation project successfully achieved the project SQOs with no residual sediment exceeding the SQOs."*

  The National Research Council



Remedial Design (RD) & Remedial Action (RA) Summary[1]

- RD/RA Costs: $57 million
- Volume removed: 420,000 cy
- Area remediated: 44.7 acres
- Averages
  - 9,400 cy/acre
  - $135/cy (RD & RA Total)
  - $1.25 million/acre

1. Dalton, Olmsted & Fuglevand, Inc. (2006). “Draft Remedial Action Construction Report – Part 1.” July 21, 2006

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Duwamish Waterway Sediment Remediation Project

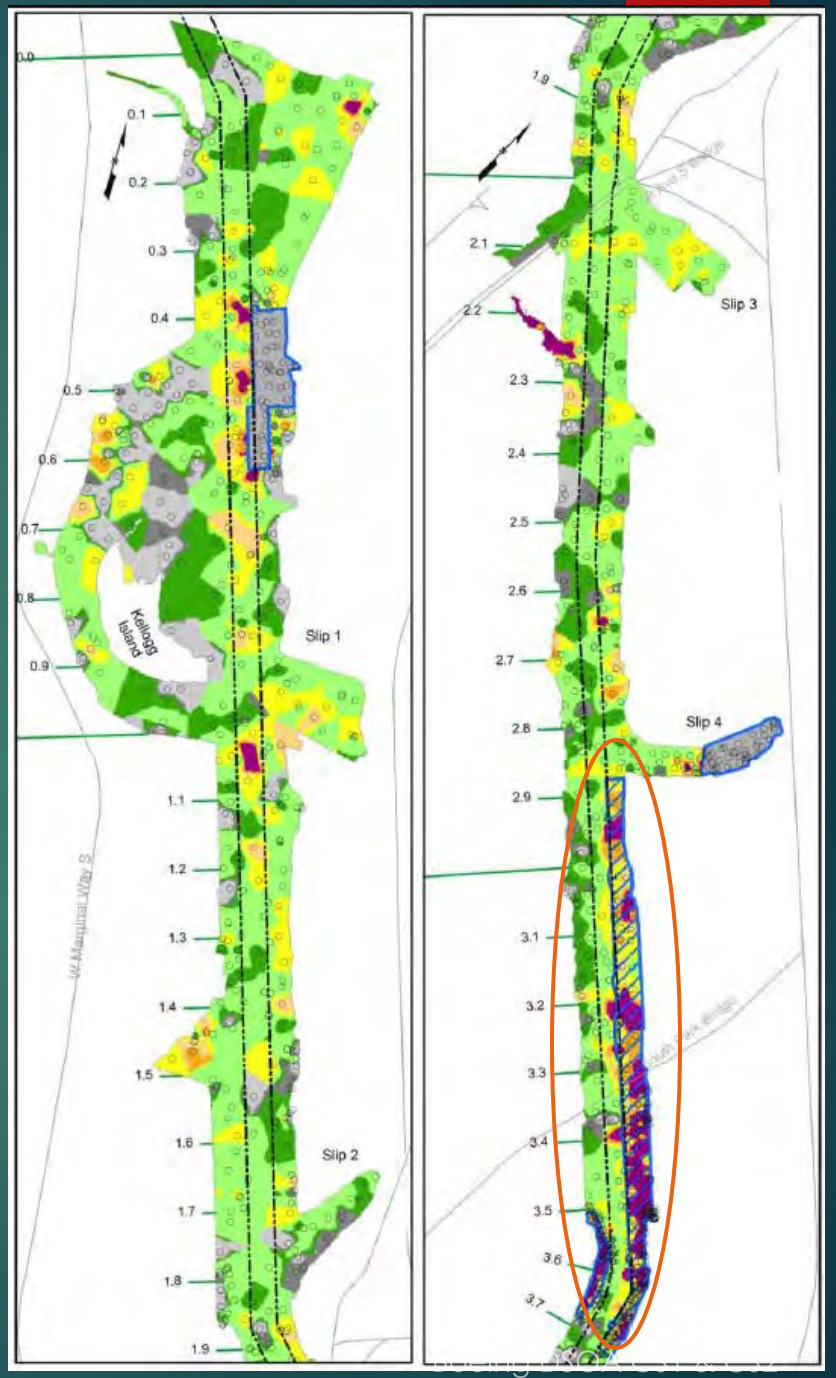
- Industrial/Residential waterway located in Seattle, WA
- 3 dredging seasons (2013-2015)
- 123,000 M3 (161,392 cy) of sediment removed

LDW - PCBs in Surface Sediment

Legend

Predicted Total PCB Concentration (µg/kg dw)

- ≤ 30
- > 30 - 60
- > 60 - 100
- > 100 - 240
- > 240 - 480 (>SQS)
- > 480 - 720
- > 720 - 1,300
- > 1,300 (>CSL)
- PCB Sample Location
- Road
- Navigation Channel
- River Mile Marker
- Early Action Area (Cleanup not Complete)
- Early Action Area (Cleanup Complete)



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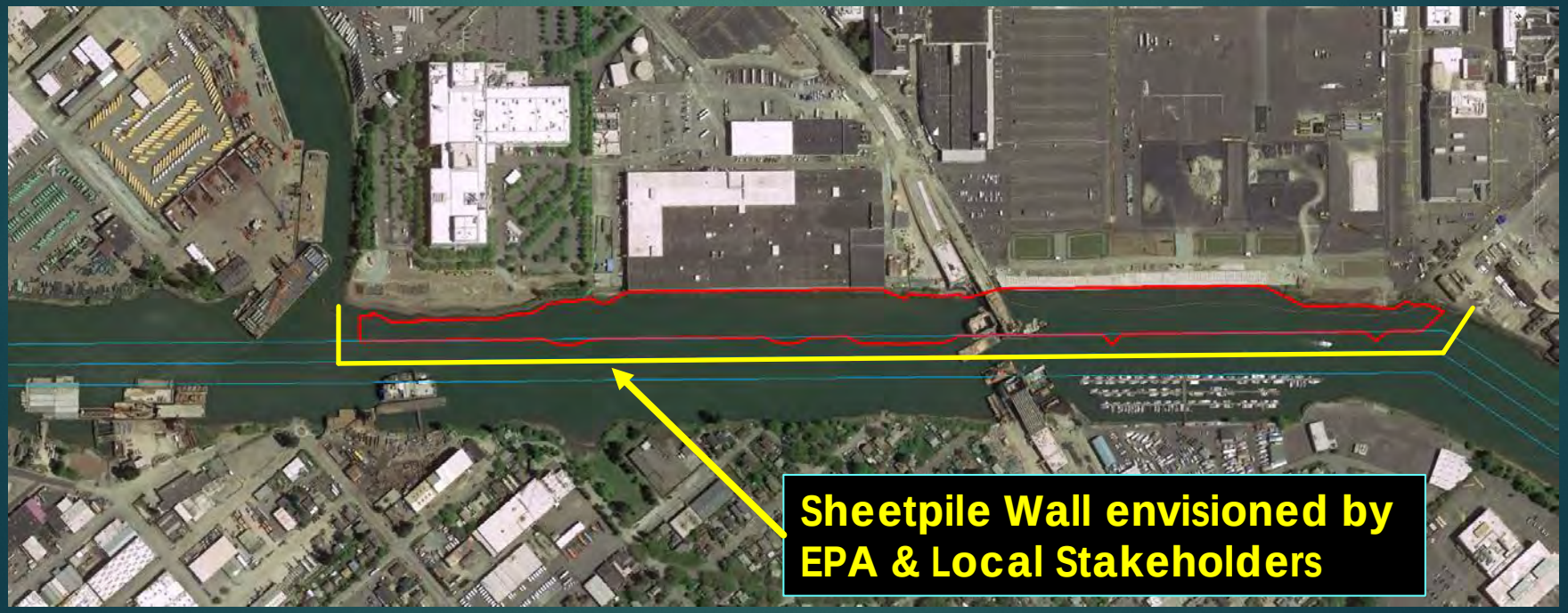
Just Build a WALL Around It…..

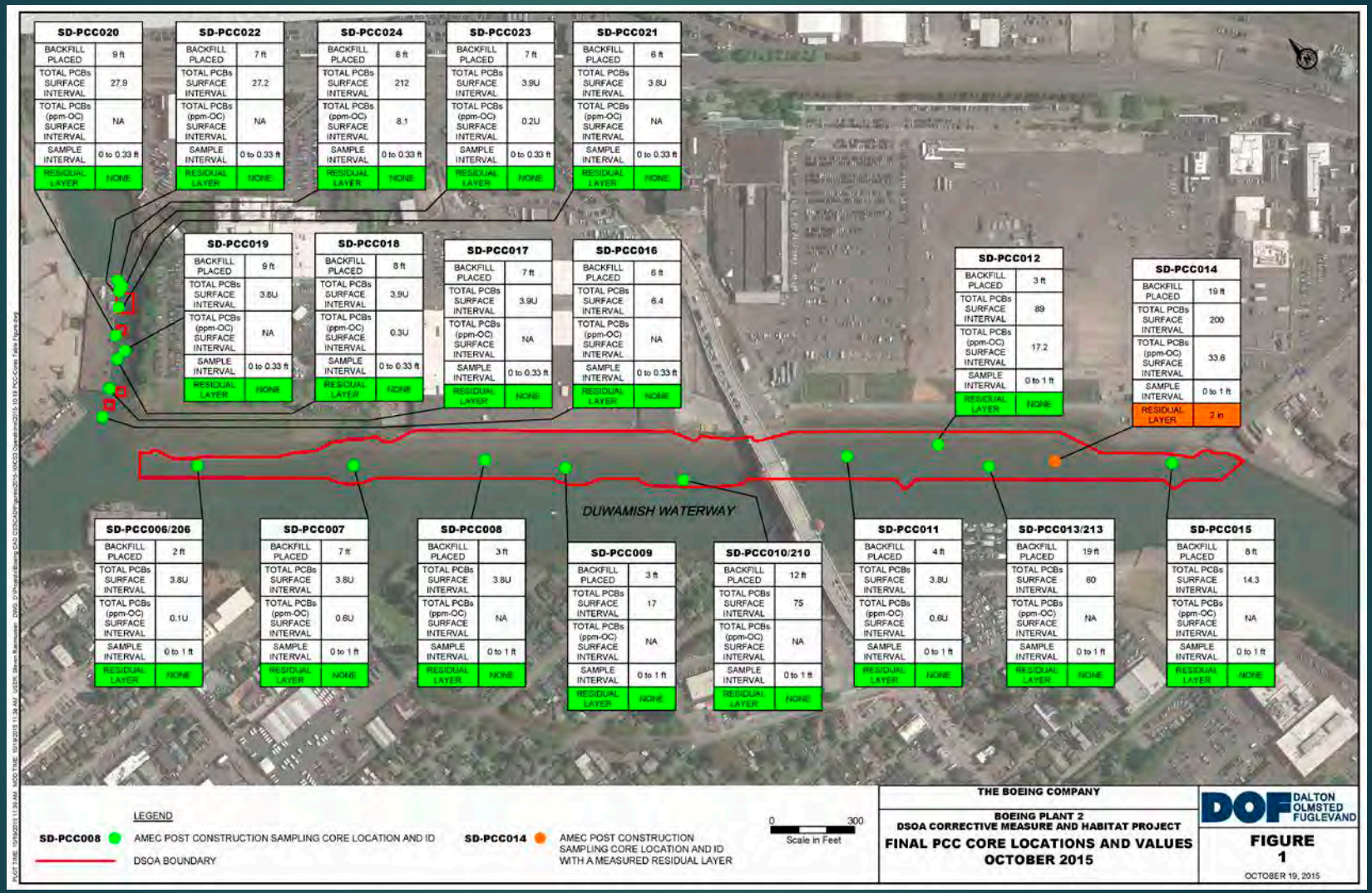
- Navigation
- Flooding
- Scour
- Community
- Other Projects

Is There an Alternative?

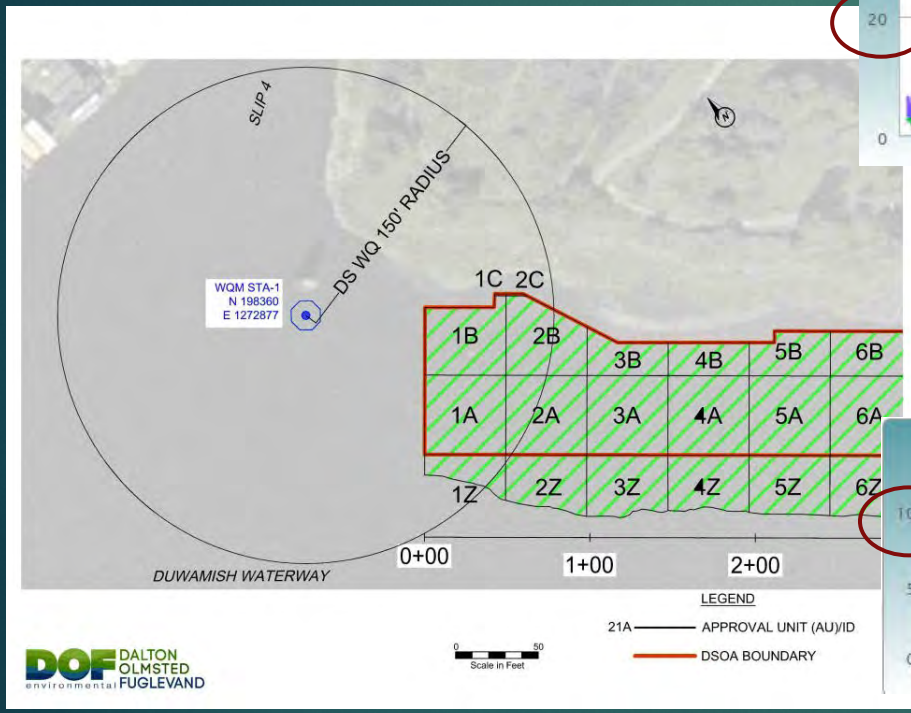
- Equally Protective? (4R's)
- Less Collateral Impacts?
- Community Acceptance?

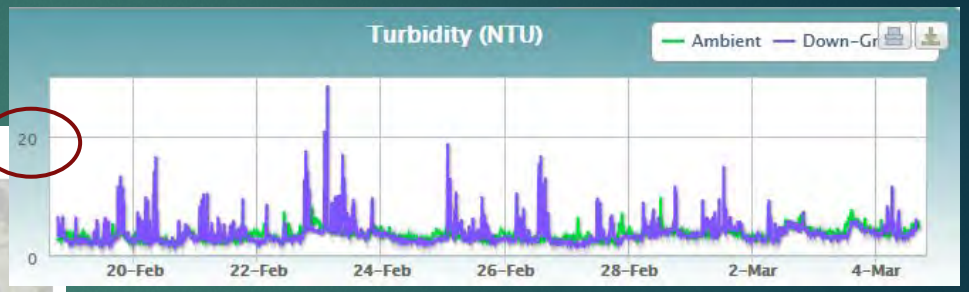


Outcomes – 18 of 19 NO Residuals

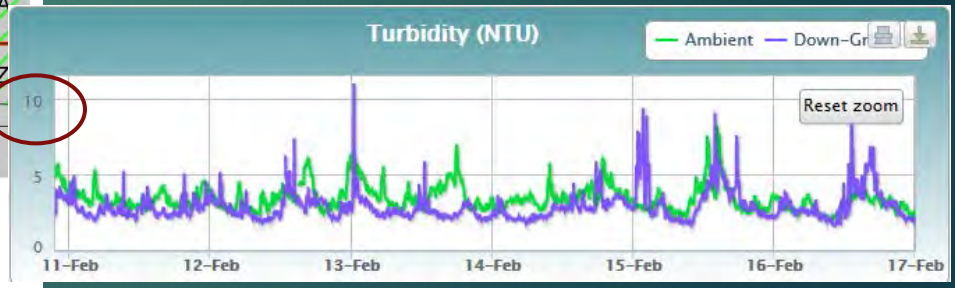


Outcome: Turbidity Monitoring from Fixed Stations





Turbidity data when placing backfill within 150' from DS WQ monitoring station



Turbidity data when dredging within 150' from DS WQ monitoring station

Outcome: Turbidity Monitoring 150 feet downstream of dredge

- Turbidity criteria: 5 NTU maximum over background at 150 feet from dredge

Monitoring Events	108
Passing Criteria	96
Exceeded Criteria	12 (5.2 to 13.4 NTU)

Issues Identified

- Debris
- Backfill
- Other Projects

Outcome: PCB Monitoring 150 feet Downstream of Dredge

- Water Quality criteria: 0.03 ug/l (PPB) PCBs maximum at 150 ft. from dredge

Monitoring events	53
Detections (@ 0.01 ug/L PCBs	20
Exceed Criteria (0.03ug/L (PPB))	1 @ 0.067 ug/L PCBs (Exceeds Chronic of 0.03ug/L)

Issues Identified

- Debris
- Other Projects

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Instead of a Wall…

Engineering Remedial Dredging Methods

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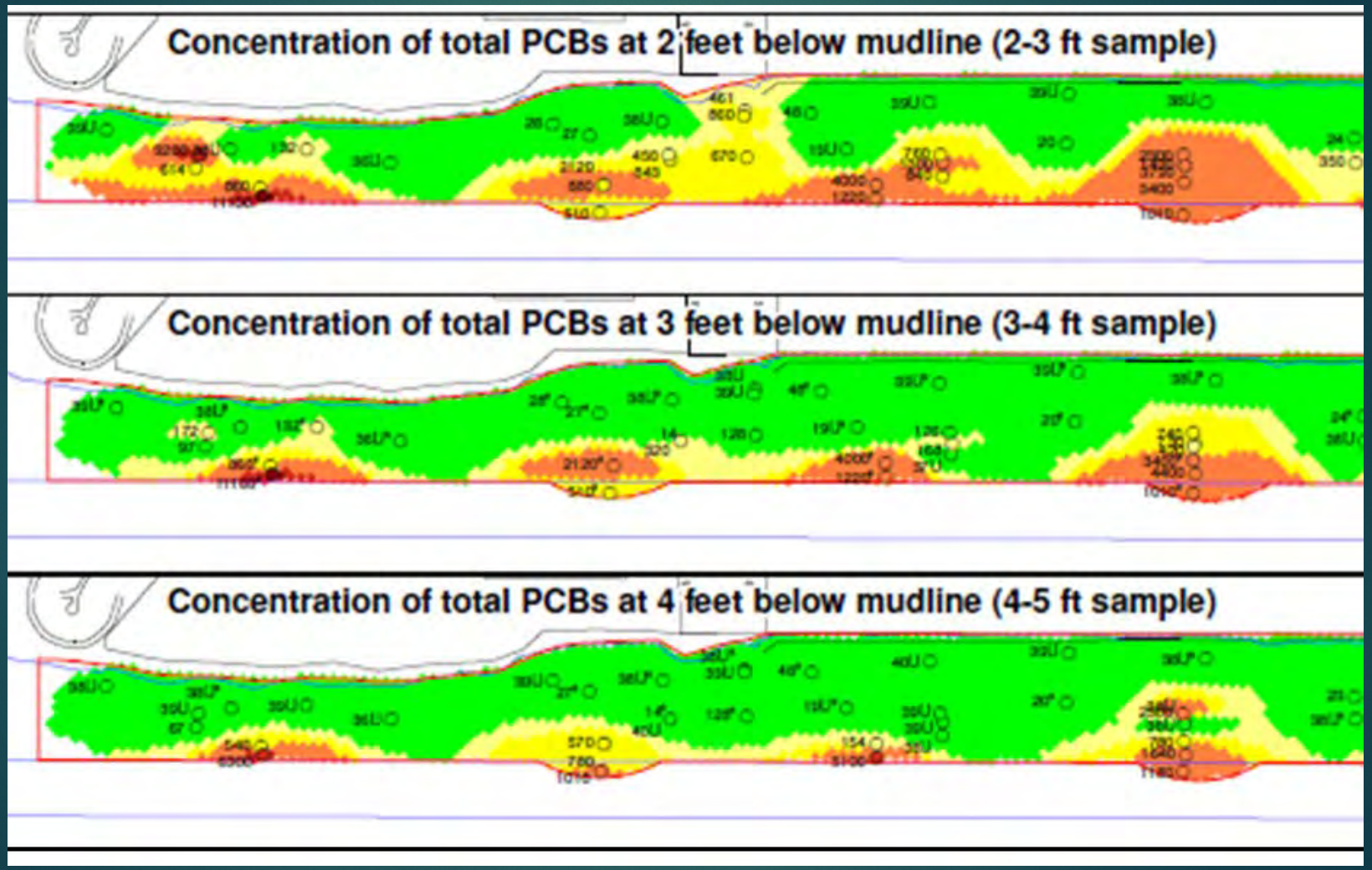
June 2016

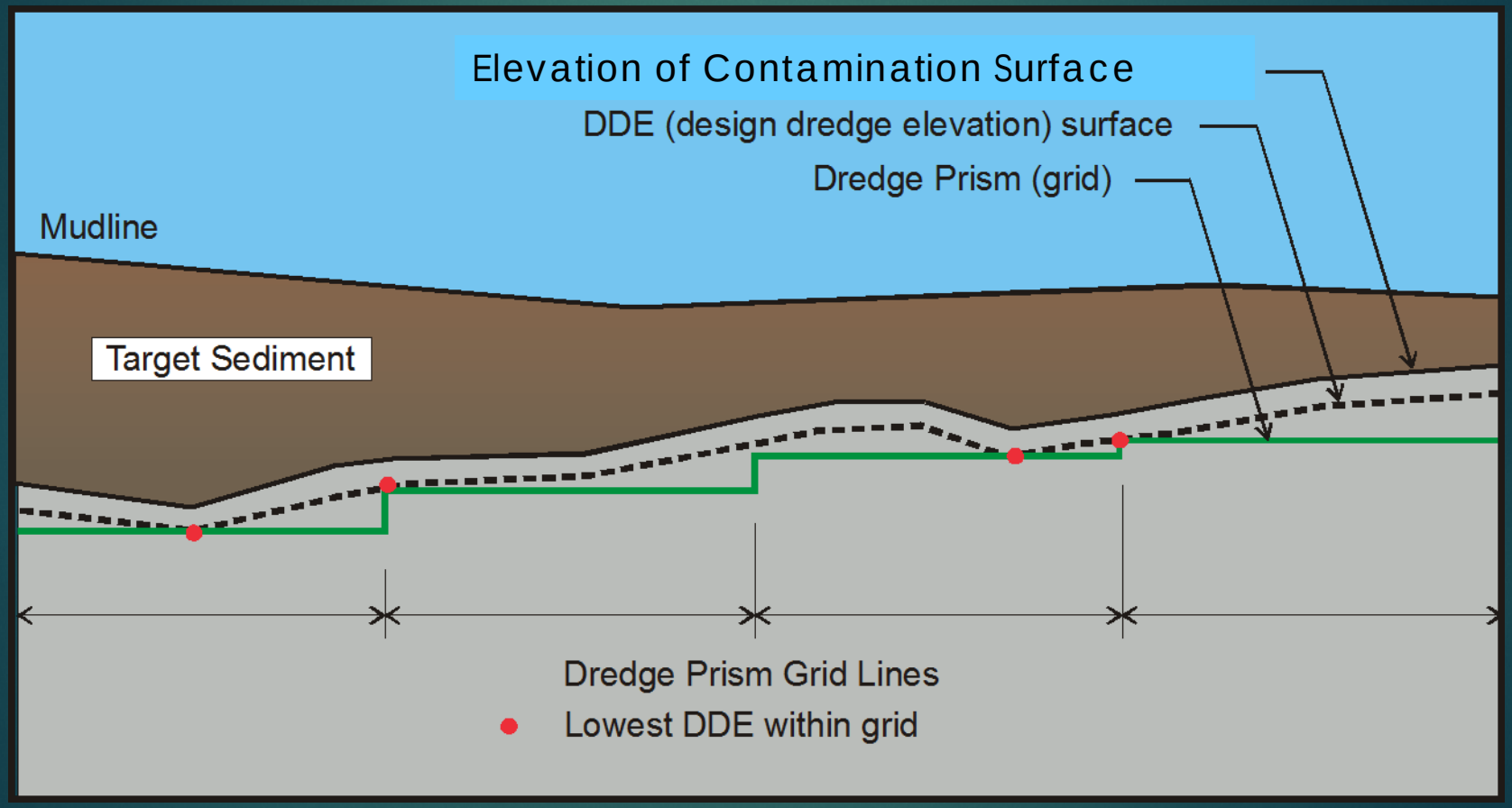
Mechanical Dredging RDM's

- Accurate delineation of elevation of contamination (EOC)
- Precision dredge plan
- Dredge to design grade
- Dredge with excavator
- Enclosed Environmental bucket
- RTK-GPS based bucket positioning
- Understanding by Project Staff
- Performance consistent with project objectives
- No overfilled buckets
- Stair-step cuts on slopes
- Dredge slopes with excavator
- Remove water from sediment barges and process – No Barge Overflow
- Place initial backfill

RDM-1. Accurate Delineation of Contamination



RDM-2. Precision Dredge Plan



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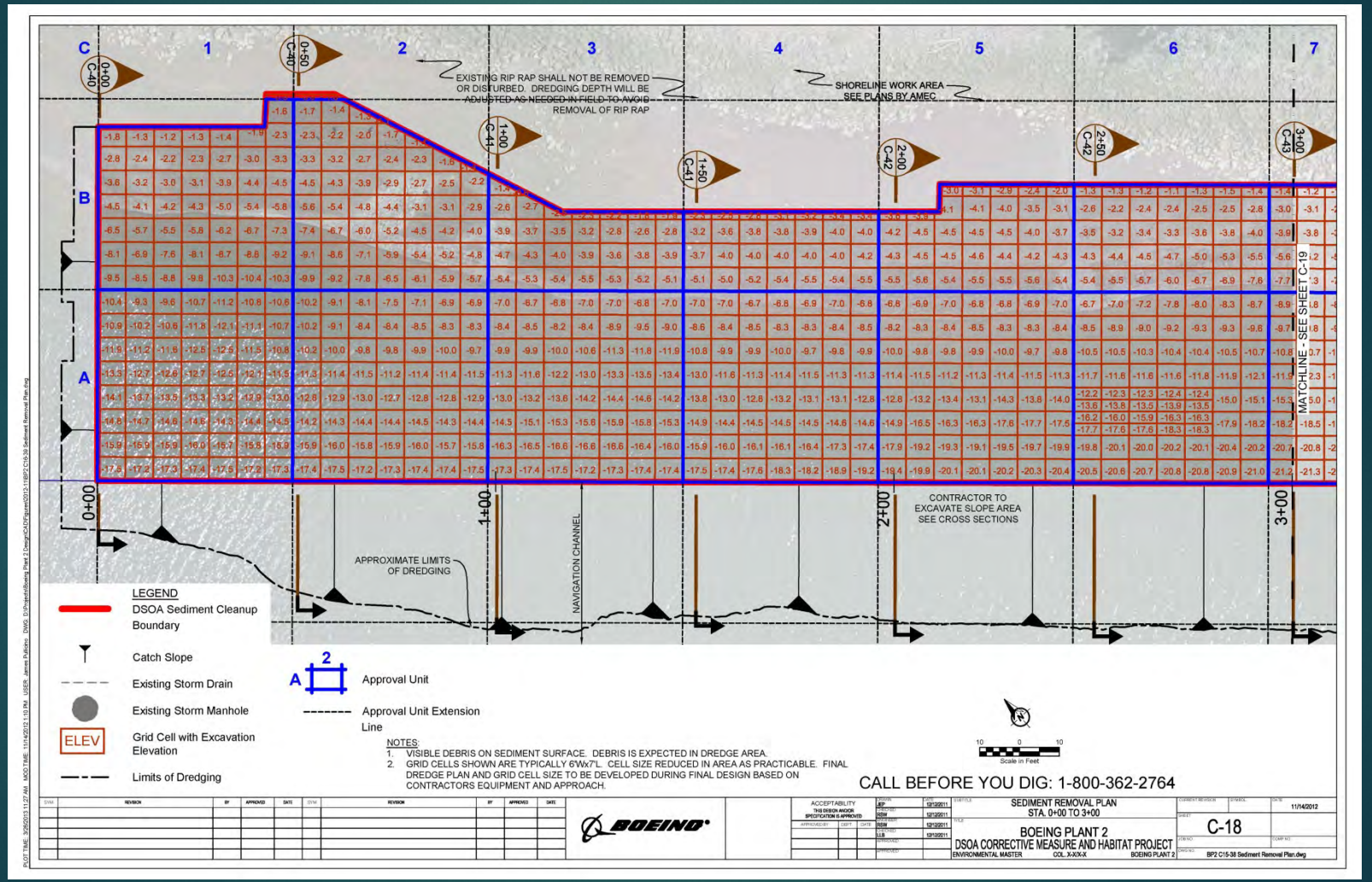

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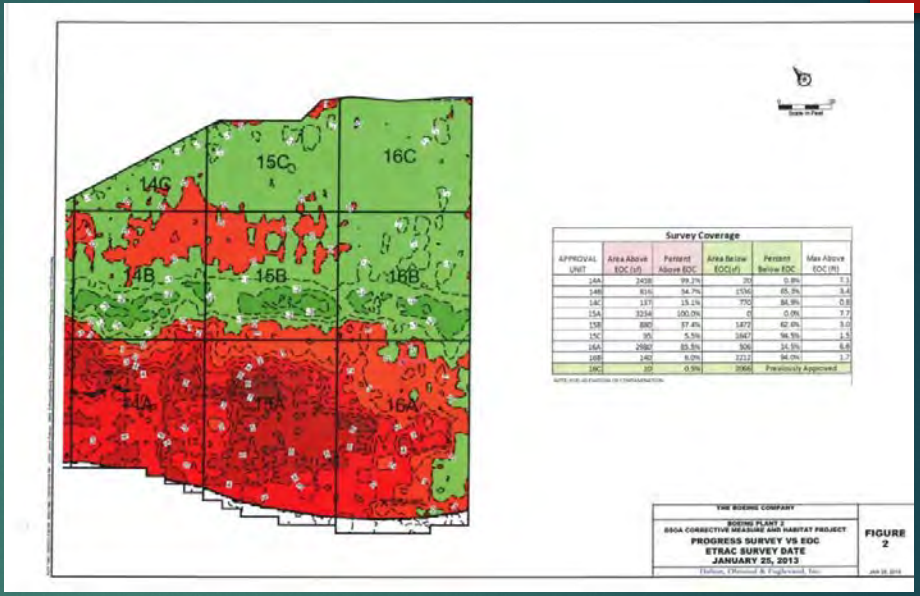
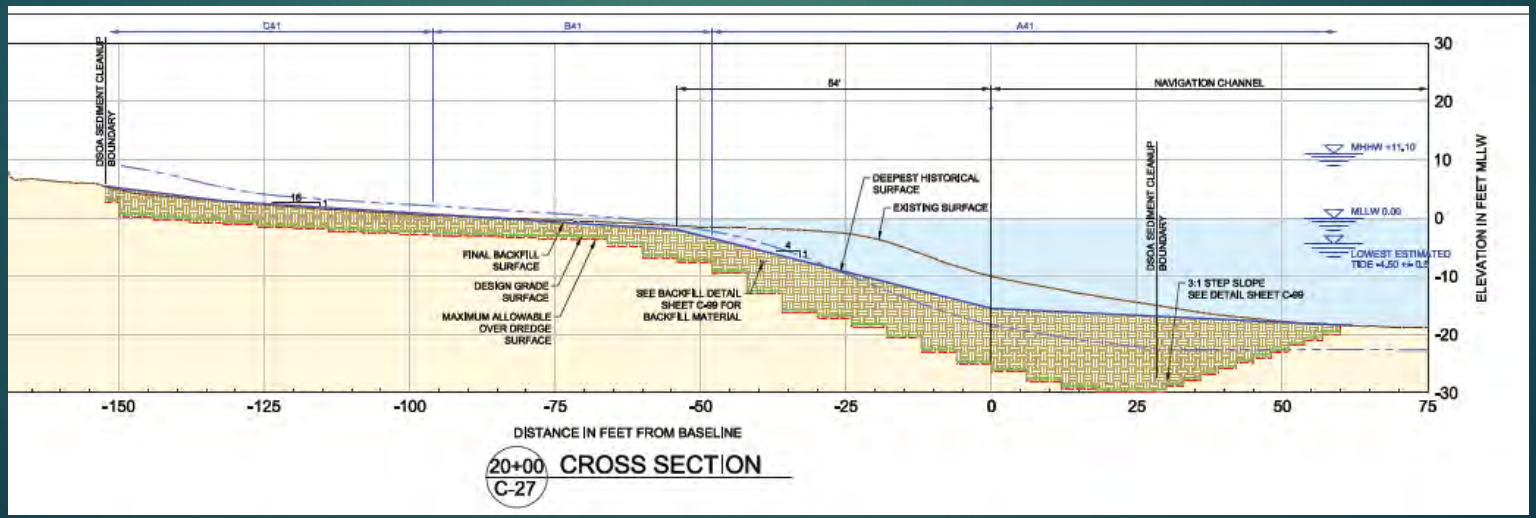
RDM-3. Dredge to Design Grade

- The contractor shall dredge to the design grade, which will be verified by daily bathymetric surveys by the contractor.





RDM-4. Excavator Dredge

- An excavator shall be the primary dredging equipment

RDM-5. Derrick for Debris Removal

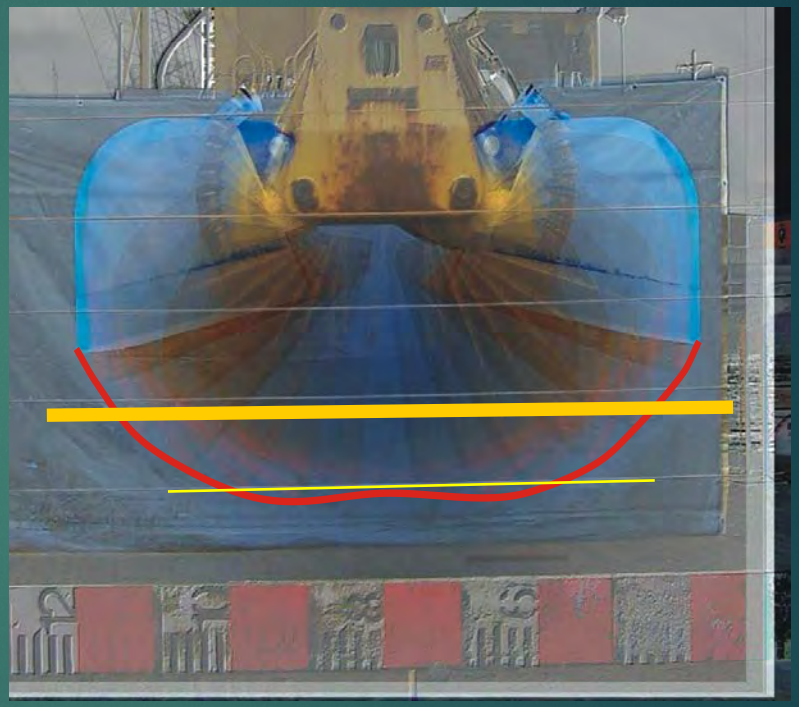
- A conventional clamshell dredge may be required to remove large debris or denser sediment deposits.

RDM-6. Enclosed Environmental Bucket

- Use an enclosed environmental type bucket to limit dredged material loss to the extent possible.

RDM-6. Double-Arc Closing Bucket
Less remolding of sediment

Young Manufacturing
Rehandling Clamshell Bucket



Surrounding Closure
Near level-cut, center 2/3
Less remolding

RDM-6. Less Remolding with Double-arc Bucket

Remolding + Water = Flowable

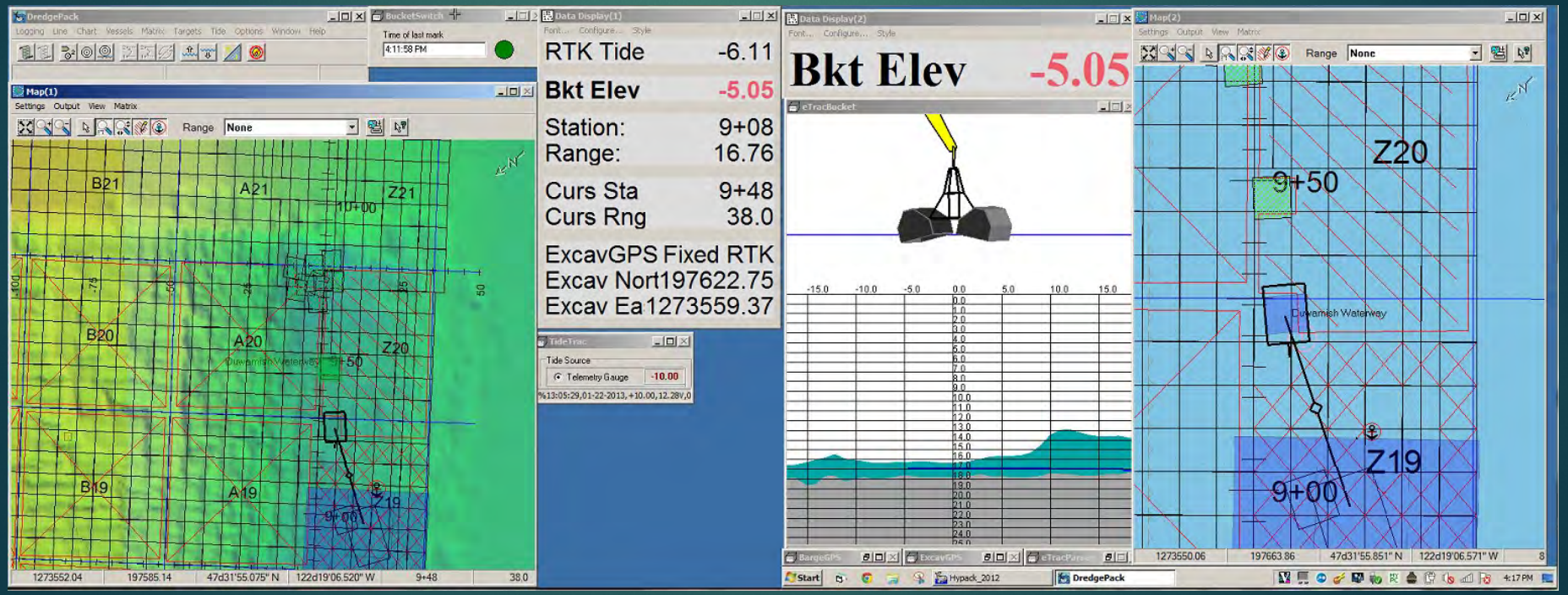
Limited Disturbance = Stackable

RDM - 7. RTK - GPS Electronic Positioning

Use appropriate GPS -based system for accurate bucket positioning.

RDM - 7. RTK-GPS Electronic Positioning

The contractor shall use sub-foot accuracy GPS - based system for accurate bucket positioning.



RDM - 8. Project Staff Understand Project Objectives

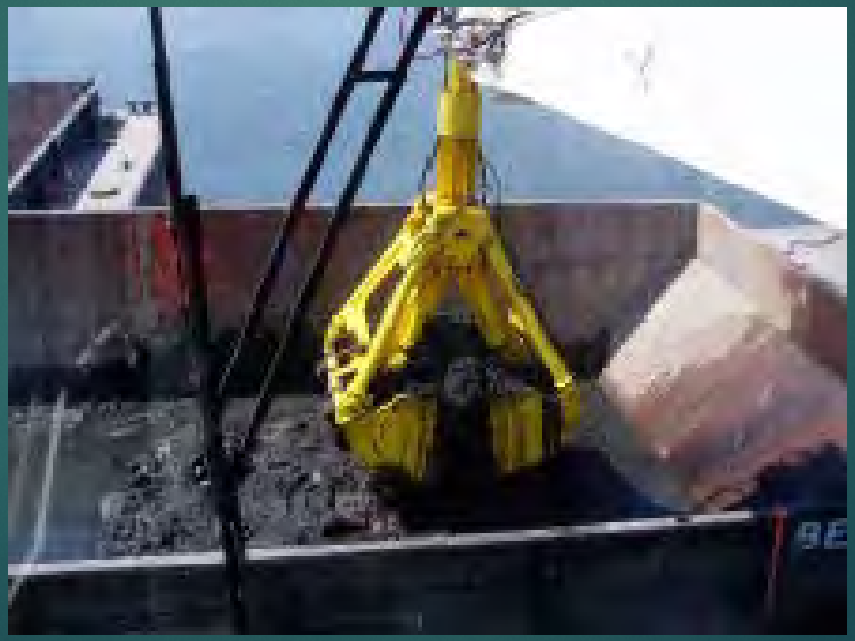
Environmental dredging is not the same as navigational dredging or other types of marine construction

RDM-9. Perform Work Consistent with Project Objectives

- Perform dredging in systematic manner intended to:
  - Reduce resuspension and residuals
  - Avoid repeated post-dredging chemical monitoring and associated re-dredging cycles
- Development of a reliable EoC DTM and dredge plan

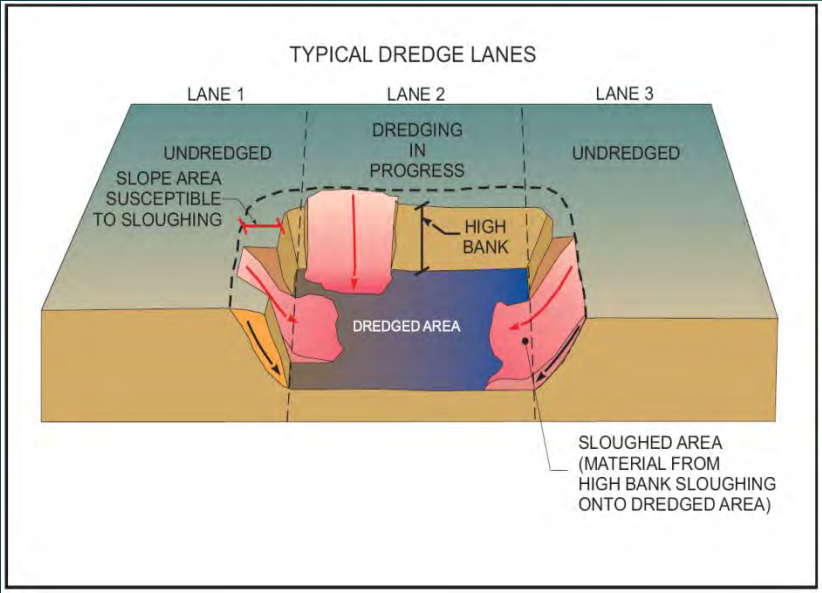
RDM-10. No Overfilled Buckets

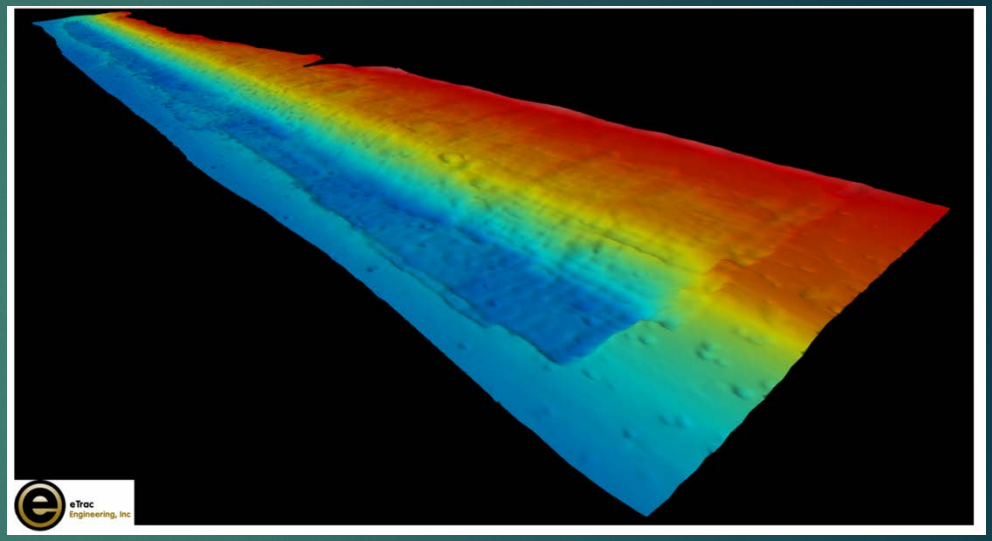
- Avoid targeting of too high of a bucket fill factor during dredging
- Overfilled buckets = increased generated residuals and resuspension
- Plan to manage water generated



RDM-11. Stair-Step Dredge Cuts

The contractor shall use stair-step dredge cuts for steeper slopes to reduce sloughing.





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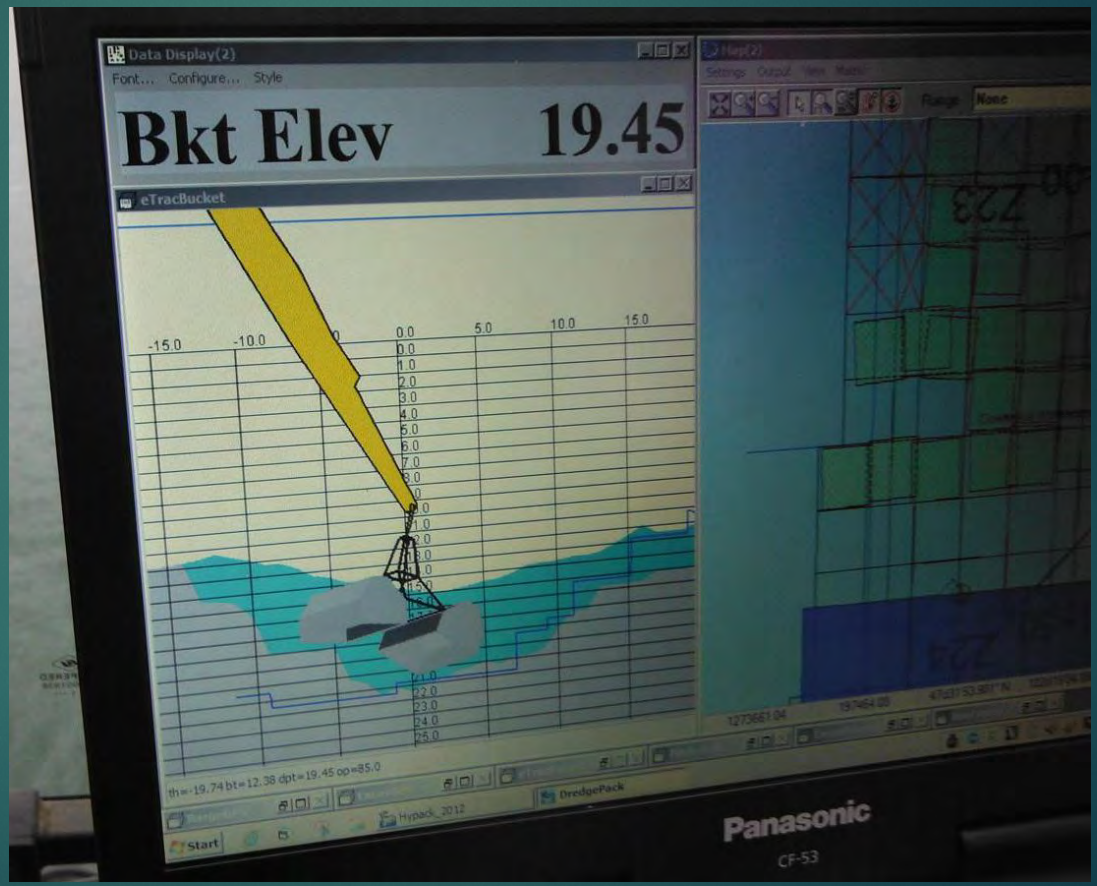
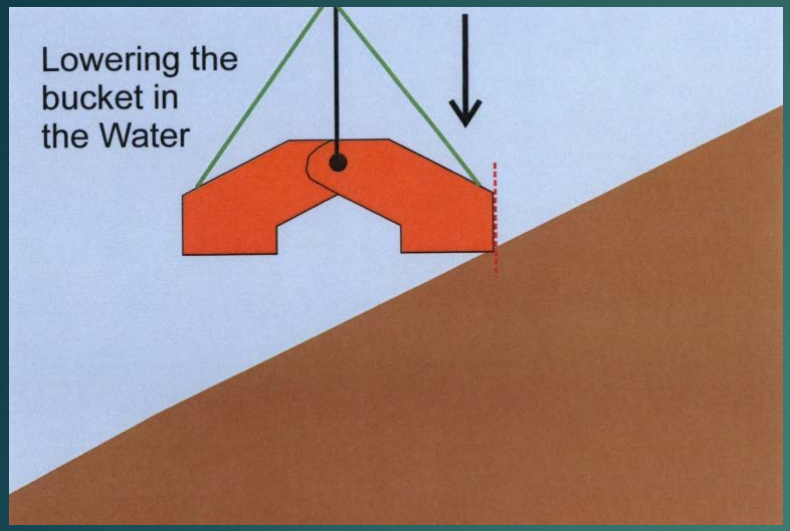
RDM-12. Excavator Dredge on Steep Slopes

Use an excavator dredge, as appropriate, for improved bucket control on steeper slopes.

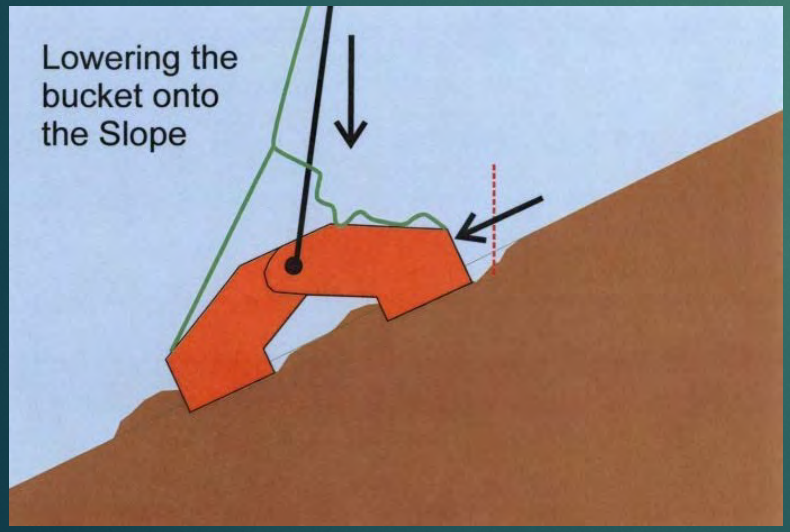


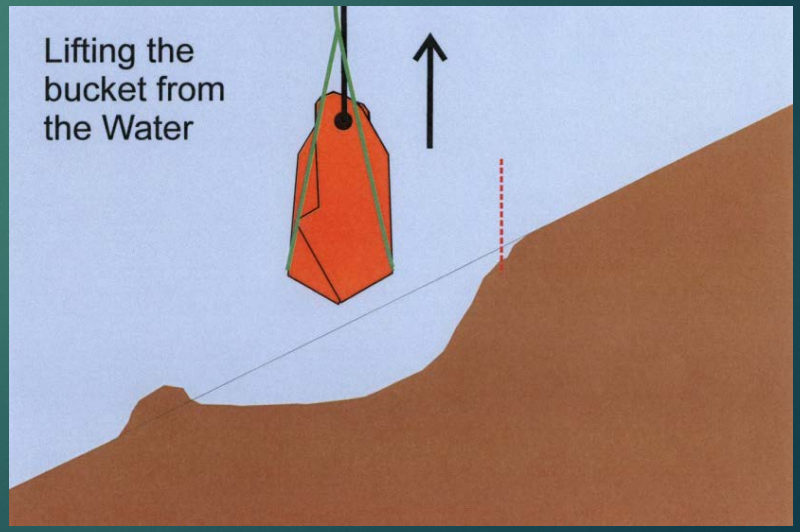
RDM-12. Concern with Derrick on Side Slopes



Derrick on Side Slopes

- Typical Clamshell Bucket tips when contact with upper slope
- Difficulty controlling depth of cut
- Disturb and slough slope material.



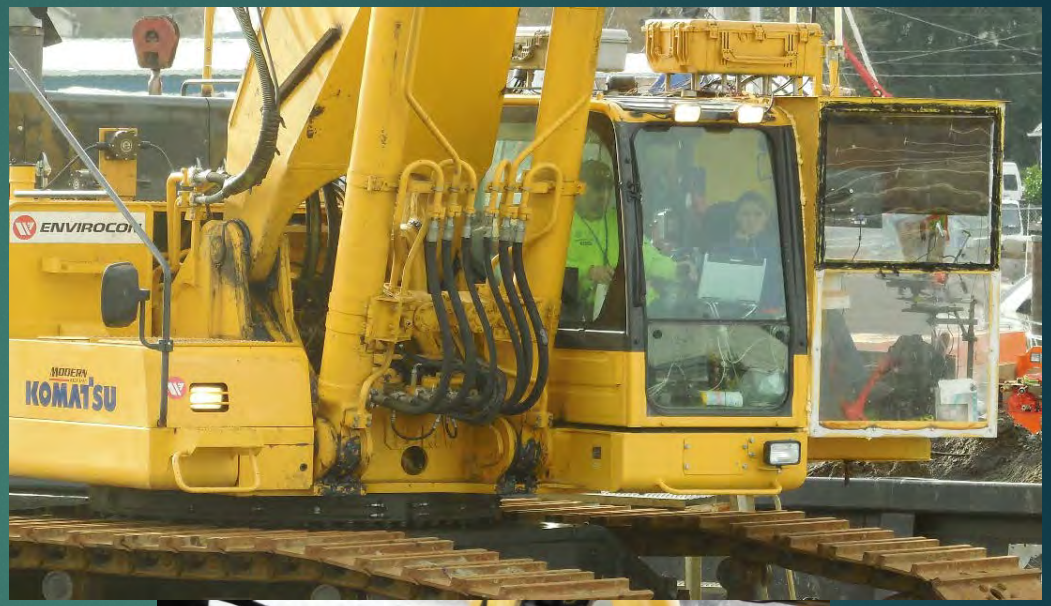


RDM-13. Remove water from barge, no overflow

Remove dredge water from dredged material barges during dredging for processing and management as dredge return water. No direct overflow will be allowed.

RDM-14. Active Oversight and Monitoring

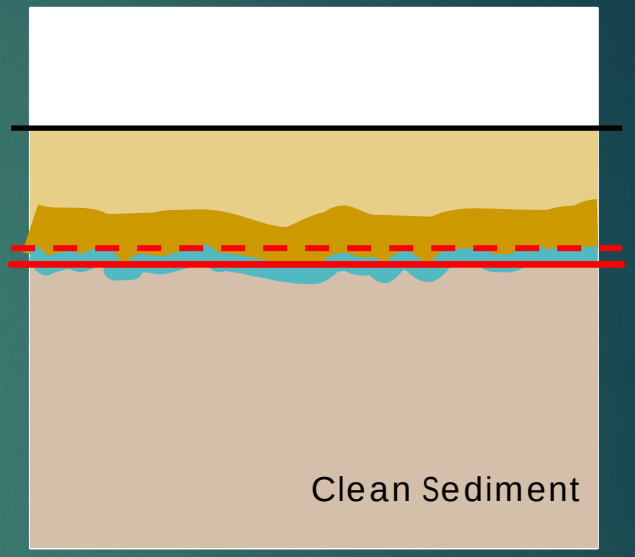
Dredge Engineer in Cab with Dredge Operator



RDM-15. Place Initial Backfill

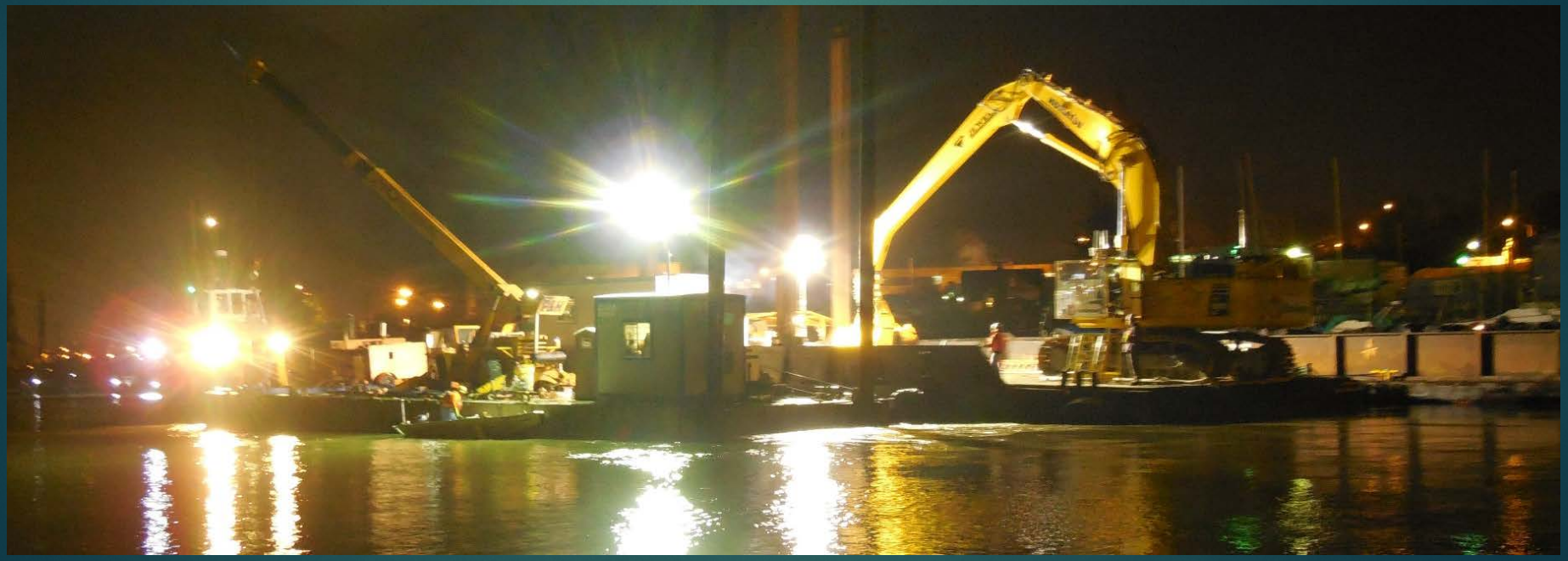
- Pre-defined dredge prism to specified elevations
- Complete the dredging to specified dredge prism
- Confirm dredging to EOC by hydrographic survey (95%)
- Immediately place initial sand cover of a few inches
- Followed by final backfilling

If have minor residuals reduces ongoing release; also can reestablish slope stability



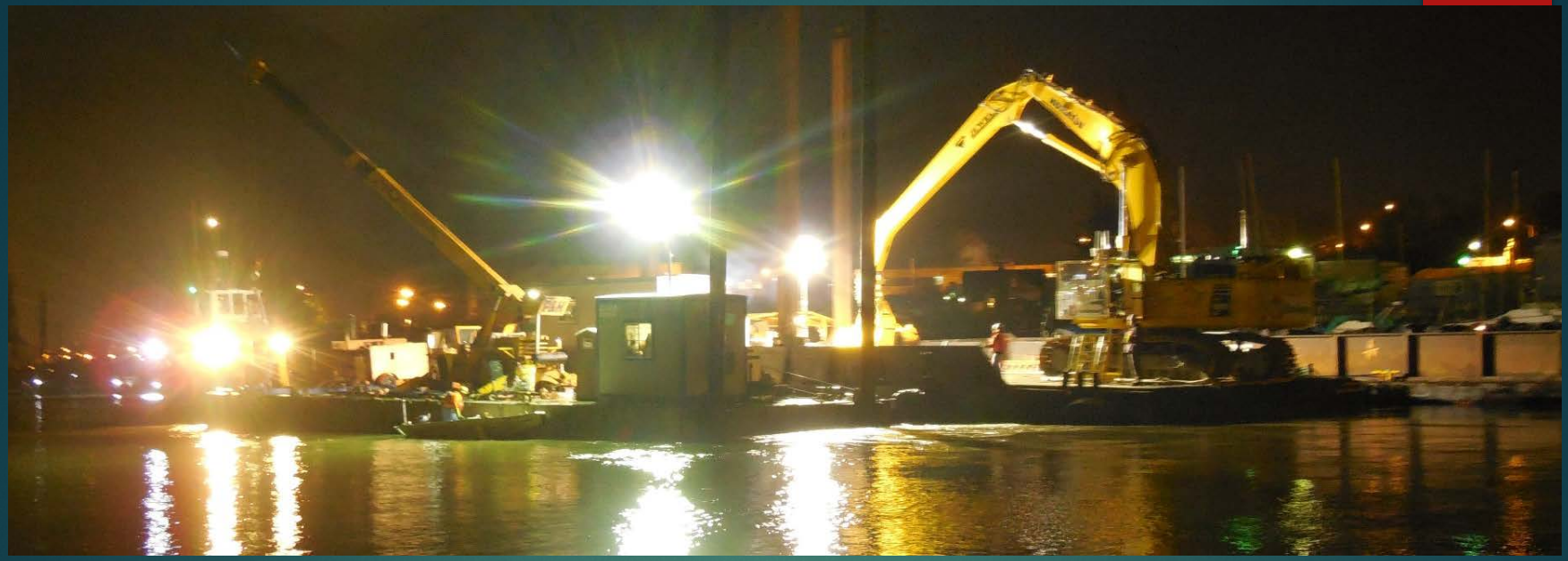
RDM-16. Manage Noise & Light to Allow 24 Hour/Day Operations

- Duwamish demonstrated work can effectively be performed in urban, residential areas day and night
- Reduces Costs and Schedule
- Requires Planning & Attention



Dredging Lessons **Confirmed for Reducing Residuals, Risks & Releases**

- **Dredge Engineer working with Operator** – Consistent Application of RDM's. Increases Efficiency & Production, Focus by Operator, Better Records.
- **Dredging RDM's** - effectively controlled/eliminated residuals, release and resuspension. Reduced overall risk.
- **Debris** - Increases Potential for Release and WQ Impacts
- **24 Hours/Day** - Dredging in Urban Waterway Can be Performed 24 Hours/Day



Questions?

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