A Custom-Built Water Injection Dredge (WID) for the North Carolina State Ports Authority (NCSPA)

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WEDA Eastern Chapter

Port of Morehead City, Ocean Inlet

Port of Wilmington, Turning Basin

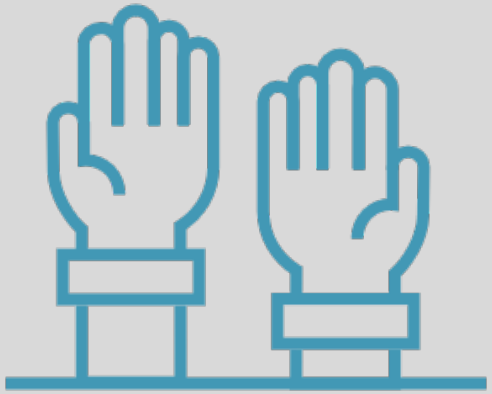
Outline

- **Dredging Methods**
  - **Mechanical & Hydraulic**
  - **Hydrodynamic**
    - **Agitation & Plow**
    - **Water Injection Dredge (WID)**
      - **Environmental Considerations**
      - **Economic Benefits**
- **Case Studies**
  - **North Carolina State Port Authority (NCSPA)**
  - **Port Tampa Bay (PTB)**
  - **Port of Charleston (SCPA)**
  - **Maryland Port Administration (MPA)**
  - **Kansas Water Office (KWO)**
- **Summary**
- **Discussion**

Presentation Format

Please ask Questions

Share your Perspective



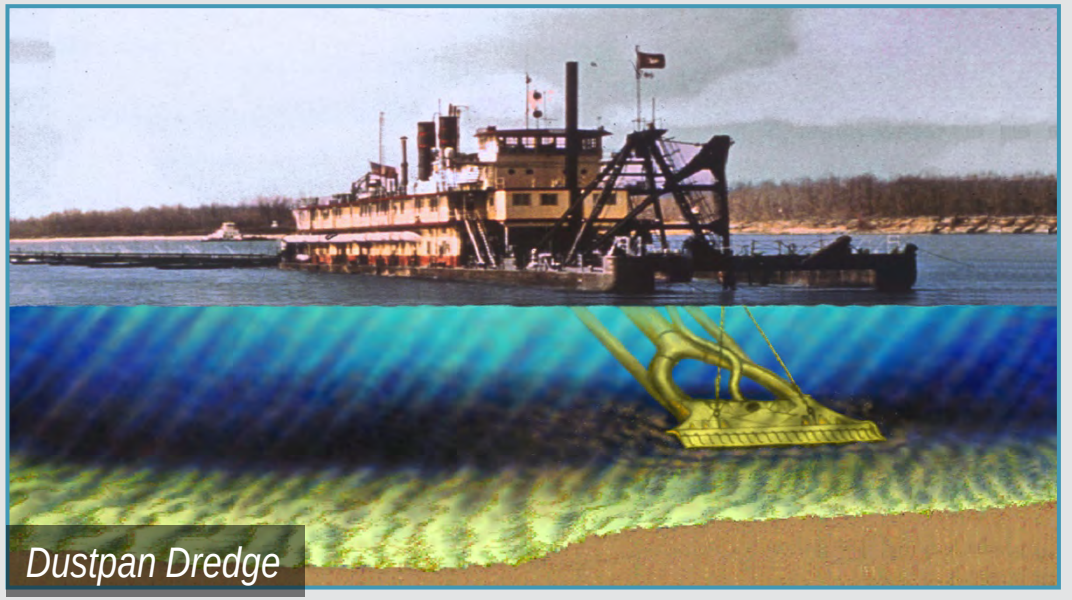
Active Participation

Dredging Methods - Traditional Dredges

Hydraulic Pipeline Dredge

Mechanical Dredge

Hopper Barge Dredge



Dustpan Dredge

Water Injection Dredge, Damen, Netherlands

Dredging Methods - Hydrodynamic Dredges

Comparison of Dredging Techniques

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

Plough Dredge, MDHY Intl, Netherlands

Water Injection Dredge, Damen, Netherlands

Boskalis Terra Plana Plough Dredge

Hydrodynamic Dredges – Agitation & Plow Dredging

Hydrodynamic Dredging - Agitation & Plow

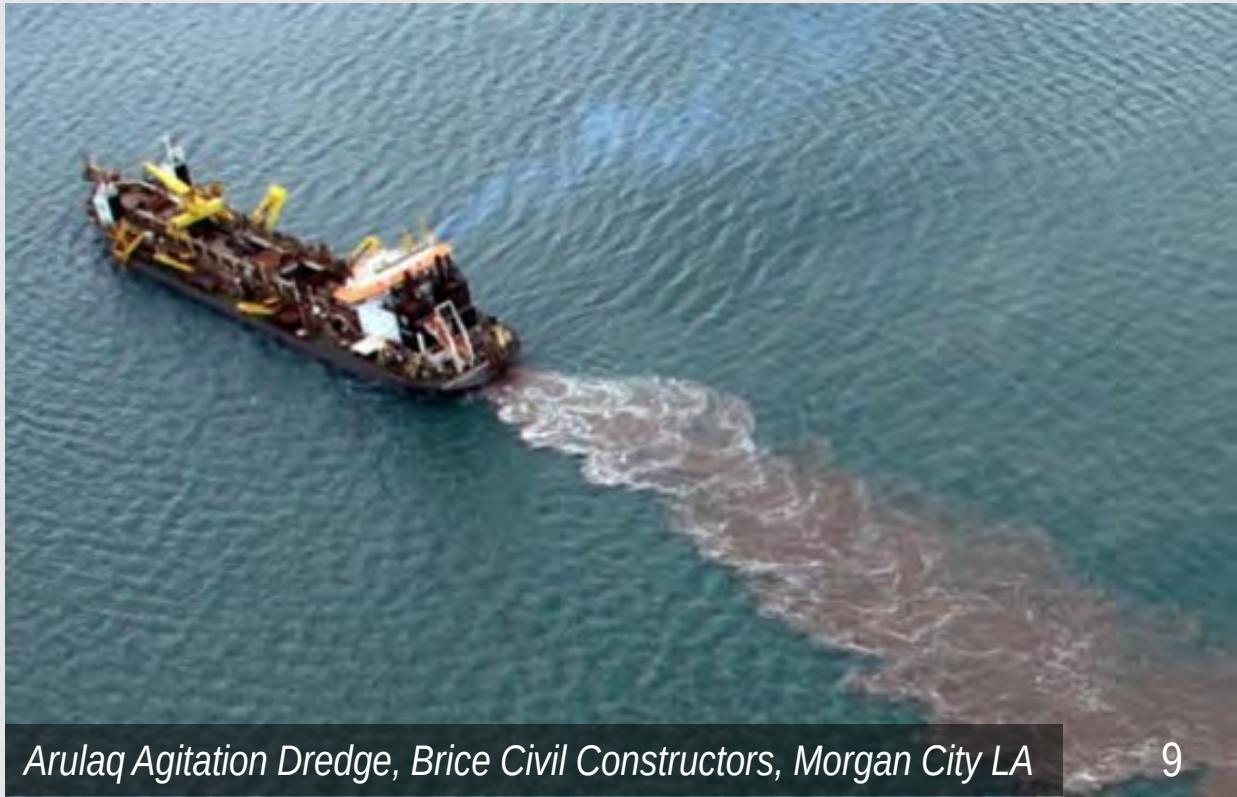
Agitation & Plow Dredging require:

1) Equipment that suspends sediments into the water column
2) Water flow that transports the sediment away from the site

Agitation & Plow Dredging produce a turbid water column & thus, at least temporarily, higher water quality impacts

Various means can be used for this process, including

- Prop-Wash
- Hopper Dredge overflow
- Vertical mixers or Air Bubbles
- Drag beams or Rakes (Plow Dredging)

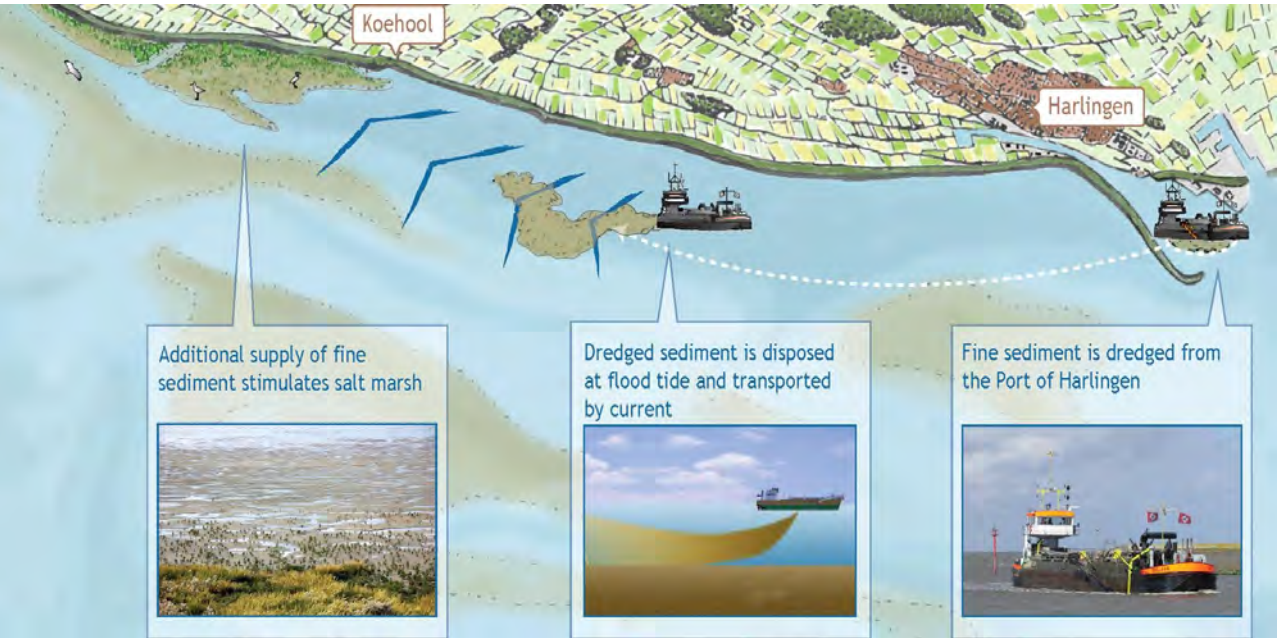


Arulaq Agitation Dredge, Brice Civil Constructors, Morgan City LA

Hydrodynamic Dredging - Agitation & Plow

Mud Motor: A semi-continuous source of dredged material (mud) is dispersed in a shallow tidal channel allowing natural processes to disperse the sediment to nearby mudflats & salt marshes

Sand Engine: Beach renourishment where a massive amount of sand is added to the coast & natural forces distribute the sand. Provides more beach, while reducing repeated ecological disturbance, at less cost



Osprey WID, IHC-America, NCSPA

Hydrodynamic Dredges – Water Injection Dredges

Water Injection Dredging

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

WID allows sediments to flow horizontally out of a waterbody using natural processes & forces, while the *fluidized sediment layer* remains close to the bottom

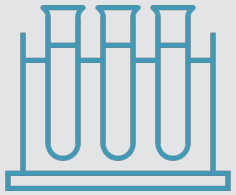
The objective is to remove the material from a selected area by taking advantage of the near-bottom *density current*

- Tides
- Currents
- Gravity
- Other Hydrodynamic Forces

Osprey WID, IHC-America, NCSPA

Density Current Demo

Environmental Considerations



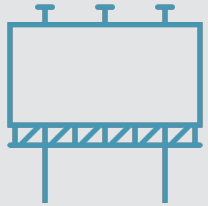
WID cannot be used where *unacceptable environmental impacts* may occur

- Contaminated resuspension
- Suspended solids effects
- Site specific impacts

Sediment transport modelling 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* & most sediments will be appropriate for the dredging technique

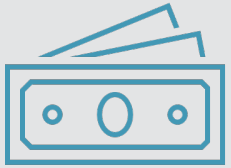


Parameters that influence *WID* production include:

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

Economic Benefits

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



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

Traditional 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 water*

Optimized ***hydrodynamic dredging***

- Rapidly moved on short notice
- Don’t require disposal facilities
- Reduced dredge plant O & M
- Higher production rates

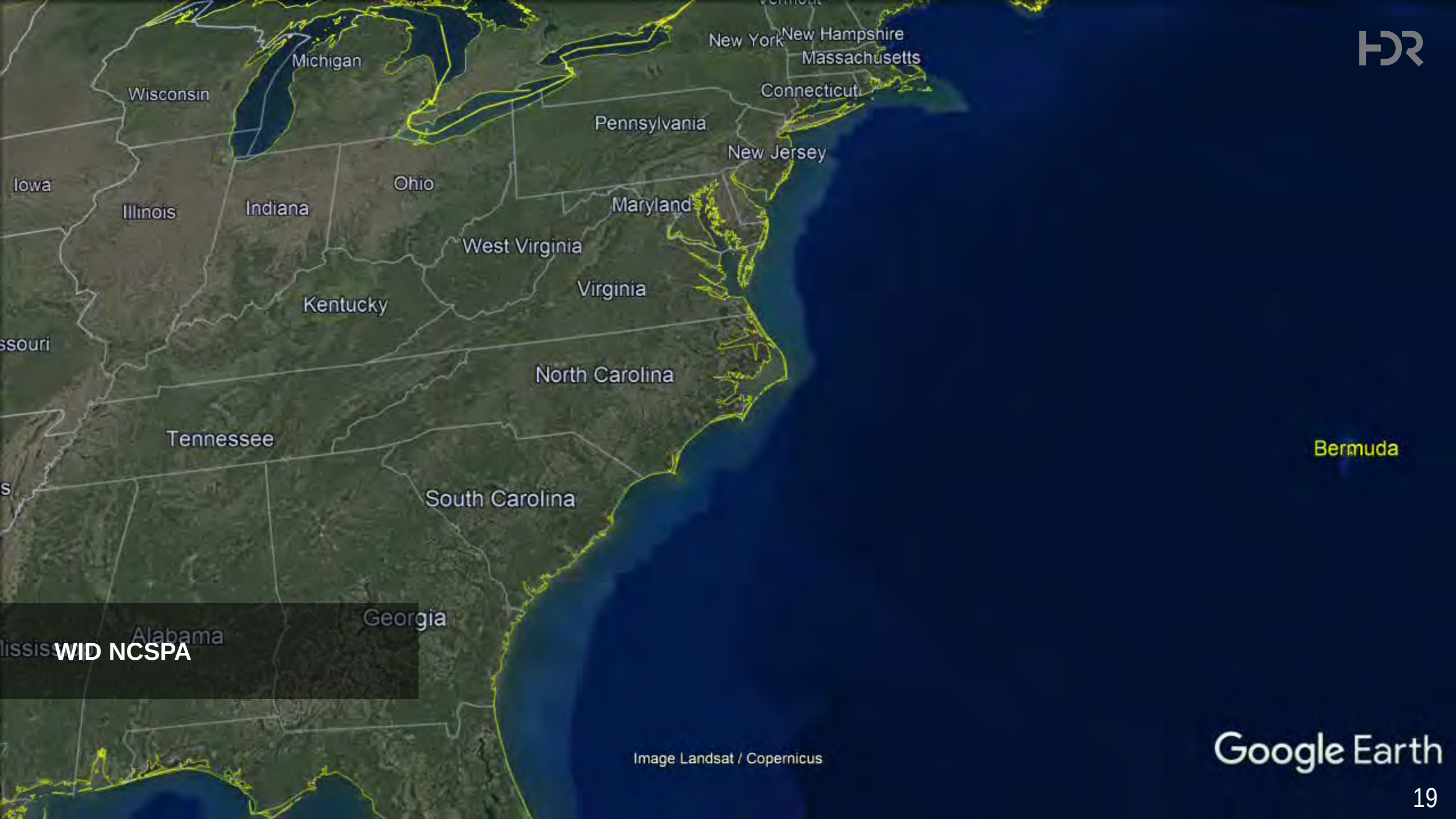
Case Studies

Osprey WID, IHC-America, NCSPA

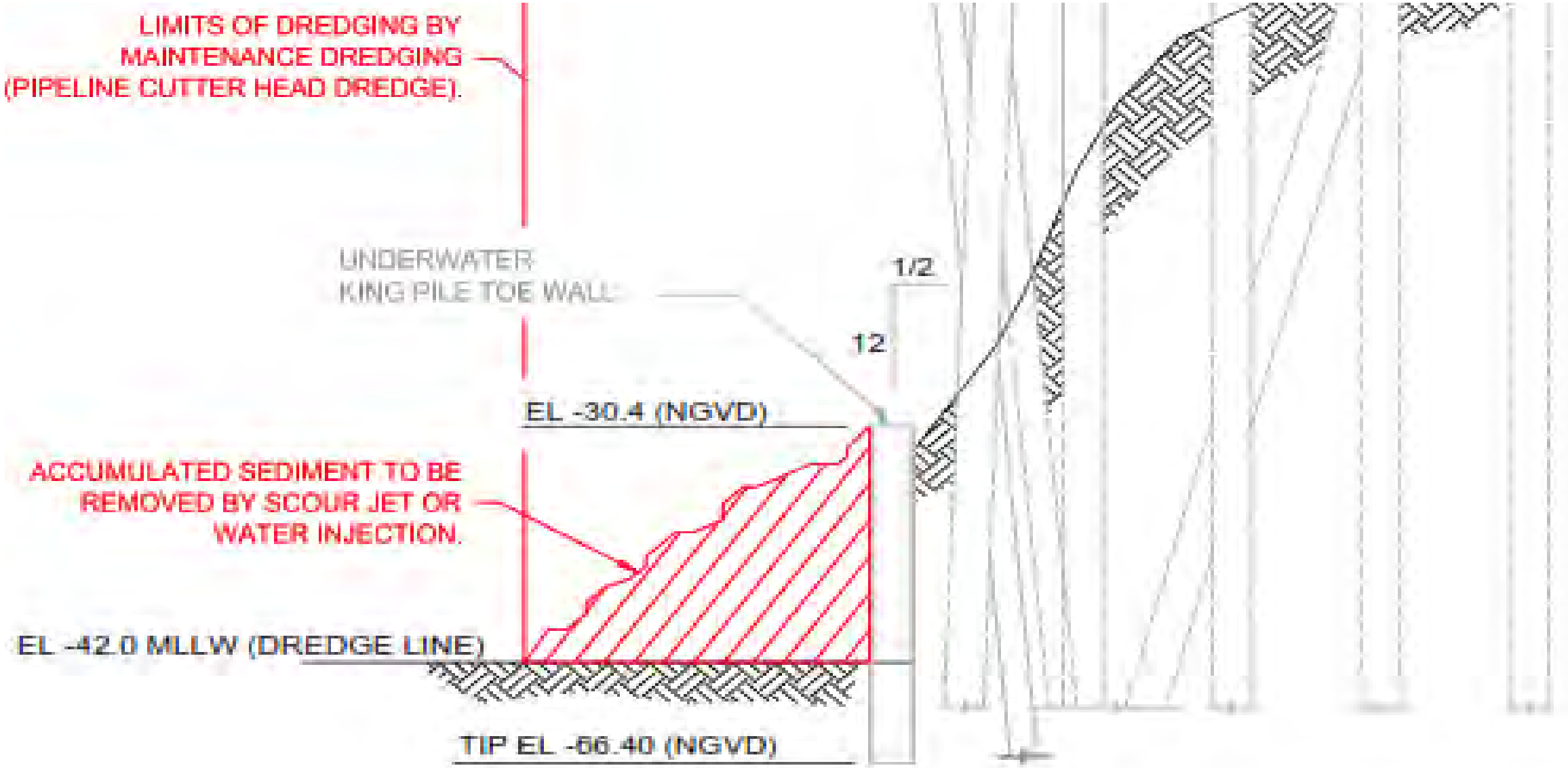
Water Injection Dredge (WID)

North Carolina State Ports Authority (NCSPA)

NORTH CAROLINA PORTS®


Michigan
Wisconsin
New York
New Hampshire
Massachusetts
Connecticut
Pennsylvania
New Jersey
Iowa
Illinois
Indiana
Ohio
Maryland
West Virginia
Virginia
Kentucky
North Carolina
Tennessee
South Carolina
Georgia
Alabama
Bermuda
WID NCSPA
Image Landsat / Copernicus
Google Earth

Dredging Template

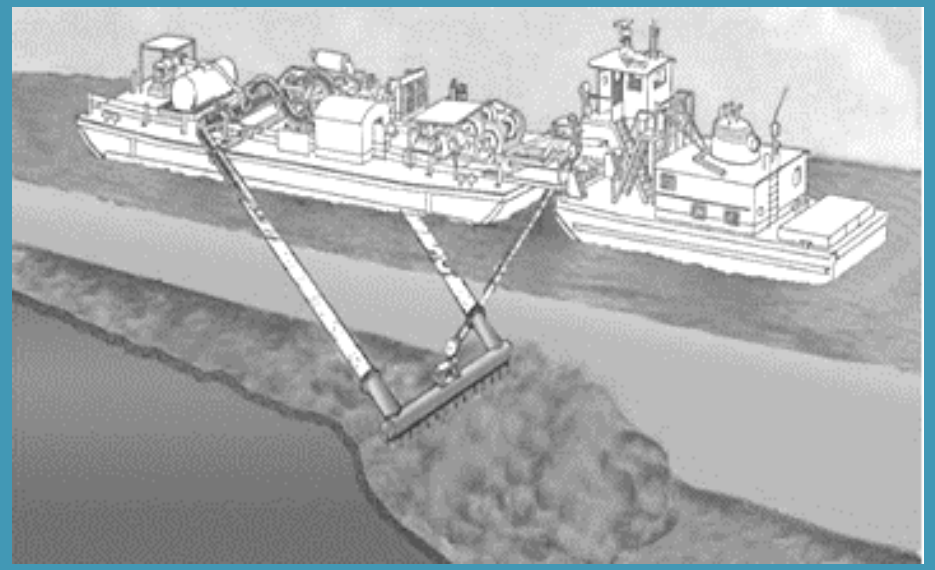


Project Approach

Procurement Fact Sheet

Contacted over ***70 organizations*** (dredge manufacturers & other possible sources of relevant information)

- ***Dredging related electronic newsletters***
- ***Trade publications***
- ***Trade show membership & attendance***
- ***Annual dredging related directories***
- ***Hydraulic agitation dredge operators***



The Jones Act

"Section 1 of the Act of May 24, 1906 (34 Stat. 204; 46 U.S.C. App. 292), provides that, "a foreign-built dredge shall not, under penalty of forfeiture, engage in dredging in the United States unless documented as a vessel of the United States."

Procurement Fact Sheet

- Solicited feedback from dredge manufacturers & others regarding several crucial project factors, including:
  - Preliminary schedule
  - Time needed to fabricate & transport the dredge to the NCSPA
- Other factors included those similar to any NCSPA purchase of large, expensive equipment, such as cranes
  - Maintenance
  - Warranties
  - Proof of concept demonstrations
  - Training requirement
  - Operation manuals

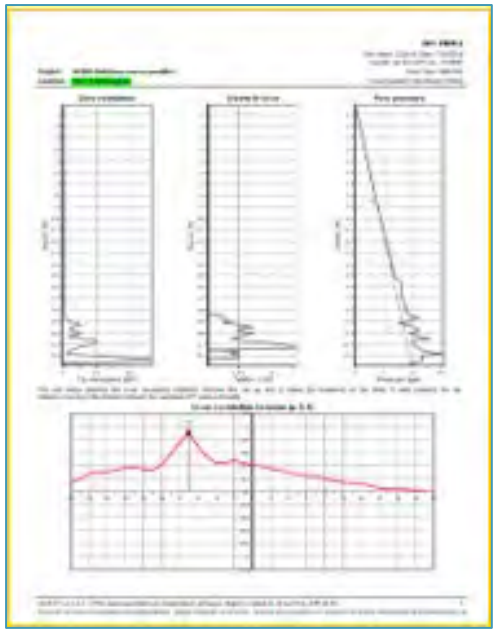
Request for Pre-Qualifications

Project sequence included the following work items:

- Commissioning of a fully equipped WID
- Delivery of WID to the NCSPA Ports of Wilmington & Morehead City
  - Execution of a Port operator's training program
  - Full week demonstration at each Port
- Report summarizing the Contractor's executed proof of concept, including pre- & post- dredge hydrographic survey data
- Modification of the WID plant, as necessary, & handover to NCSPA

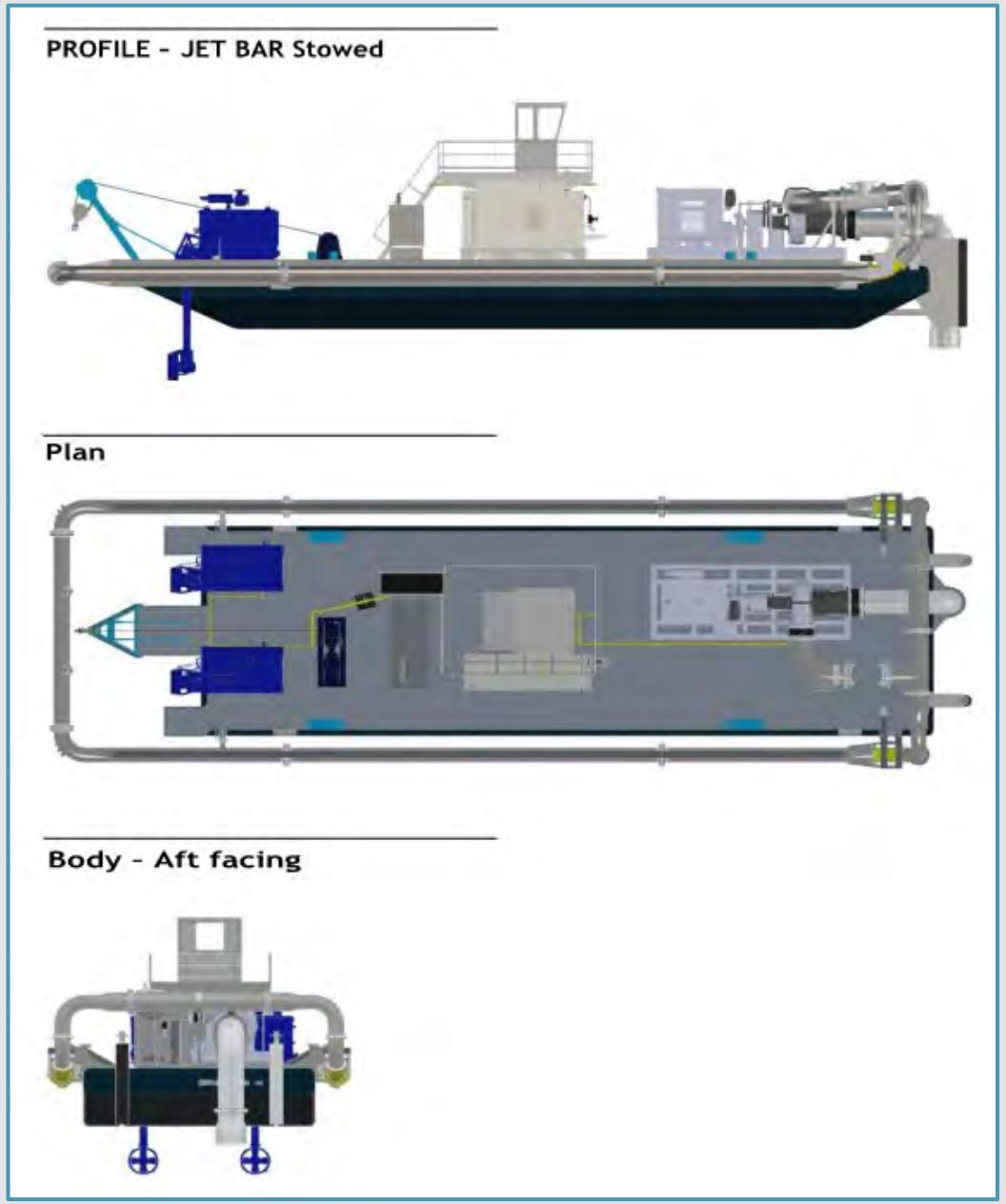
Request for Information & Geotechnical Data Collection

- Sediment characterization fieldwork performed at both ports late 2019
- Report documented the location of the samples (ponar grab & cone penetrometer test [CPT])
- Analysis included several unique sediment parameters
  - CPT Testing
    - Tip resistance
    - Sleeve resistance
    - Pore water pressure
  - Measurements to determine how well the material fluidizes
    - Post-decant solids mass loss
    - Slurry mass loss
    - Slurry volume loss



Request for Proposals (RFP), Selection, & Delivery

- **Design-Build RFP**
  - Issue RFP to all Potential Teams
  - Technical Proposals & Sealed Price Proposals Due
  - Technical Presentation by Teams
- **Selection & Delivery**
  - Recommend Selection – NCSPA Board of Directors Meeting
  - Final Selection – NCSPA Board of Directors Meeting
  - Contract Execution



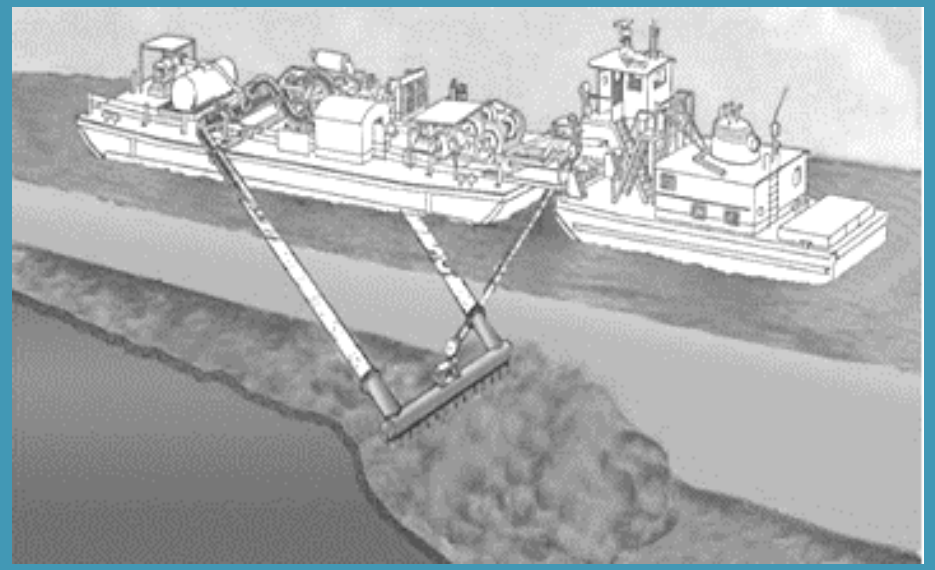
Summary

Several designs were submitted, but two firm's responses stood out:

- ***Modular Dredge & Barge Combination***
- ***Self-Contained Vessel***

Lessons Learned:

- ***Economics***
- ***Legal & regulatory concerns***
- ***Site conditions (sediment & hydrodynamic forces)***
- ***Technical feasibility***



Future Phases

WID Monitoring

- The USACE-ERDC is developing a dredging monitoring plan, with hopes of mobilizing in January 2022
- The study will
  - Compare pre- and post-dredging hydrographic surveys ‘upstream’ and ‘downstream’ of the WID
  - Establish production rates for the WID
  - Develop baseline dredging efficiencies for the WID, which the NCSPA will use to adopt alternative means and methods
  - Provide a better understanding of how the fluidized material is dispersed utilizing ADCP, turbidity sondes, density meters, and other technology

Dredging Efficiencies Investigation

Port Tampa Bay (PTB)

PORT TAMPA BAY™

Tampa Bay's Federal Waterways

USACE District:

All

USACE Channel:

All

Channel ID:

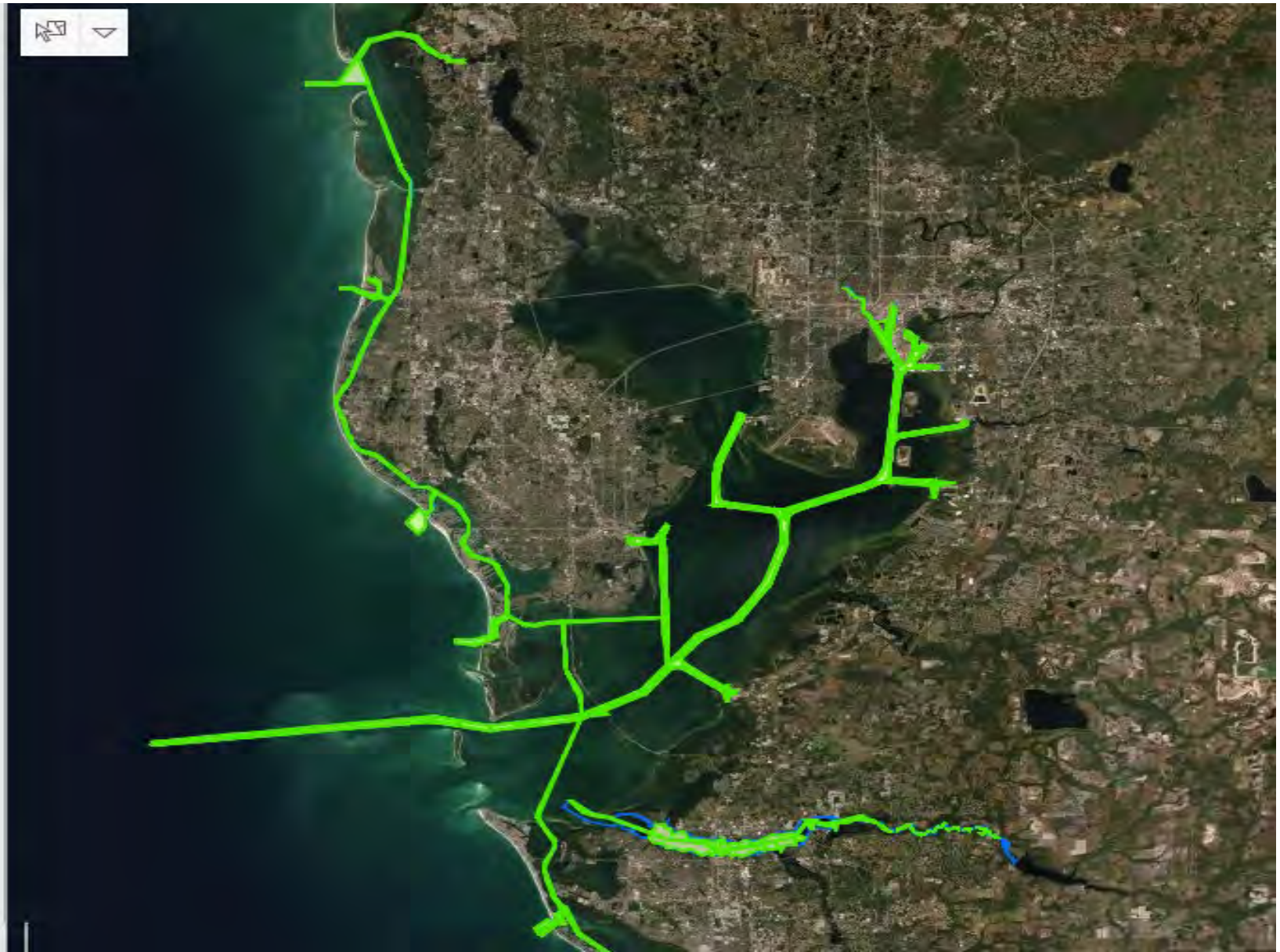
All

Survey Date Range:

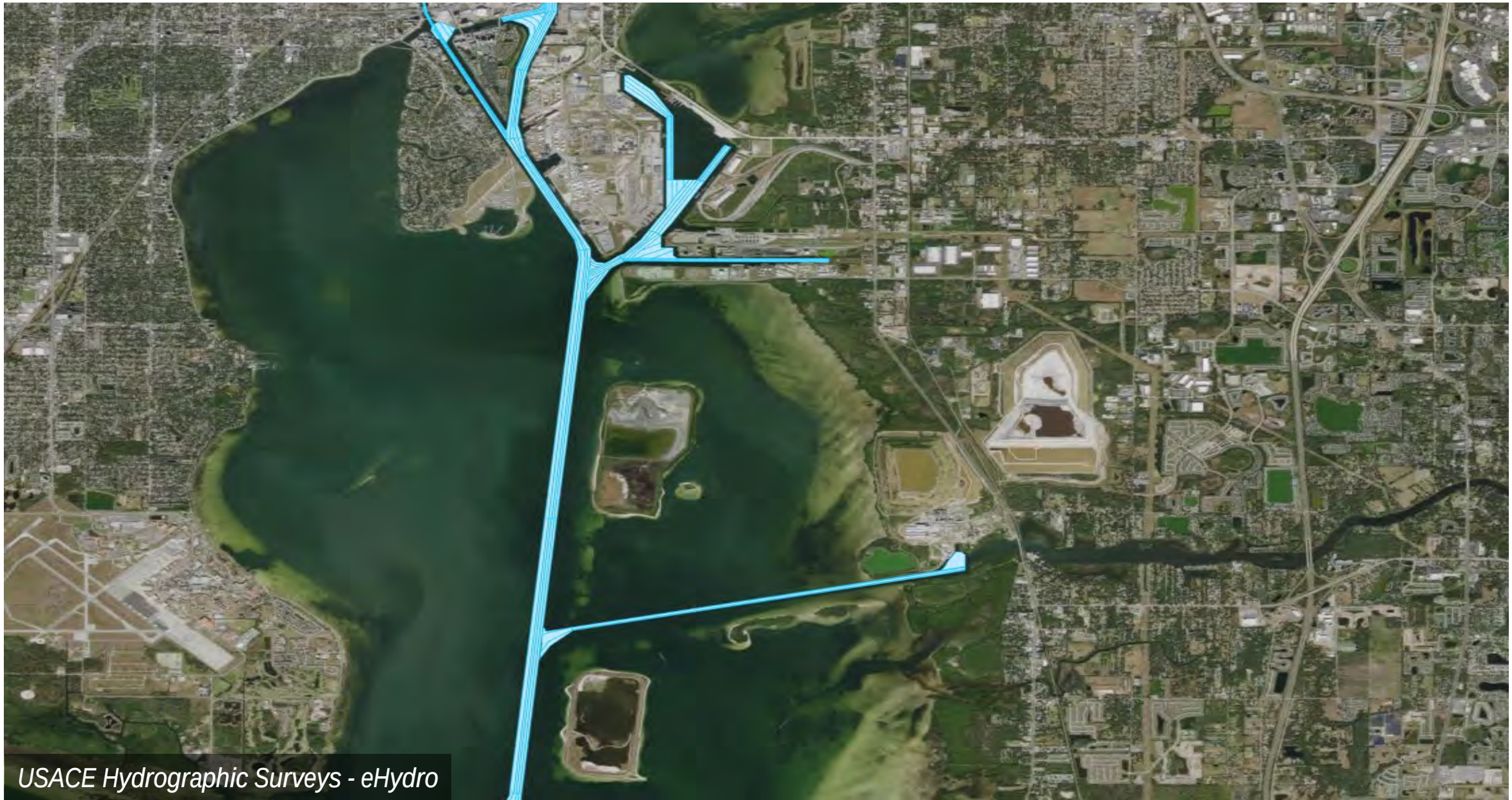
All Surveys | Last 60 days | 2019 | 2018

Custom Date Range

USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro



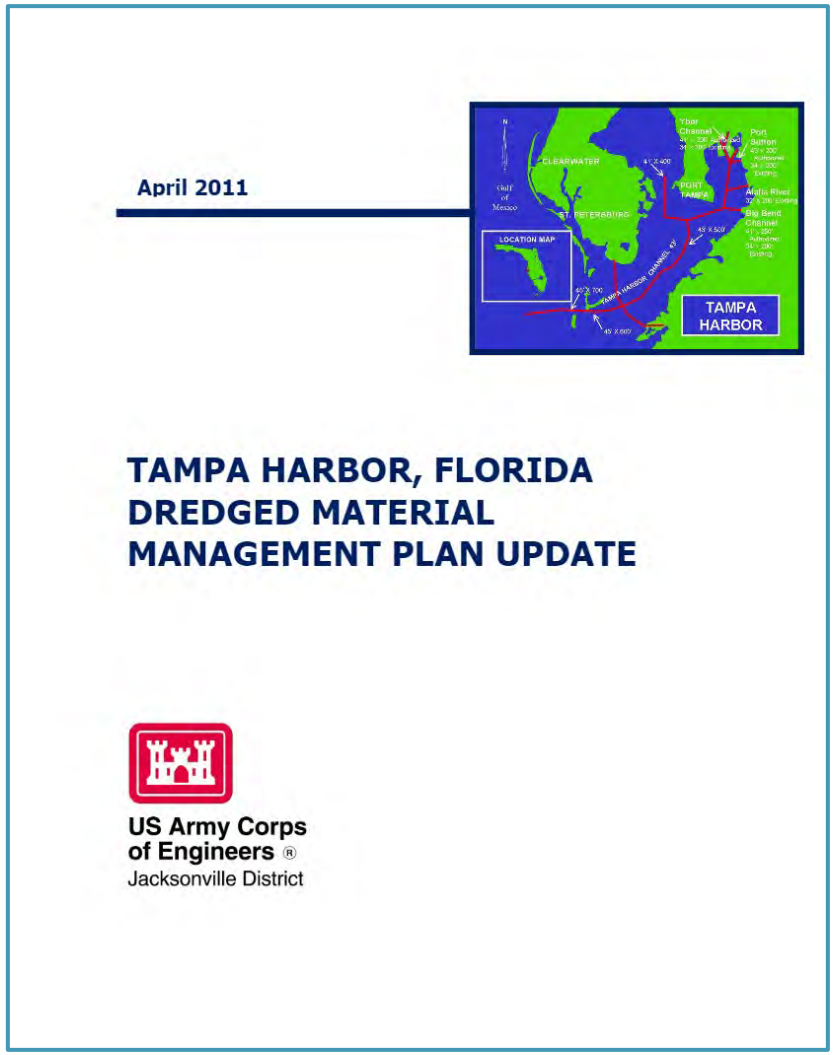
Tampa Harbor



USACE Hydrographic Surveys - eHydro

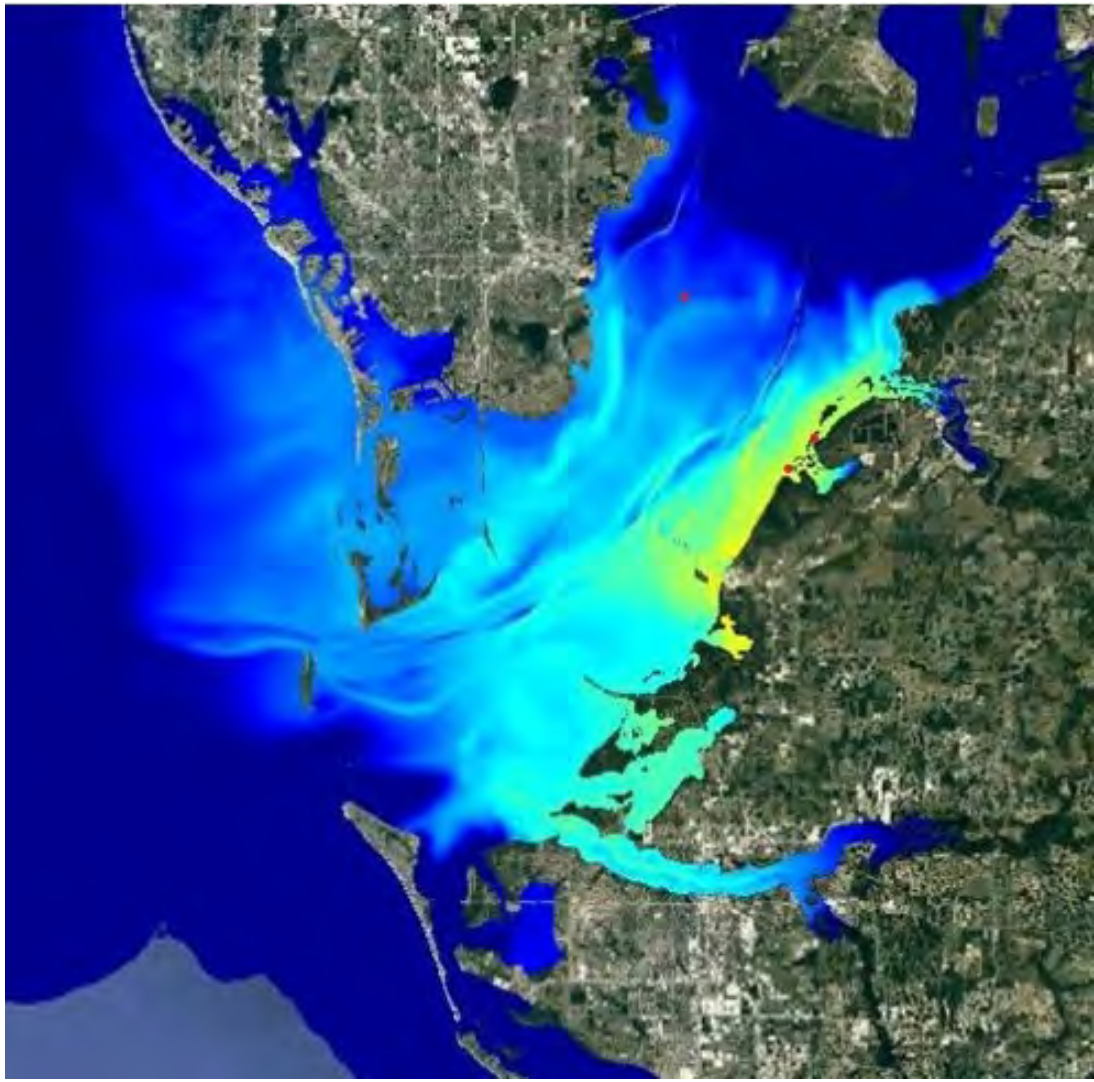
Dredged Material Management Plan (DMMP)

- More than 67 miles of channels with various depths & widths & six turning basins
- Roughly 1 MCY of maintenance dredging per year
- Approximately 7.5 MCY of capacity is available
- The USACE DMMP calls for:
  - Continual raising of existing Dredged Material Containment Facility Dikes
  - More disposal in Ocean Dredged Material Disposal Site (ODMDS)
  - Beneficial Reuse of dredge material
  - Reducing dredging needs



Discussion Summary & Feasibility Study Outline

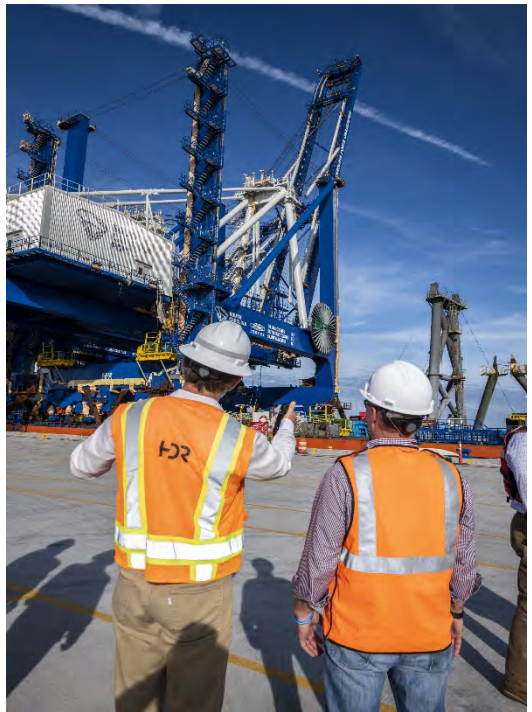
- $3 M maintenance dredging annual budget
  - Includes PTB's federal responsibilities
  - Does not include any new infrastructure
- Feasibility study outline evaluation:
  - Efficiency of currently used dredging methods
  - Review & summarize existing studies documenting the dominant circulation features
  - Potential effectiveness of WID
  - Possibility of using in-channel sumps & wideners to "collect" material re-fluidized by the WID



Water Injection Dredge (WID)

South Carolina Ports Authority (SCPA)

SOUTH CAROLINA PORTS
THE WORLD CONNECTS HERE℠



SCPA Waterways

USACE District:

All

USACE Channel:

All

Channel ID:

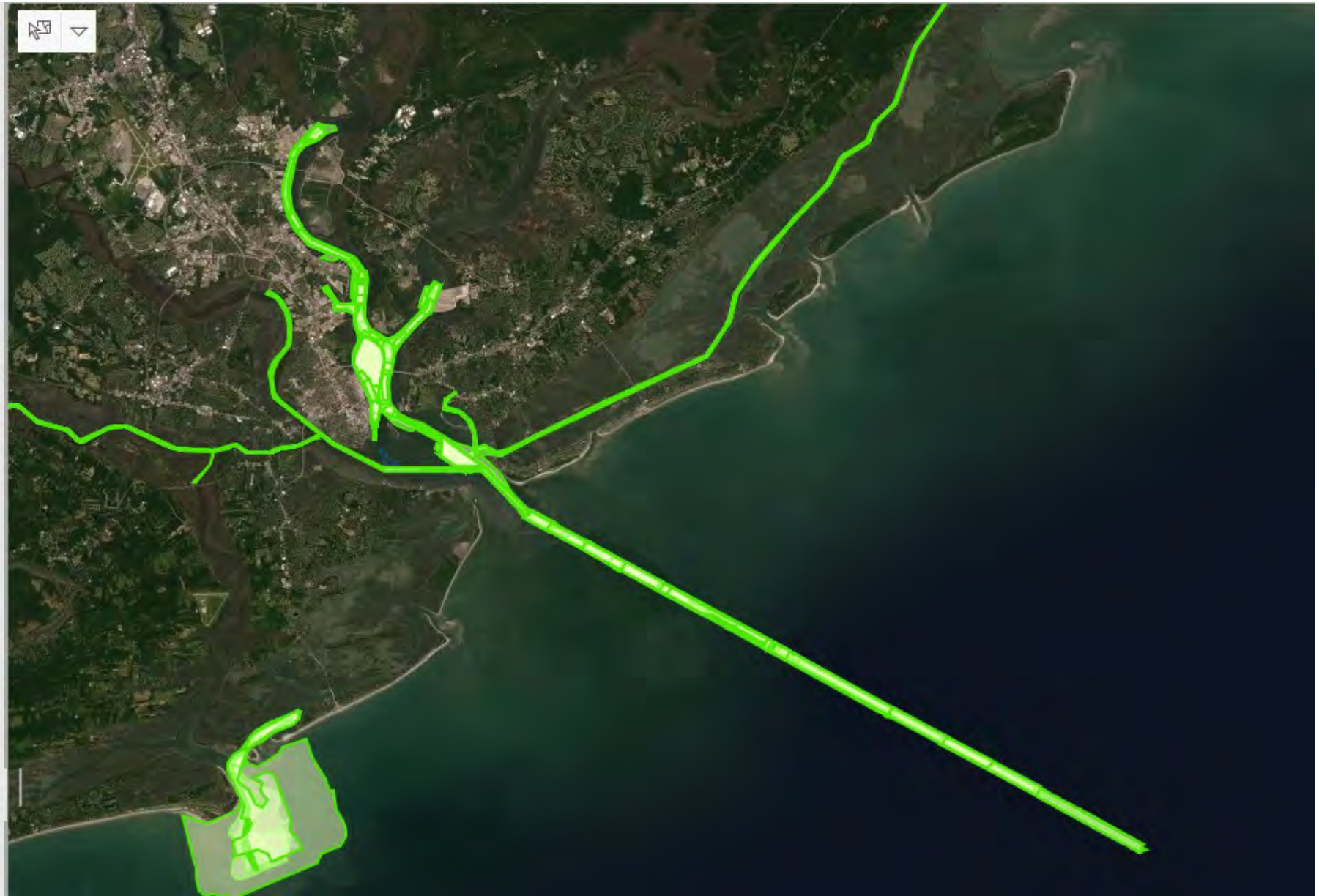
All

Survey Date Range:

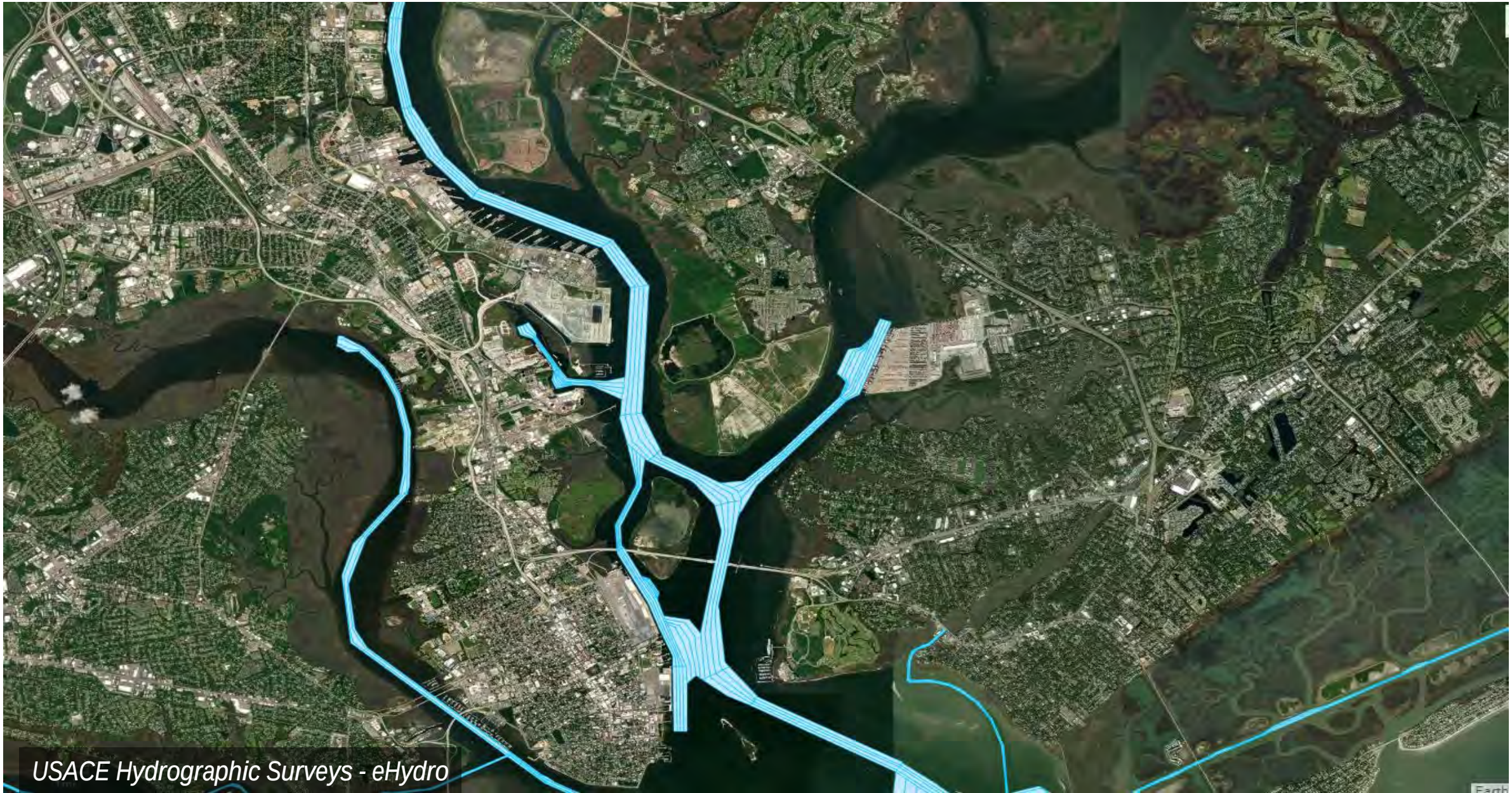
All Surveys | Last 60 days | 2019 | 2018

Custom Date Range

USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro



Cooper River & HLT

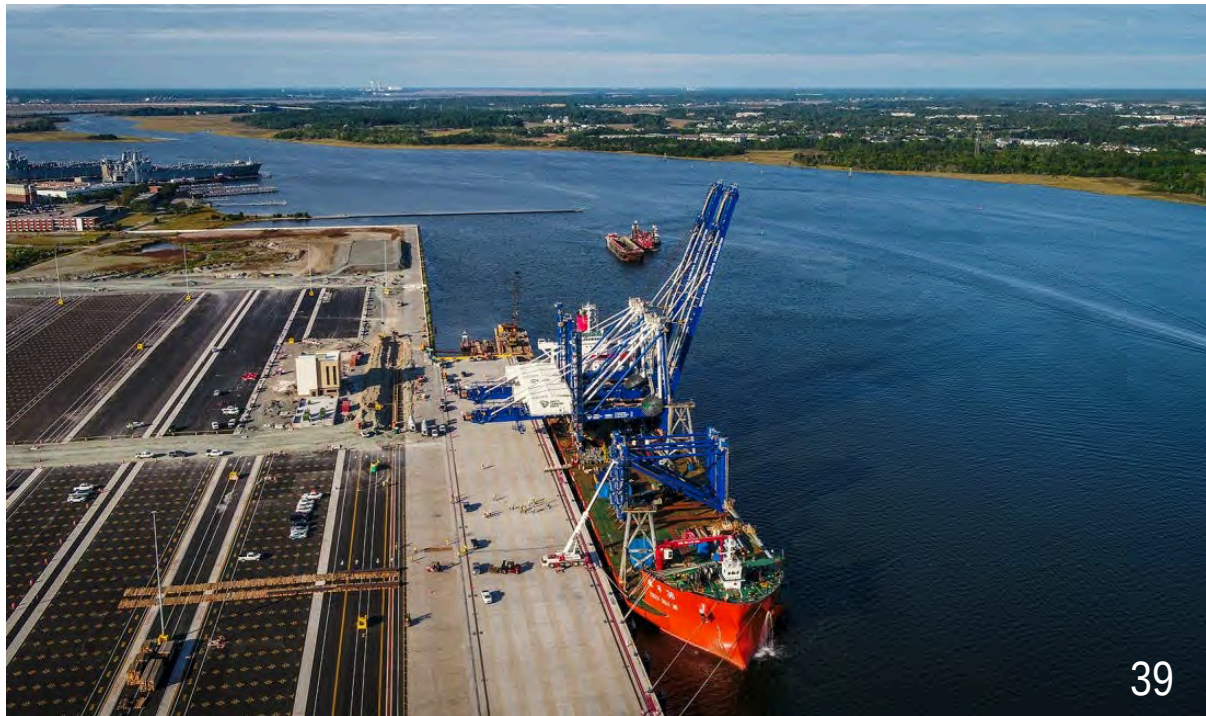


Charleston Harbor Regional Sediment Management (RSM) Update

- More than 39 miles of channels with various depths & widths & six turning basins.
- Roughly 6.9 MCY of maintenance dredging per year
- ODMDS is roughly 8 miles from the inlet & over 12 square miles, with a smaller drop zone
- USACE Charleston District is currently dredging parts of the Harbor to 52 feet & entrance channel to 54 feet

Project Focus

- Charleston Harbor is formed by the junction of the Ashley, Wando, & Cooper Rivers
- In 1942, Santee-Cooper Hydroelectric Project was completed, & was flow into the west branch of the Cooper River
- In 1959 three (3) ***contraction dikes*** were constructed in the Cooper River
- As long ago as 1992, the USACE has acknowledged the need to reconfigure the ***contraction dikes***
- HDR's proposed study would, among other issues like the ***contraction dikes***, look at the potential effectiveness of WID in the Charleston Harbor



Water Injection Dredge (WID)

Maryland Port Administration (MPA)

MPA Waterways (Northern)

USACE District:

All

USACE Channel:

All

Channel ID:

All

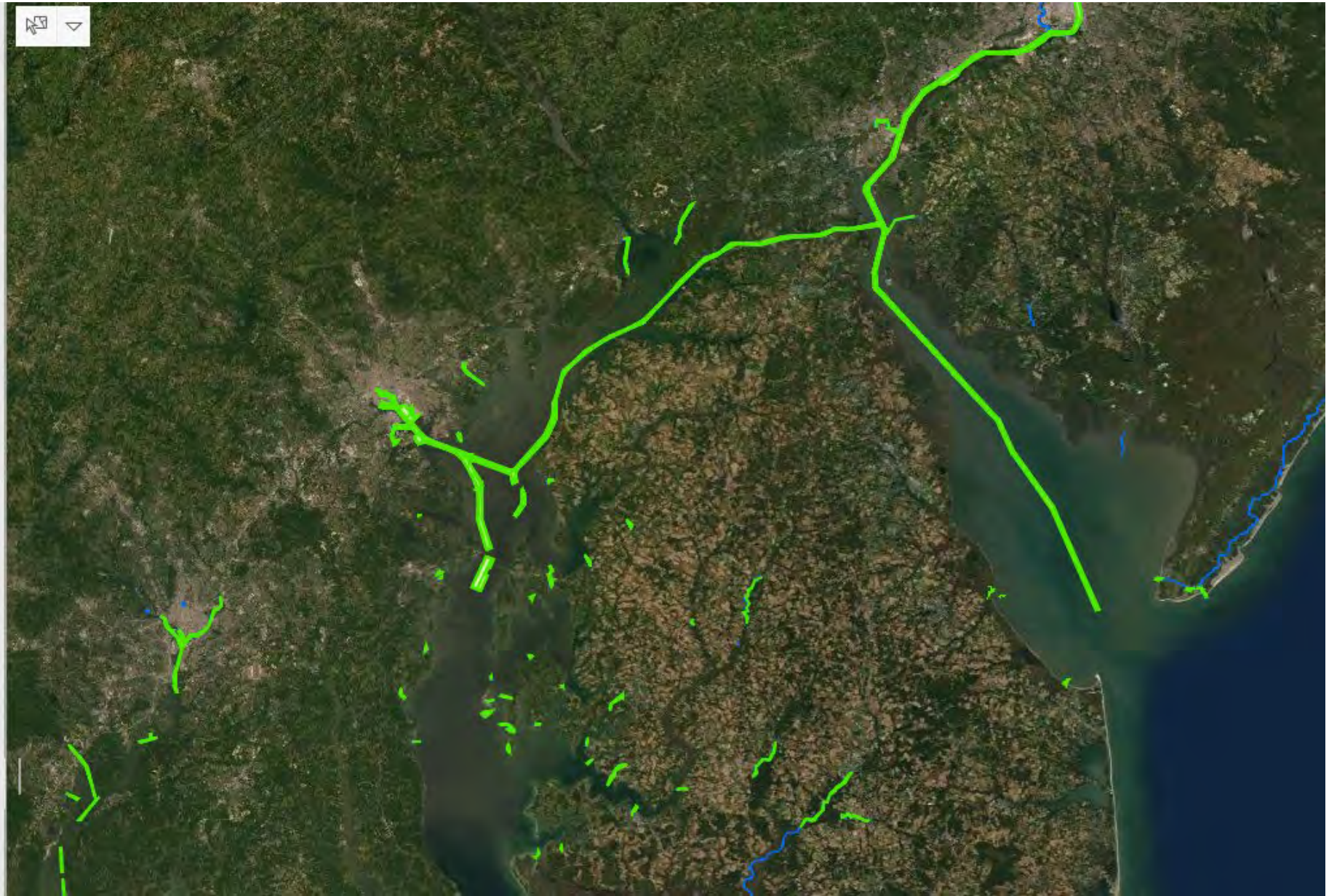
Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

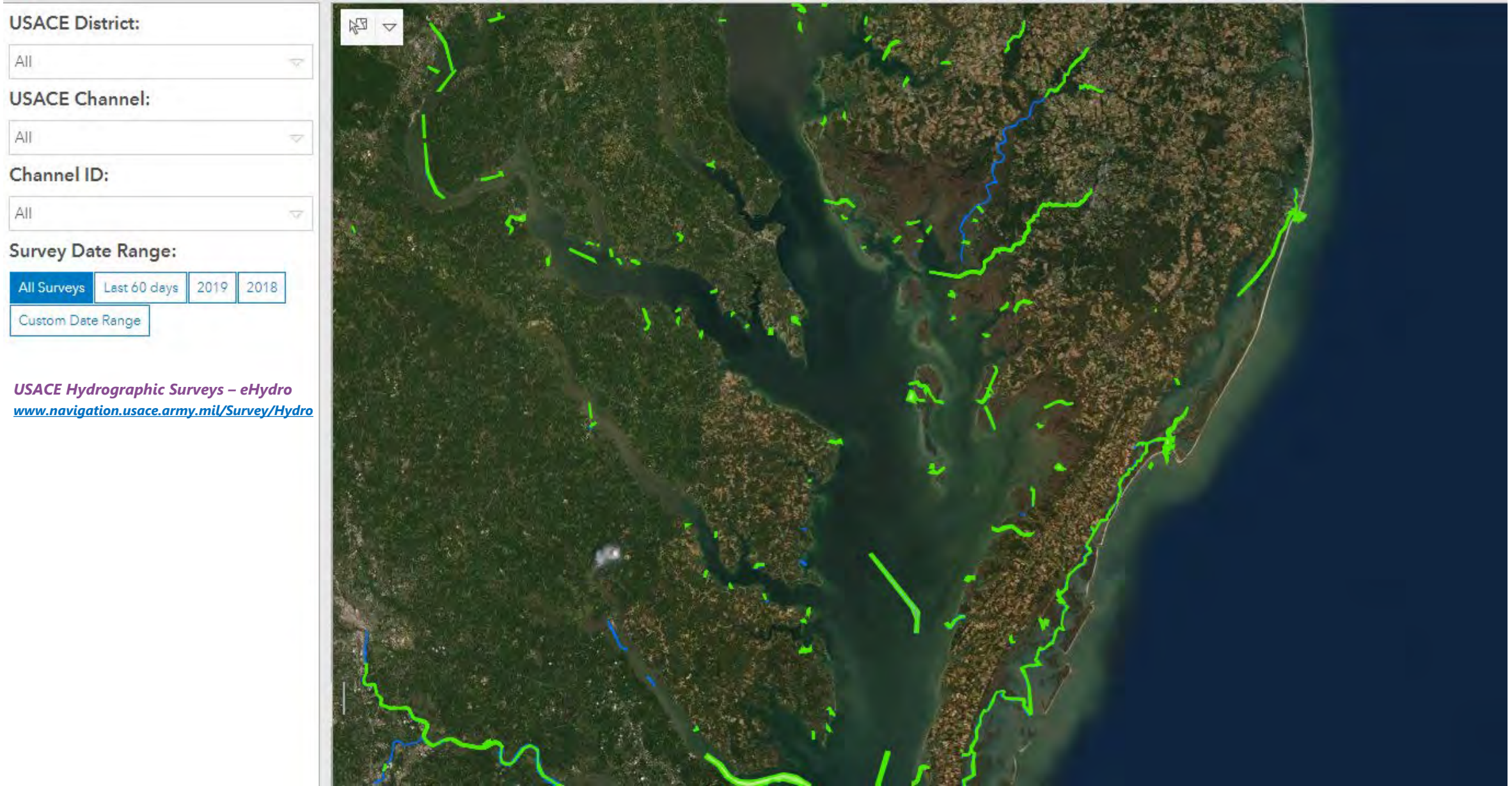
Custom Date Range

USACE Hydrographic Surveys – eHydro

www.navigation.usace.army.mil/Survey/Hydro

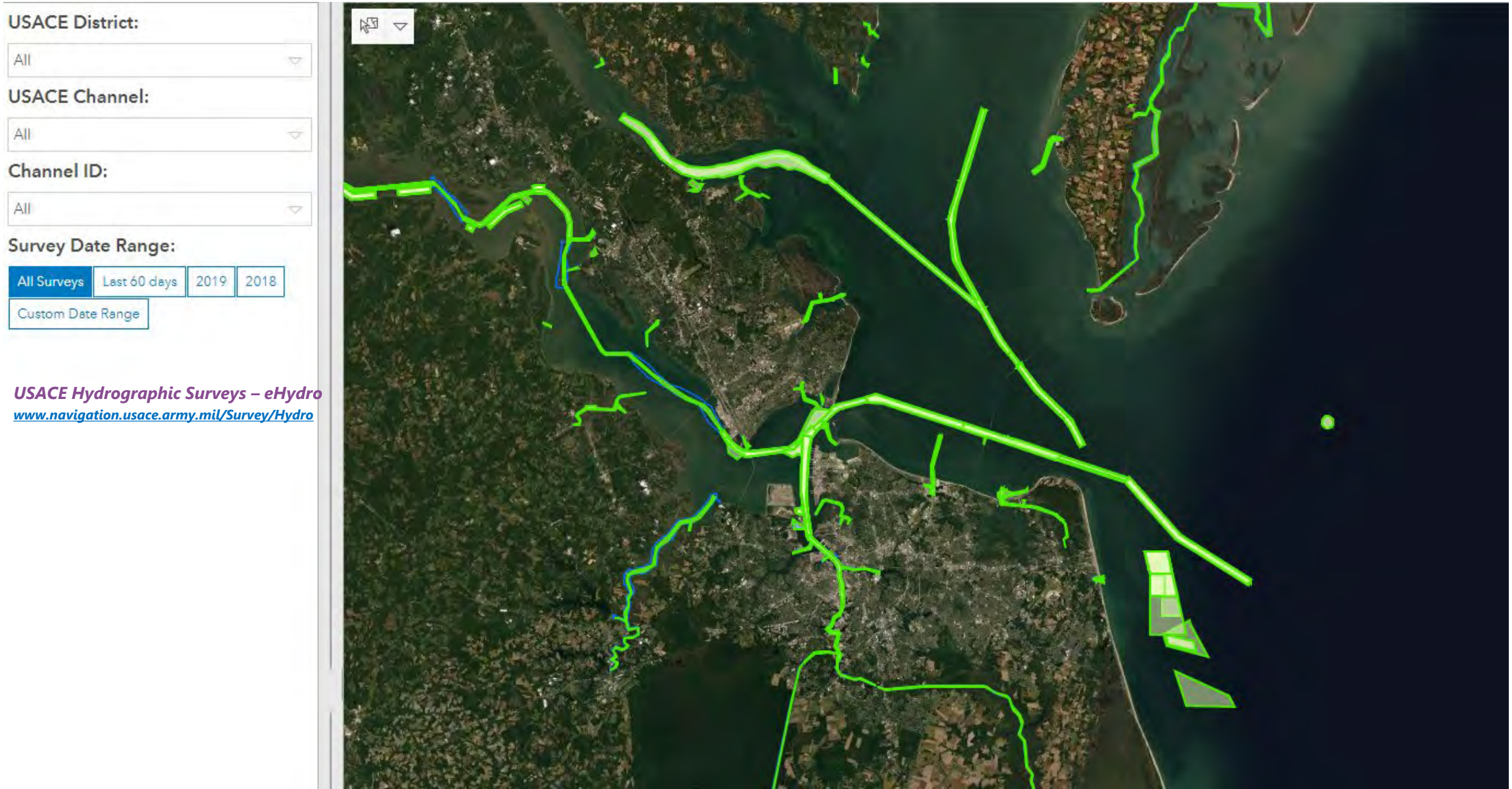


MPA Waterways (Central)



USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro

MPA Waterways (Southern)



USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro

Port of Baltimore

USACE Hydrographic Surveys - eHydro

MDOT MPA DMMP 2020

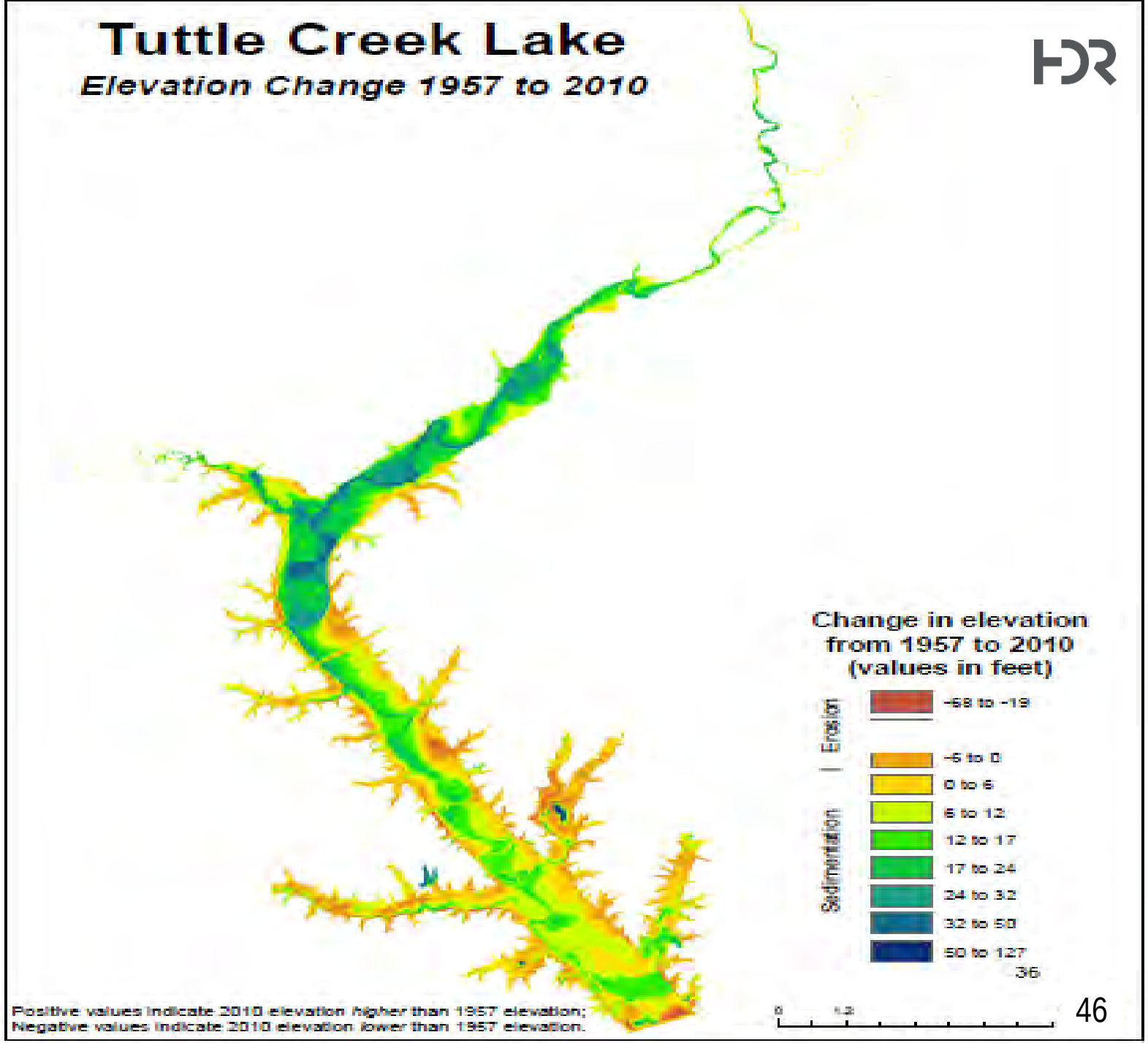
- A series of vast & complex channels with various depths & widths & multiple turning basins
- Roughly 5 MCY of maintenance dredging per year
- Mid-Bay Island Ecosystem Restoration Project's beneficial use of dredged material is the Port's number one federal priority
- What is the Future of Confined Aquatic Disposal?
- What are the most daunting & potentially long-lasting programmatic challenges?
- What are the crucial budget concerns?

MDOT MPA DMMP 2020
www.maryland-dmmp.com

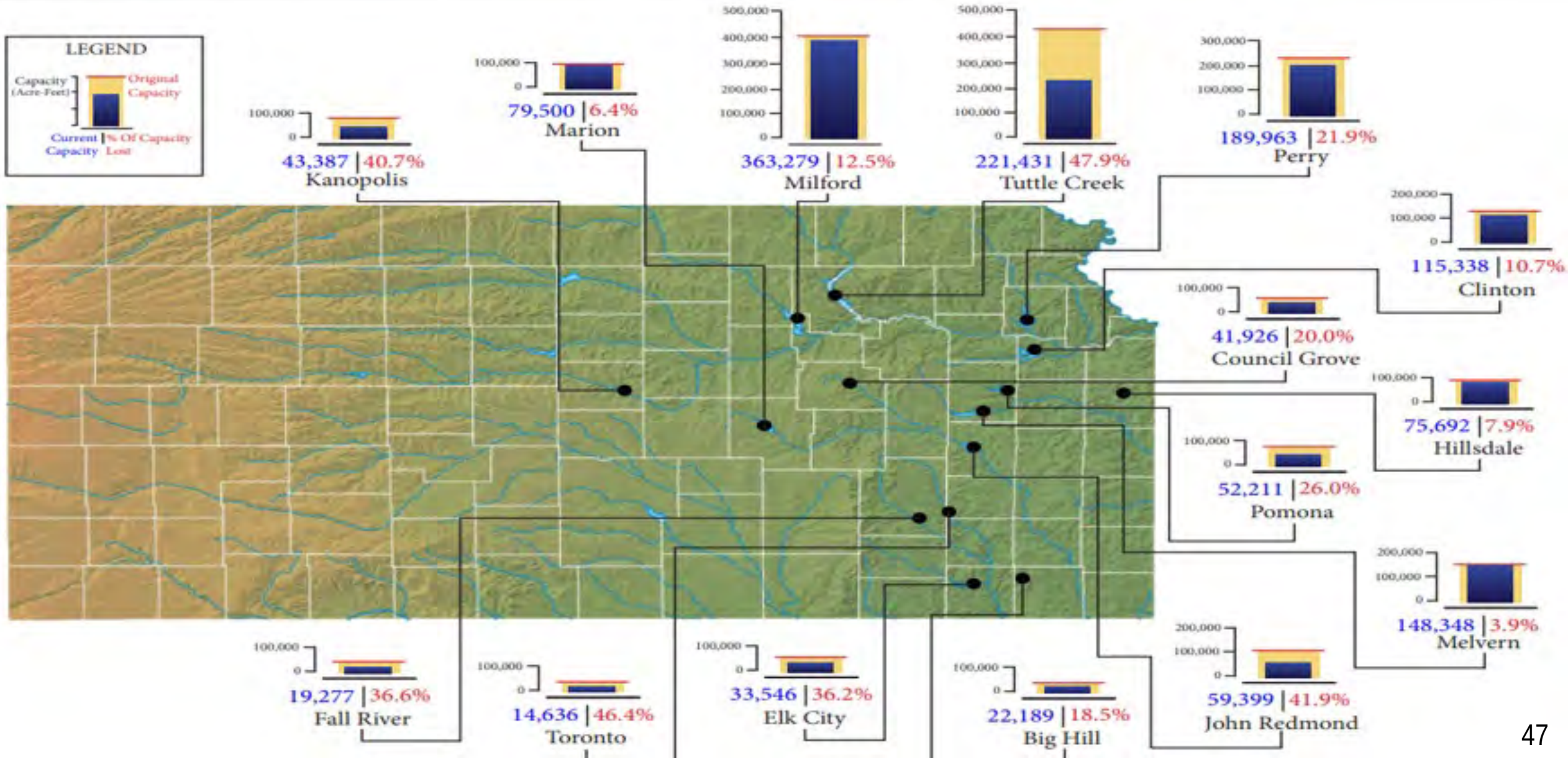
Water Injection Dredge (WID) in Reservoirs

Kansas Water Office (KWO)

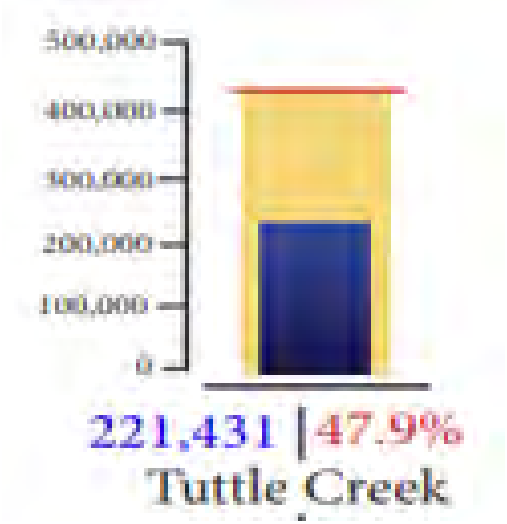
Tuttle Creek Lake

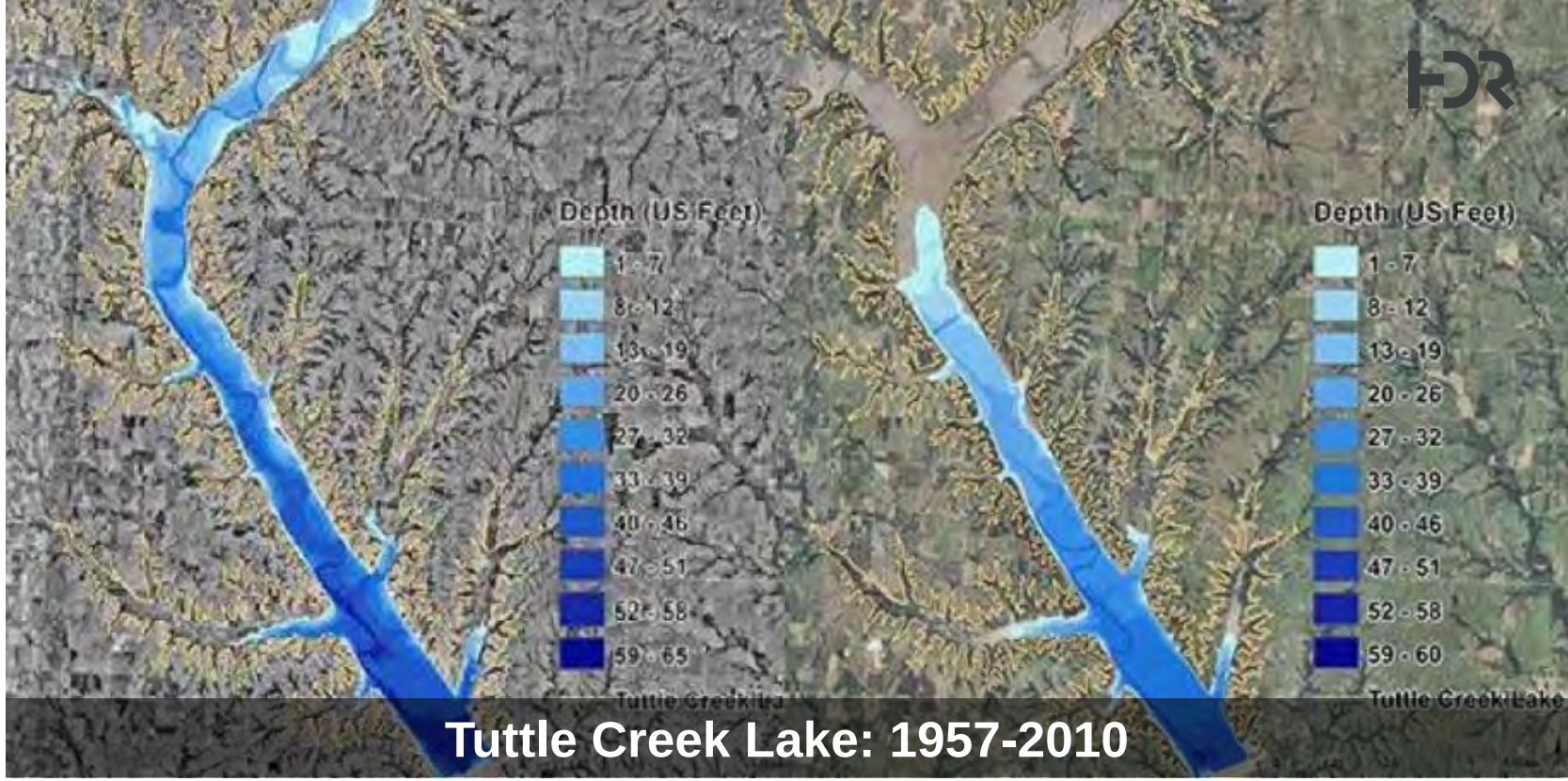


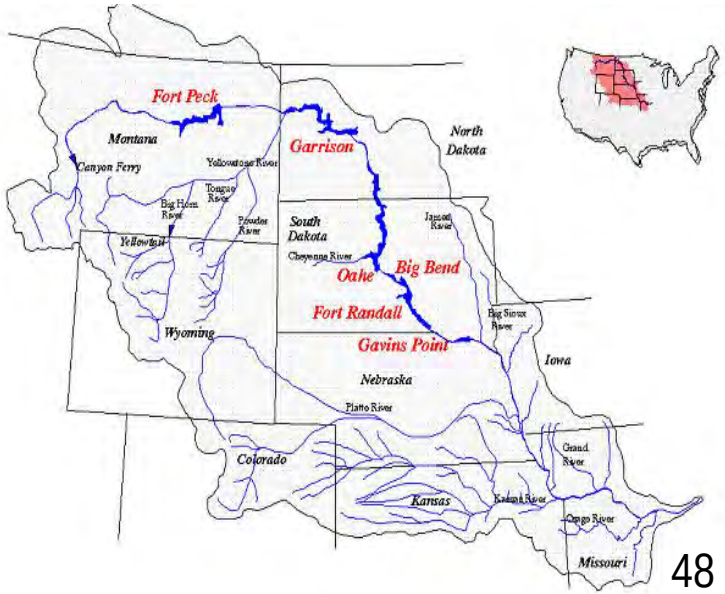
WID Kansas Water Office (KWO) Tuttle Creek Lake



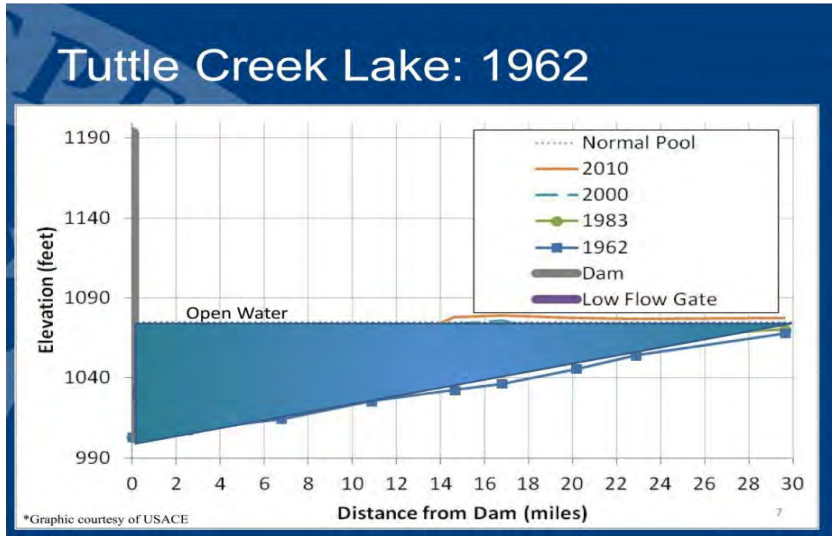
WID KWO – Tuttle Creek Lake (Cont.)

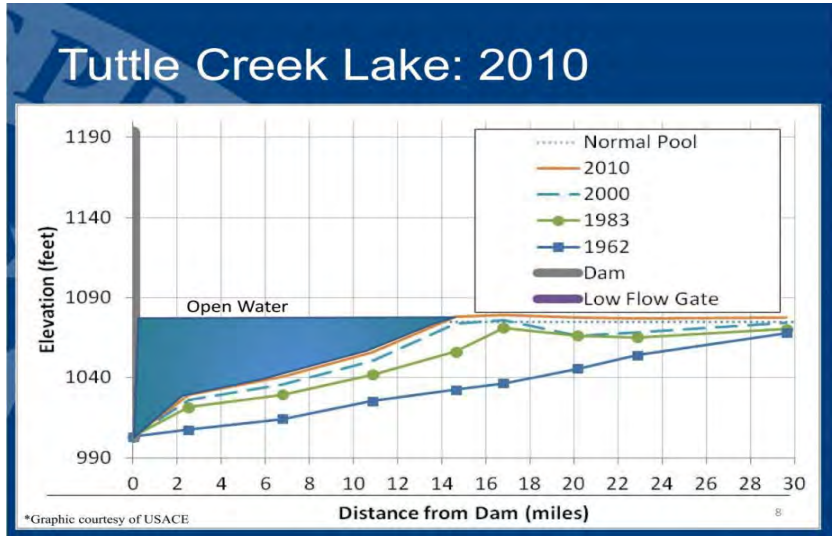




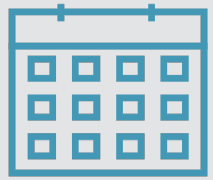


WID KWO – Tuttle Creek Lake (Cont.)



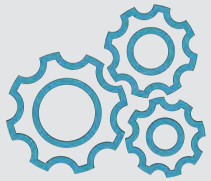


WID KWO – Tuttle Creek Lake (Cont.)



Annual Storage Volume Lost

- Sedimentation Rate in the Reservoir's Multi-Purpose Pool (1957 – 2010)
  - 3,600 acre-feet/year
  - 5.8 million cubic yards per year



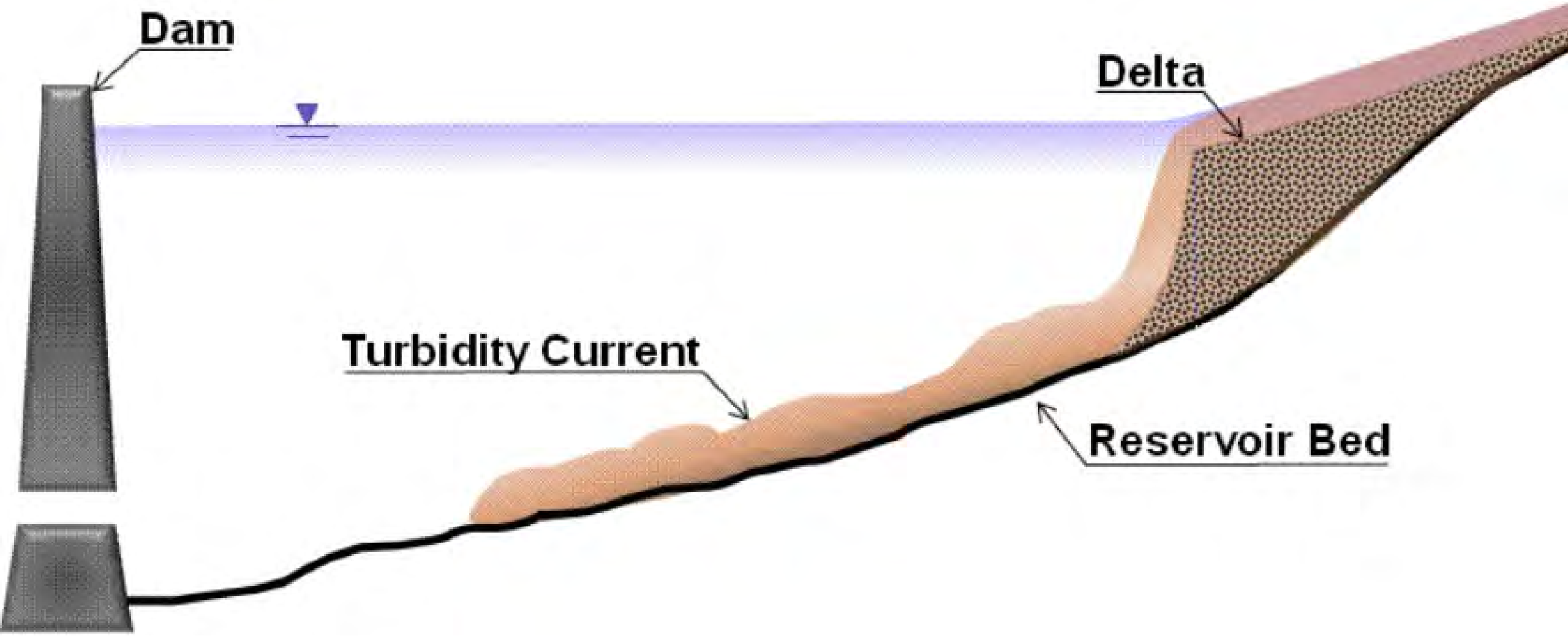
Water Injection Dredging

Inject water into the sediment deposits to induce a *density current*

Open the sluice gates & release the sediment through the existing low elevation discharge conduit under the forces of:

- Gravity due to elevation changes
- Current (suction) from the low elevation discharge conduit

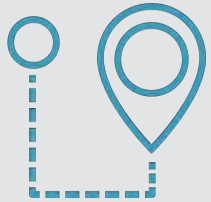
WID KWO – Tuttle Creek Lake (Cont.)



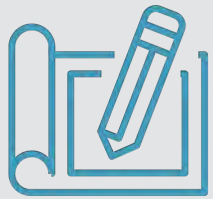
Summary - Takeaways

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

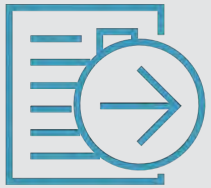


Traditional dredging is often as much about transporting & handling water as it is about the removed sediment



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 higher density than the surrounding water

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