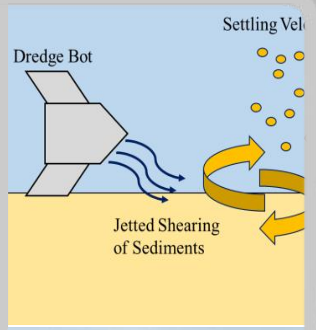
North Carolina Ports Water Injection Dredging (WID) Results and Implications for Research and Development at Tuttle Creek



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11/17/2022 Kansas Governor's Water Conference

North Carolina Ports Water Injection Dredging (WID) Results and Implications for Research and Development at Tuttle Creek

- **Traditional Dredging Methods**
  - Hydraulic
  - Mechanical
- **Hydrodynamic Dredging**
  - Agitation & Plow
  - Water Injection Dredge (WID)
- **North Carolina State Ports Authority (NCSPA)**
  - U.S. Army Engineer Research & Development Center (USACE-ERDC) Monitoring Program
- **Summary**


Port of Morehead City, Ocean Inlet

Hydraulic Cutter Suction Dredge

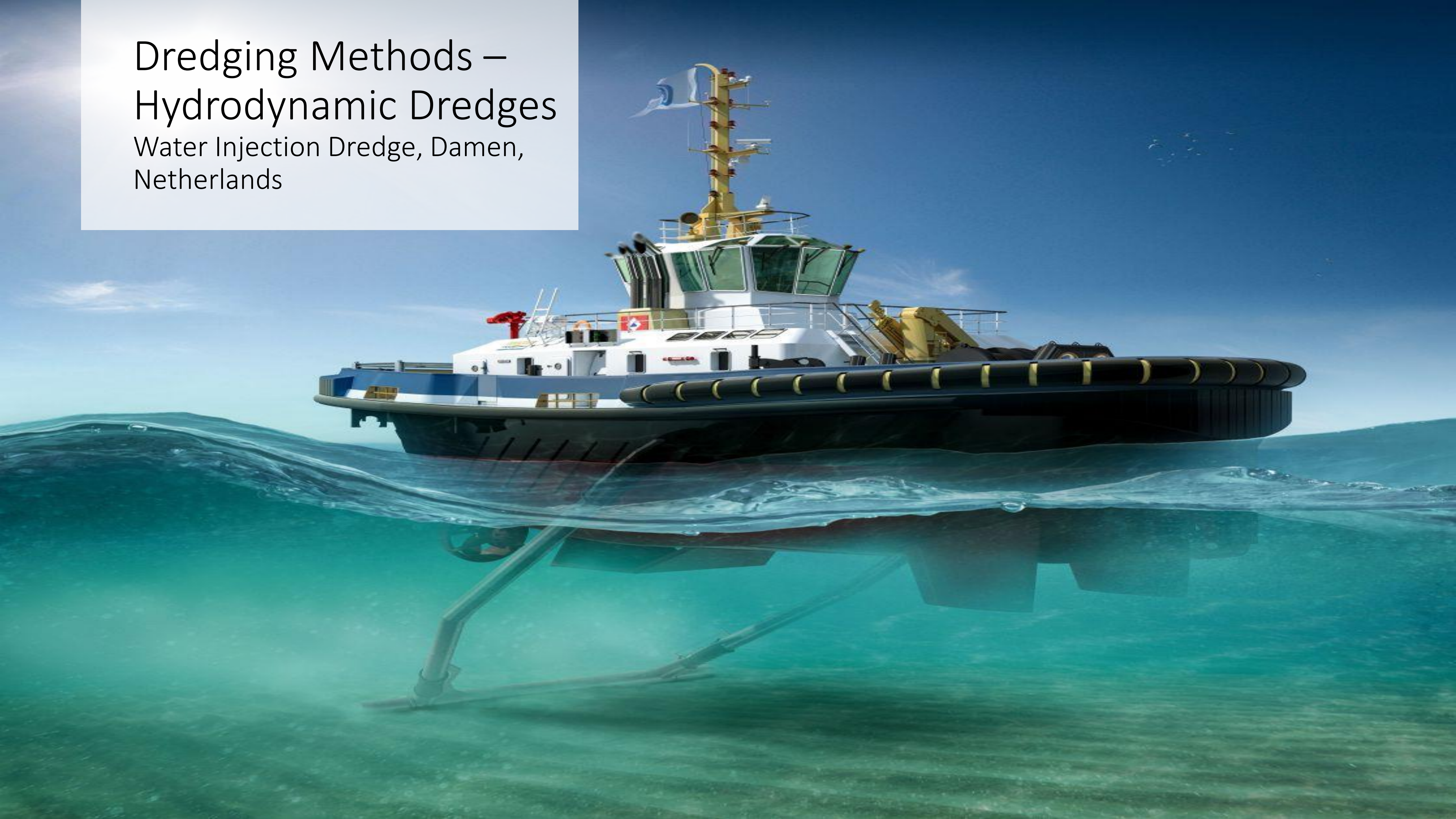
Courtesy Damen

Mechanical Backhoe Dredge

Courtesy Boskalis

Dredging Methods – Hydrodynamic Dredges

Water Injection Dredge, Damen, Netherlands



Dredging Methods

Hydraulic & Mechanical Dredging are ***traditional dredging*** techniques that hydraulically or mechanically remove sediments from a waterbody

In comparison, all ***Hydrodynamic Dredging*** techniques horizontally transport the dredged material ***entirely within the water column***

All ***Hydraulic & Mechanical Dredged*** sediments are ***transported*** using buckets, pipelines, hoppers, barges, etc.

All ***Hydrodynamic Dredging*** sediments ***flow through the water*** from the dredge area to the final disposal area

Types of Hydrodynamic Dredges

Agitation & Plow Dredging disperses the sediments from the bottom into the ***whole water column***

Water Injection Dredging fluidizes the sediments, creating a near-bottom ***density current*** with a higher density than the surrounding water

Plough Dredge, MDHY Intl, Netherlands

Water Injection Dredge, Damen, Netherlands

Water Injection Dredging

WID pumps water into channel bottom sediments at relatively ***high-volume & low pressure***

WID stimulates sheet flow wherein the ***fluidized sediment layer*** propagates horizontally along the waterbody surface

The objective is to remove the material from a selected area by taking advantage of the near-bottom ***density current***

- Tides
- Currents
- Gravity
- Other Hydrodynamic Forces

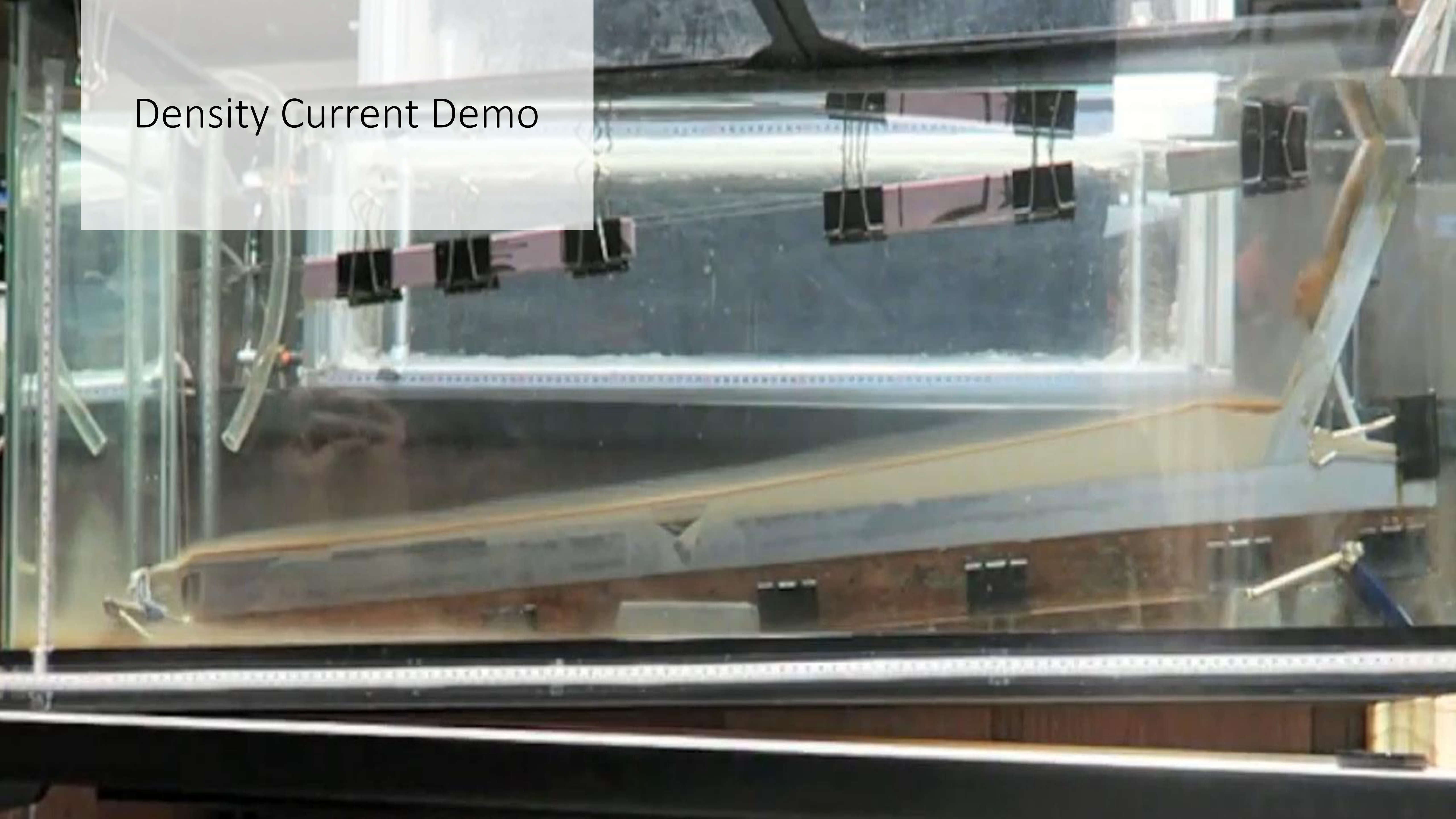
Osprey WID, IHC-America, NCSPA

Hydrodynamic Dredges – Water Injection Dredges

Osprey WID, IHC-America, NCSPA

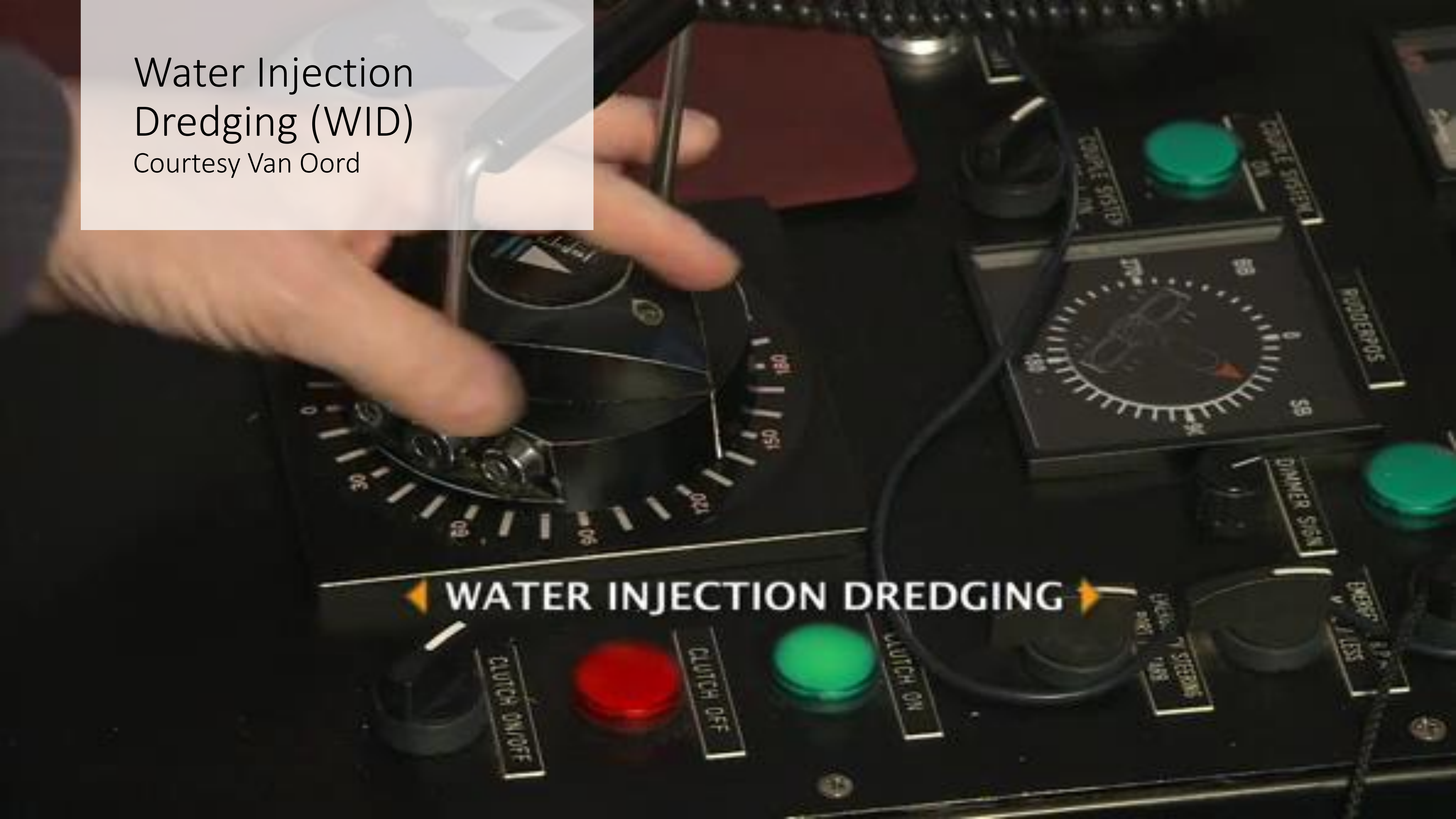
Osprey WID, IHC-America, NCSPA

Density Current Demo



Water Injection Dredging (WID)

Courtesy Van Oord



Environmental Considerations

WID cannot be used where ***unacceptable environmental impacts*** may occur

- Contaminated resuspension
- Suspended solids effects
- Site-specific impacts

Sediment transport modeling is required to determine the destination of ***dredged sediments***

WID has the ***ecological advantage*** as it does not disturb the sediment distribution & waterbody balance

All ***WID*** sediments ***must be analyzed for contaminants*** & most sediments will be appropriate for the dredging technique

Parameters that influence ***WID*** production include:

- Soil characteristics
- Site bathymetry & geometry
- Hydrodynamic conditions
- Geographic location
- Type & level of contamination
- Regulatory agency acceptance

Economic Benefits

Traditionally dredged sediments require more costly transportation, using pipelines, buckets, hoppers, barges, etc.

Traditionally dredged sediments require acquiring placement or disposal areas for the storage

Traditionally dredging costs:

- Mobilization/Demobilization
- Transportation & Storage
- Complex dredge plant O&M
- Lower production rates

In comparison, for all ***hydrodynamic dredging*** (including WID), the dredged material is transported ***entirely within the water column***

In comparison, for all ***hydrodynamic dredging*** (including WID) techniques, the sediments ***flow through the water***

Optimized hydrodynamic dredging

- Rapidly moved on short notice
- No disposal facilities required
- Reduced dredge plant O&M
- Higher production rates

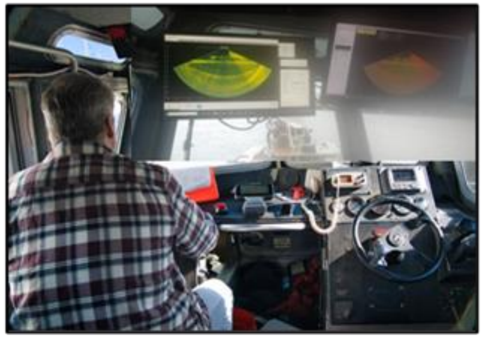
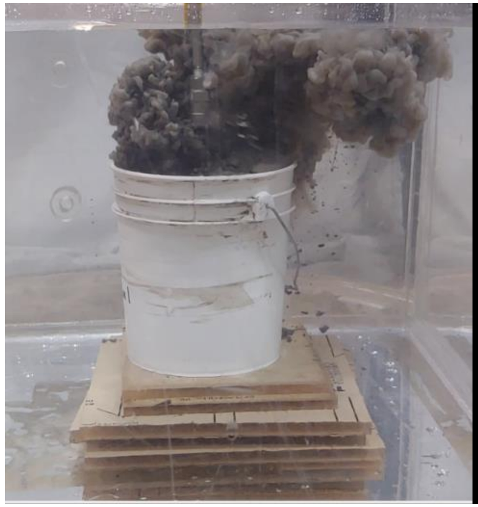
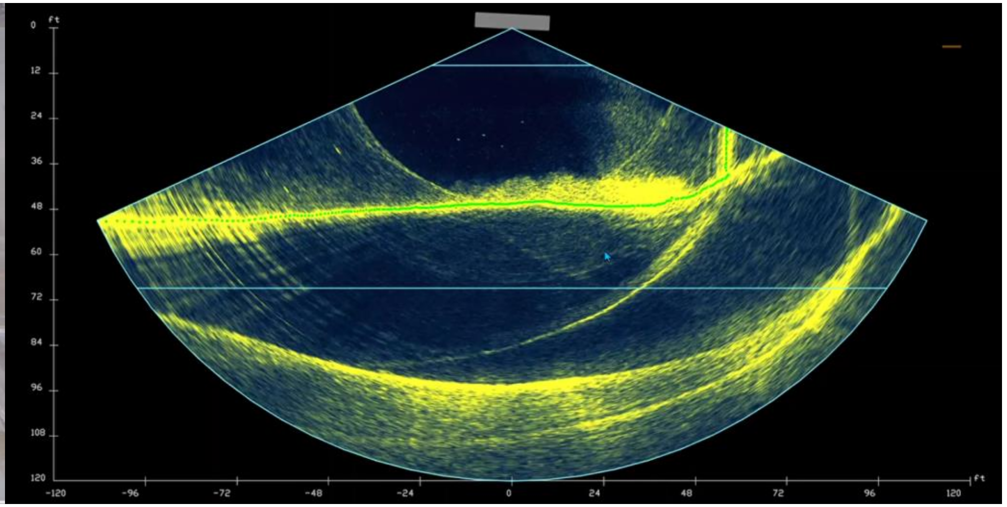
WID NCSPA

Innovative Dredging Research – WID Monitoring
U.S. Army Corps of Engineers
Engineering Research & Development Center
Dredging Operations & Environmental Research Program

Research Objectives

- Develop geotechnical screening criteria to determine the fluidization potential of sediments for WID operations
- Monitor & measure WID density current, formation, transport, and deposition to improve predictive modeling capabilities

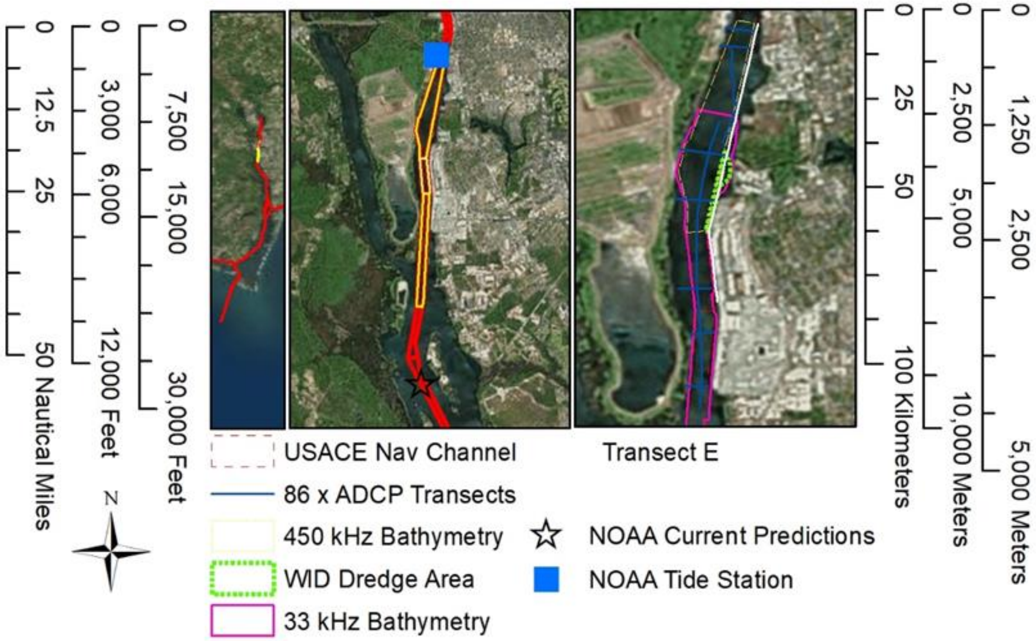


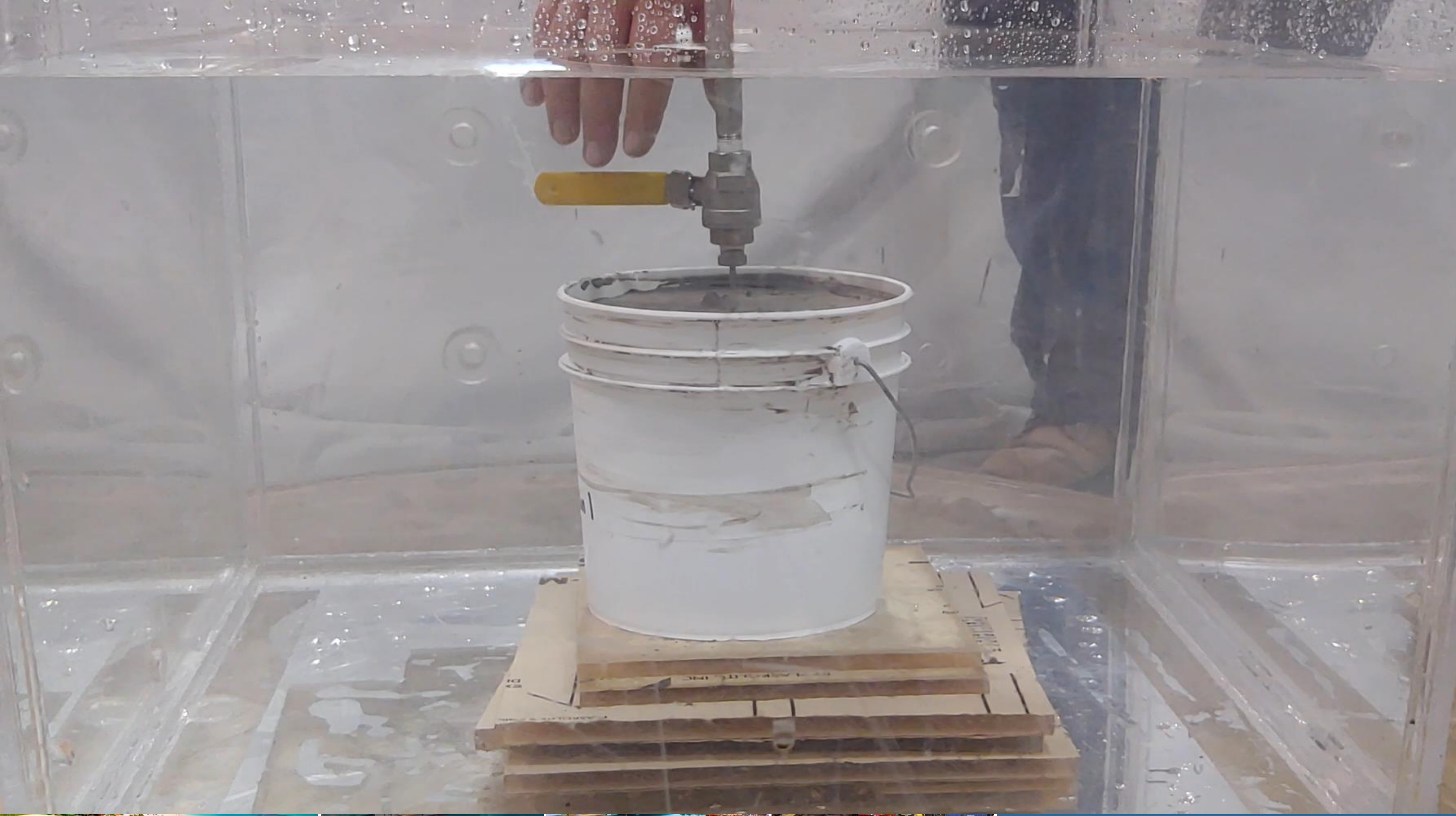




WID Monitoring - U.S. Army Corps of Engineers

Research Monitoring Program

- Fluidization testing of Wilmington Harbor sediment-August 2019
- WID operations monitoring at Wilmington Harbor- January 2022
    - Before & after dredging hydrographic surveys
    - During dredging acoustic doppler current profiling & backscatter surveys
    - Water column sampling, turbidity & density sonde casts





USACE-ERDC Monitoring Event

- Since June 2021
  - Dredged ~270,000 cubic yards (CY)
  - Approximately 90 hours
  - Production rate of around 3,000 CY/hr.
- NCSPA costs include:
  - Annual depreciation of the vessel
  - Annual insurance costs
  - Dredging operation costs
  - Fuel
  - Other O&M costs (repairs, parts, contract services, expendables, training unrelated to a dredging event, etc.)
  - Pre- & post-dredging surveying
- Estimated $1M per year in cost savings

Vessel	
Length Overall (ft)	88
Beam Overall (ft)	28.75
Draft (ft)	3
Max Dredging Depth (ft)	55
Sailing Speed (kts)	6
Dredge System	
Dredging Speed (kts)	1.5
WID Manifold Width (ft)	27.5
Nozzles (Number)	41
Nozzle Diameter I.D (in)	2
Max Rated Pump Pressure (PSI)	35
Max Rated Flow Rate (gal/min)	20,000
Production – January 2022	
Volume Dredged (cu yd)	70,990
Dredging Time (Hrs)	29
Production Rate (cu yd/hr)	2,448
Production – Oct/Nov 2021	
Volume Dredged (cu yd)	113,646
Dredging Time (Hrs)	32.5
Production Rate (cu yd/hr)	3,497

Osprey with jet bar deployed

Osprey with jet bar above water

Summary-Takeaways

The key benefit of WID is that horizontal ***transport*** of the dredged material takes place ***entirely within the water column***

Worldwide WID is a ***rapidly evolving field*** & will require educating regulatory agencies & the public

Traditional dredging is often as much about transporting & ***handling water*** as it is about the removed sediment

Four-part formula for WID success:

- Site conditions (sediment & hydrodynamic forces)
- Technical feasibility
- Legal & regulatory concerns
- Economics (benefits/costs ratio vs. cost only)

The ***WID technique*** dilutes & fluidizes the sediments, creating a ***near-bottom density current*** with a higher density than the surrounding water