



# Challenges and Considerations for Underpier Remediation Approaches



Presented by

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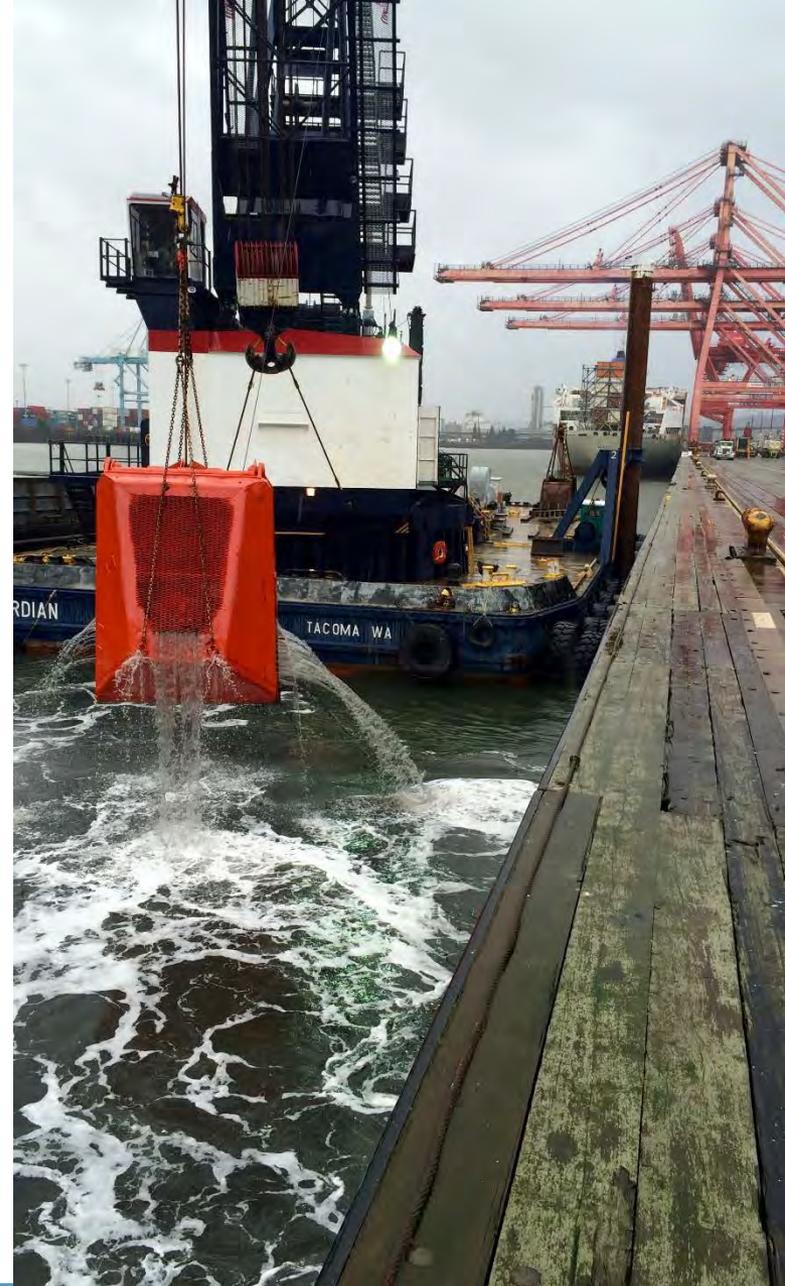
# Overview

- Technical Challenges
- Underpier Removal – Direct and Indirect
- Underpier Placement
- Quality Assurance of Material Placement



# Technical Challenges

- Assessment of existing condition
- Structural stability
- Reliability of information
- Physical conditions (piling, sediment composition, debris, utilities)
- Geometry of structure
- Accessibility and clearance
- Realistic expectations with owners and regulators



# Underpier Removal

- Feasibility considerations
  - Design
  - Debris, broken piles, and slope conditions
  - Condition of piling
  - Structural protection
- Direct or indirect material removal



# Direct Removal

- Decking removal or temporary relocation
- Mechanical dredging (if sufficient space)
- Excavator with telescoping arm
- Dragging (and temporary stockpiling)
- Hydraulic dredging



## Direct Removal (cont.)

- Esquimalt Graving Dock, BC, Canada
- “Dragging” sediment from below structure





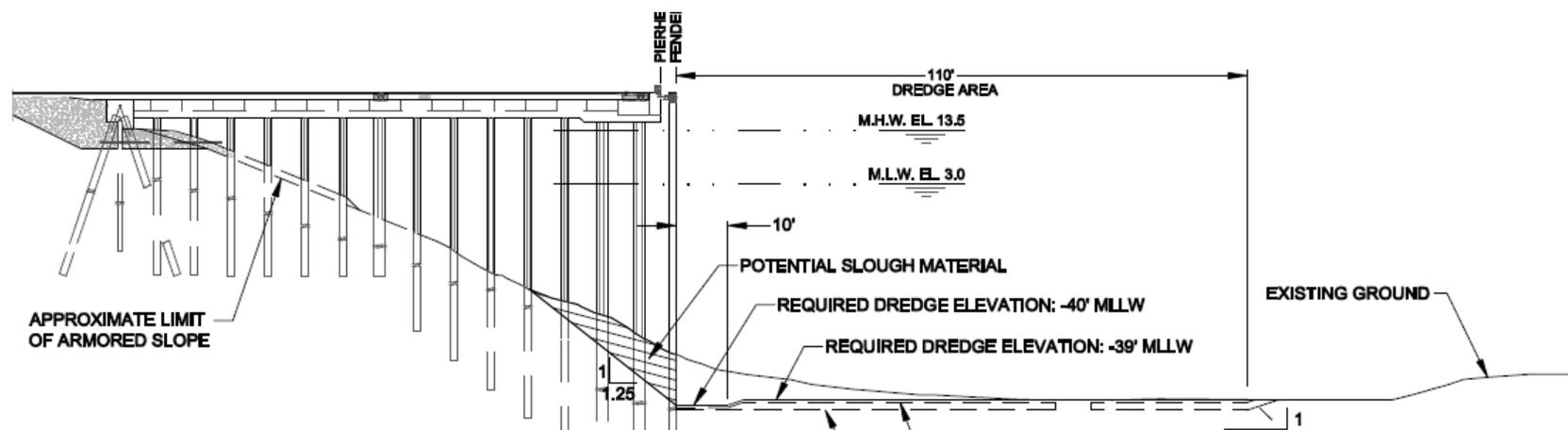
## Direct Removal (cont.)

- Diver-assisted hydraulic dredging
  - Archer Rowing Dock, Long Beach, California
  - Esquimalt Graving Dock, BC, Canada
  - Des Moines Marina, Des Moines, WA
  - Meydenbauer Marina, Bellevue, WA



# Indirect Removal

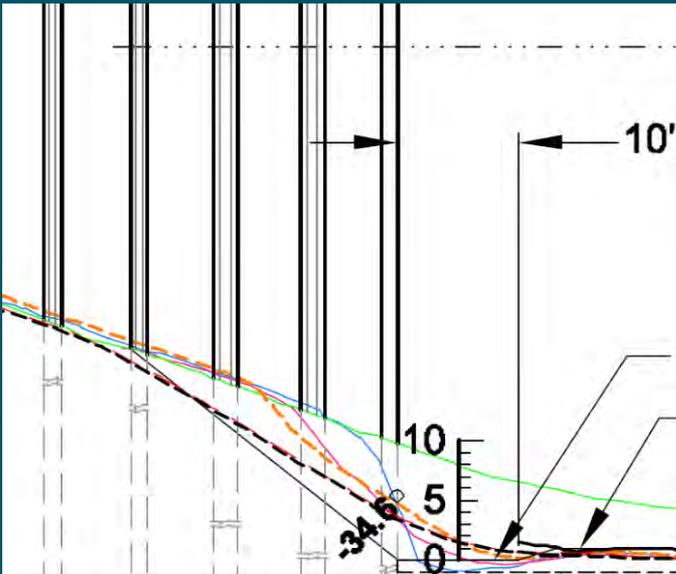
- Considered when direct removal is not feasible
- Dredge immediately adjacent to structure to promote controlled sloughing
- Dredge outcome difficult to predict
- Consider structural limitations and effects on piling





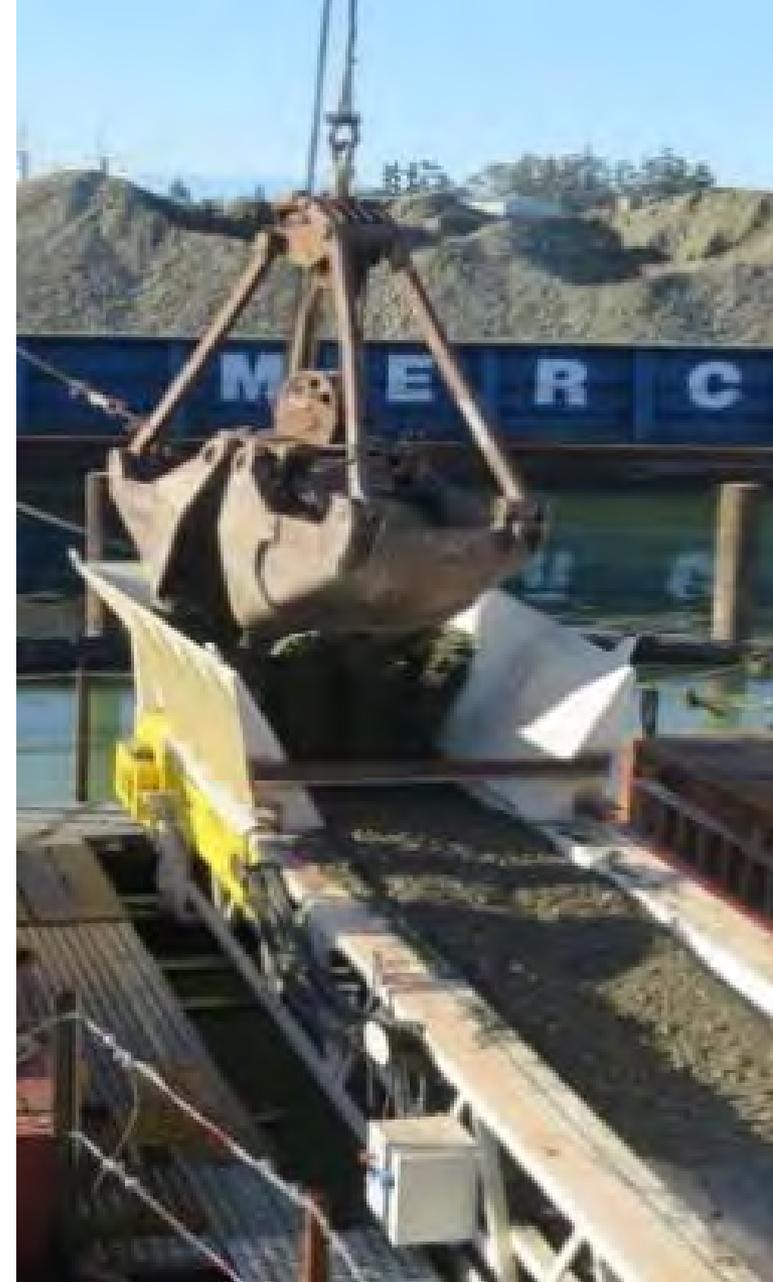
## Indirect Removal (cont.)

- Port of Olympia, Washington
  - Dredged at wharf edge
  - Controlled sloughing
  - Steeper slough angle than anticipated



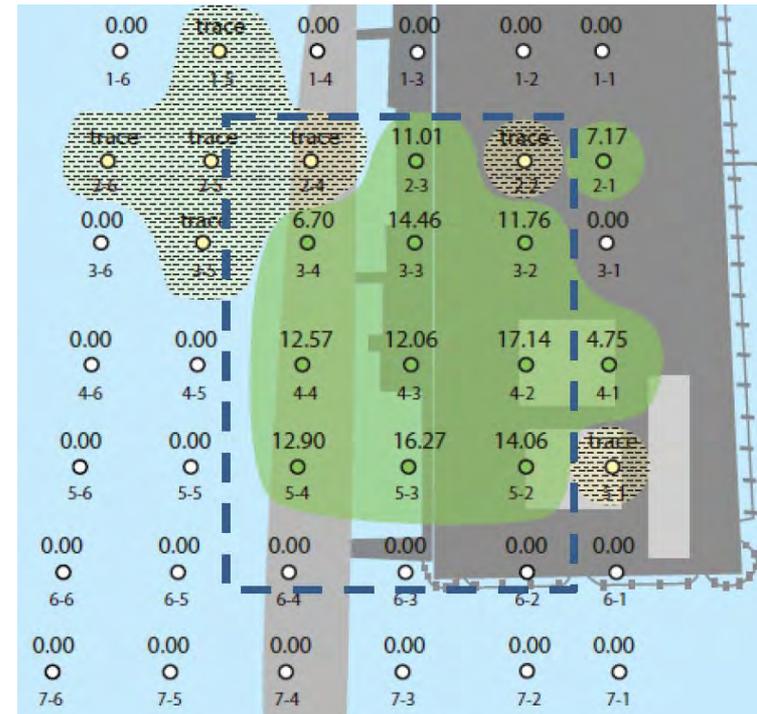
# Underpier Placement

- Can be more feasible than removal
- Methods
  - Temporary “windows” in structure
  - Manual placement at low tide
  - Telescoping conveyor
  - Pneumatic placement
- Containment berms or walls



# Underpier Material Placement

- Telescoping Conveyor
  - San Diego Shipyards
  - Esquimalt Graving Dock
  - Puget Sound Naval Shipyard
  - Todd Shipyard
  - Campbell Shipyard



# Pneumatic Underpier Material Placement

- San Diego Shipyards



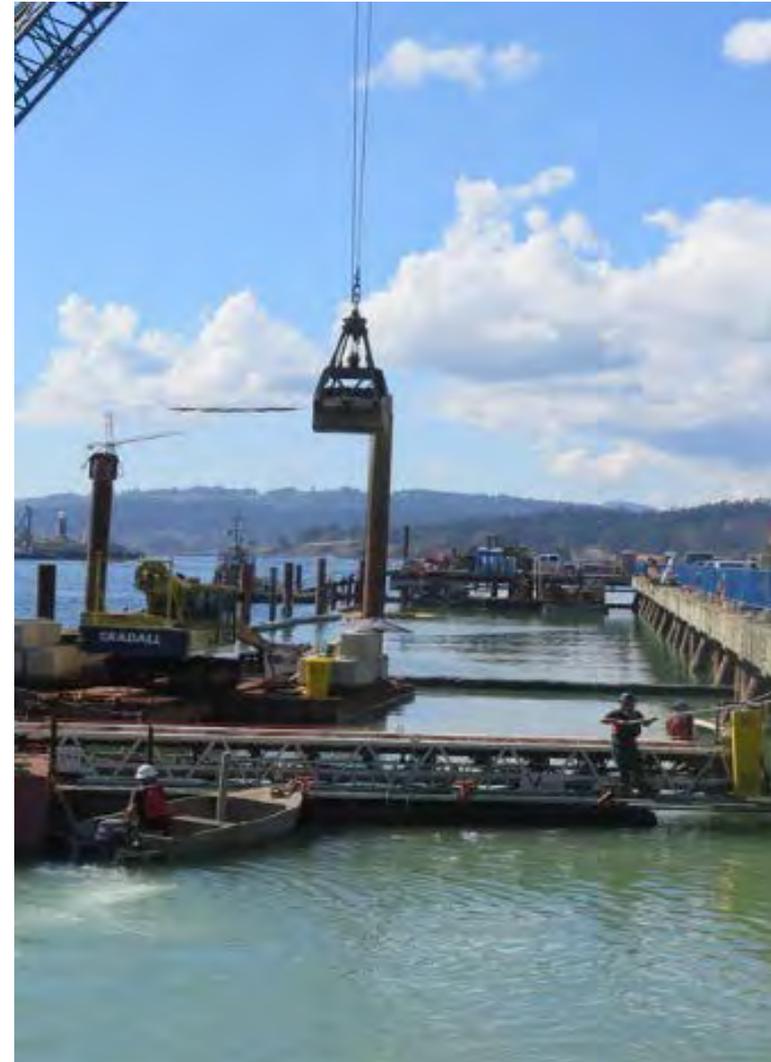
# Quality Assurance of Material Placement

- Multi-beam bathymetric survey
- Mark and measure via leadline
- Direct observation by divers
- On-land trials, but may not be representative
- Test area



# Closing

- Significant challenges of underpier work
- Structural considerations
- Equipment and methods
- Low production rates
- Quality assurance
- Set realistic expectations



# Questions/Discussion

