HDR

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

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WEDA Gulf Coast CHAPTER

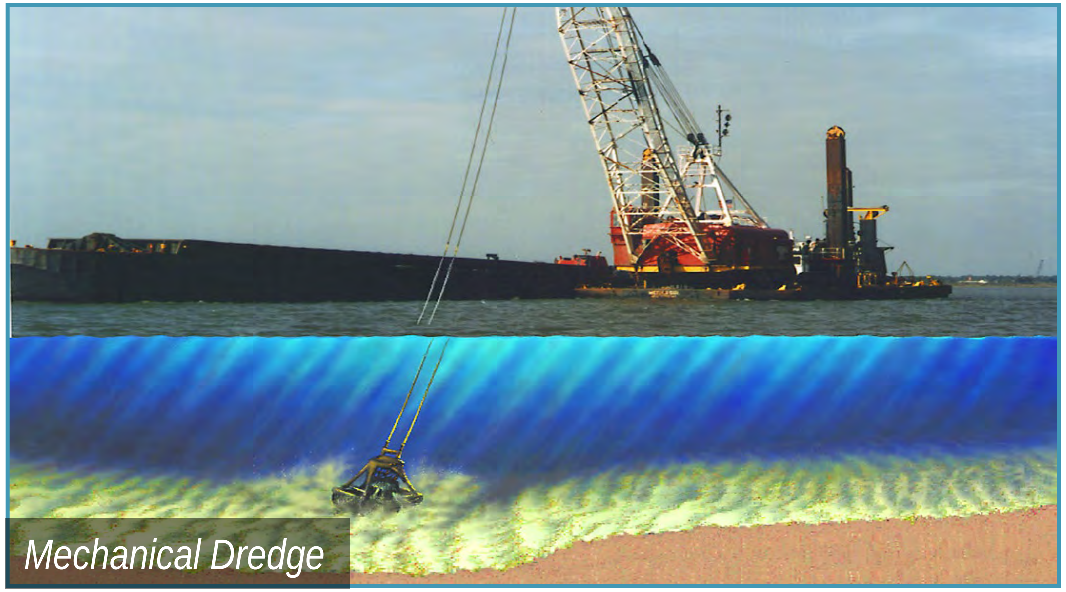
Port of Wilmington, Turning Basin

Outline

- **Traditional Dredging Methods**
- **Hydrodynamic Dredging**
    - o **Agitation & Plow**
    - o **Water Injection Dredge (WID)**
        - **Environmental Considerations**
        - **Economic Benefits**
- **Case Studies**
    - o **North Carolina State Ports Authority (NCSPA)**
    - o **Port Tampa Bay (PTB)**
    - o **Georgia Ports Authority (GPA)**
    - o **South Carolina Ports Authority (SCPA)**
    - o **Maryland Port Administration (MPA)**
    - o **Kansas Water Office (KWO)**
- **Summary**
- **Discussion - Alabama State Port Authority (ASPA)**

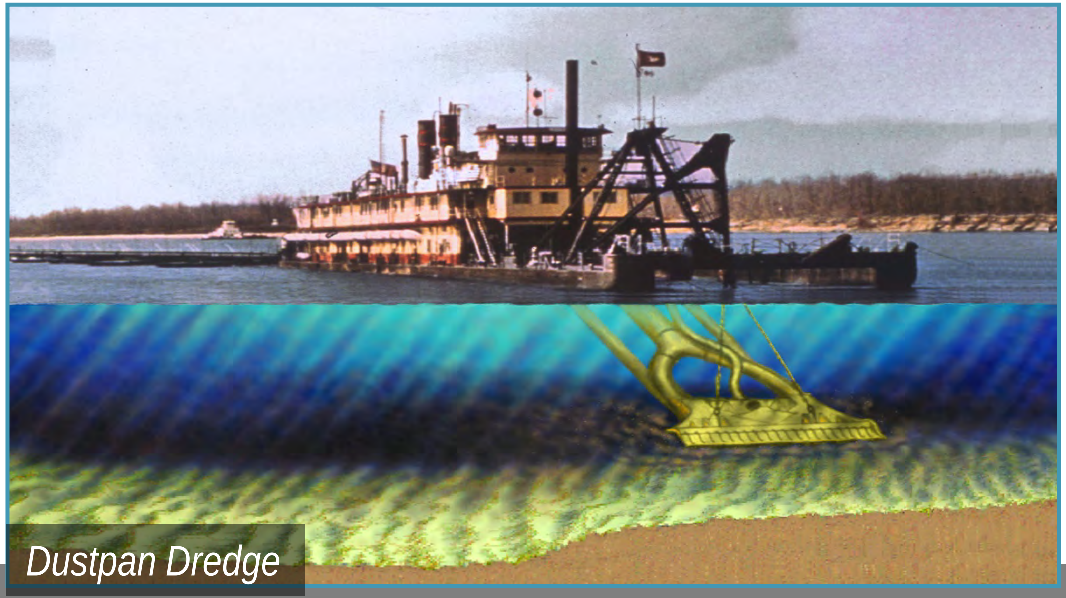
Port of Morehead City, Ocean Inlet

Hydraulic Pipeline Dredge



Mechanical Dredge

Hopper Barge Dredge



Dustpan Dredge

Dredging Methods - Traditional Dredges

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 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

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)

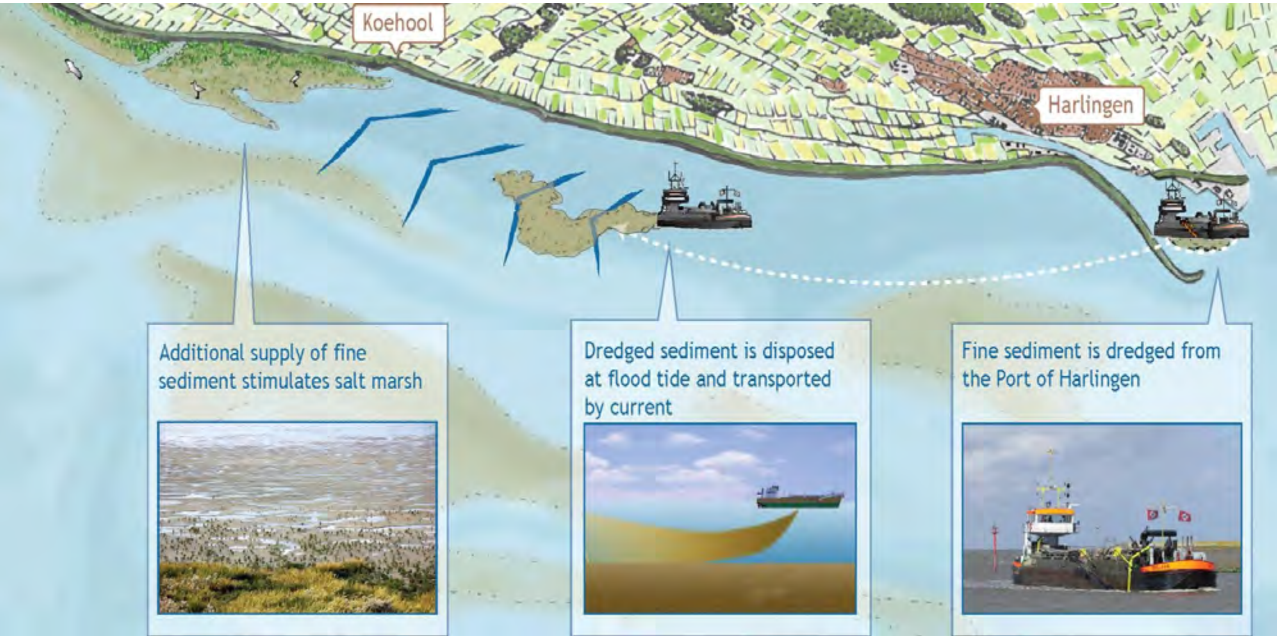
Agitation & Plow Dredging produce a turbid water column & thus, at least temporarily, higher water quality impacts

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

Sand Engine: Beach renourishment where a massive amount of sand is added to the coast & natural forces distribute the sand - more beach, while reducing 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, 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

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 & level of contamination
- Regulatory agency acceptance

Economic Benefits

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

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

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

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

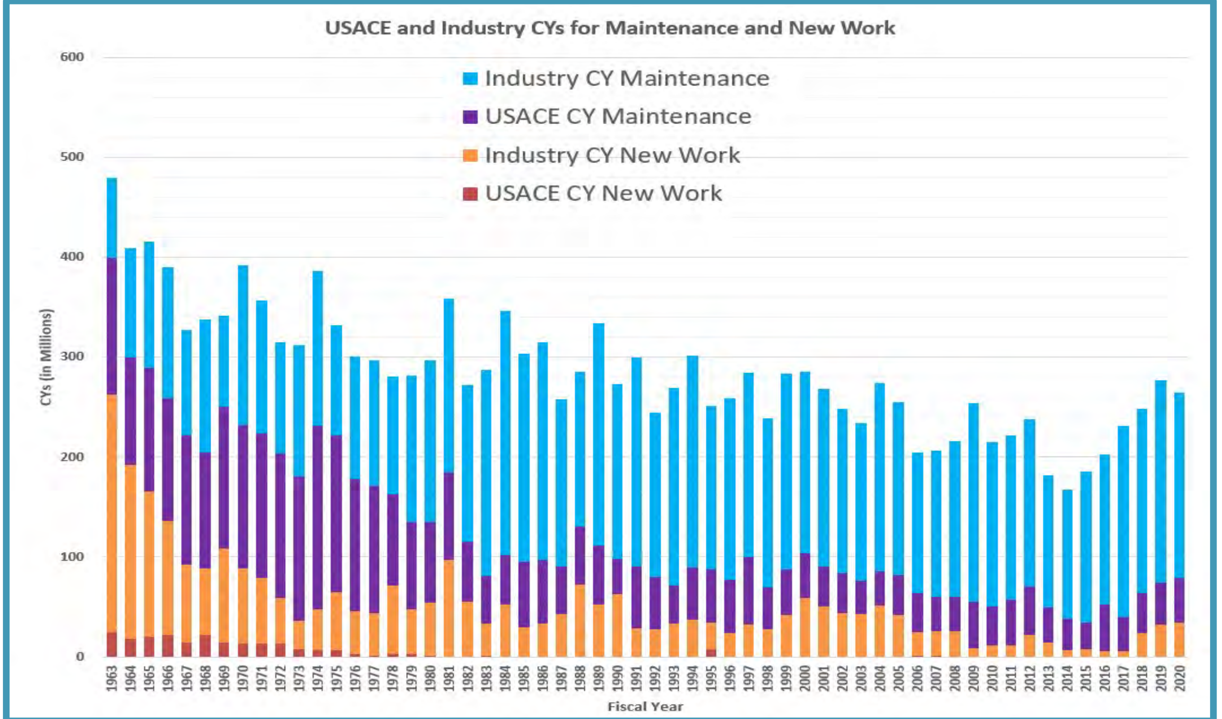
Traditional dredging costs:

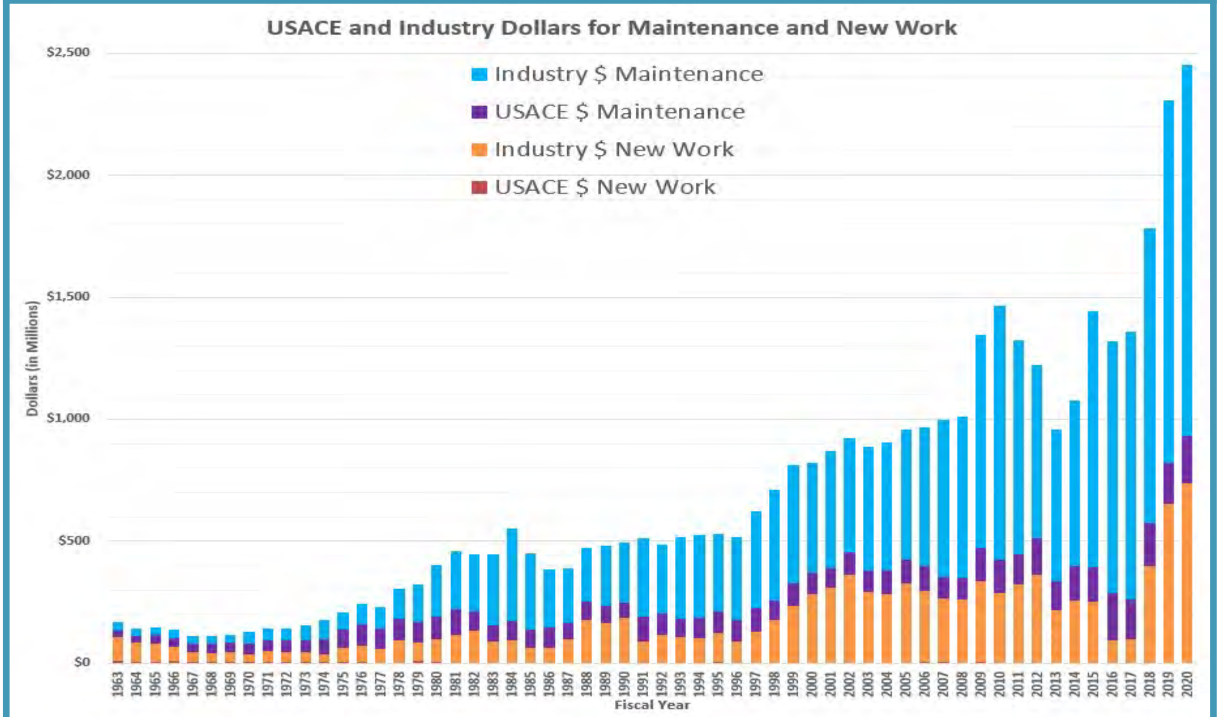
- Mobilization/Demobilization
- Transportation & Storage
- Complex dredge plant O & M
- Lower production rates

Optimized ***hydrodynamic dredging***

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

USACE NDC Dredging Costs (1963-2020)





- Overall US dredging volumes have decreased
- New work dredging volumes have dramatically decreased
- Maintenance dredging volumes have slightly decreased
- Overall US dredging costs have significantly increased
- Overall US maintenance dredging responsibility (both volume & dollars) has shifted to Industry

Case Studies

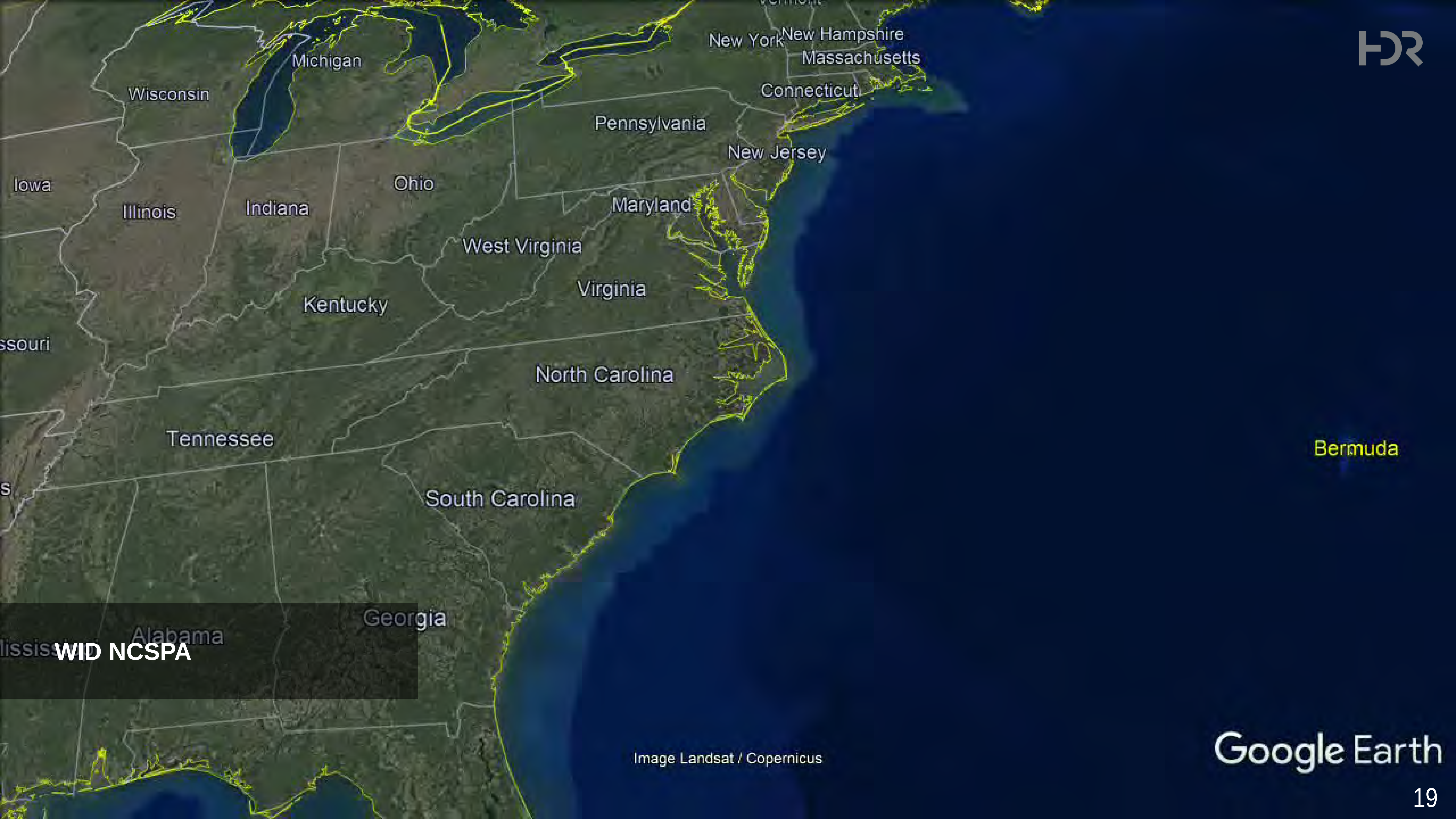
Osprey WID, IHC-America, NCSPA

Water Injection Dredge (WID)

North Carolina State Ports Authority (NCSPA)

NORTH CAROLINA PORTS®

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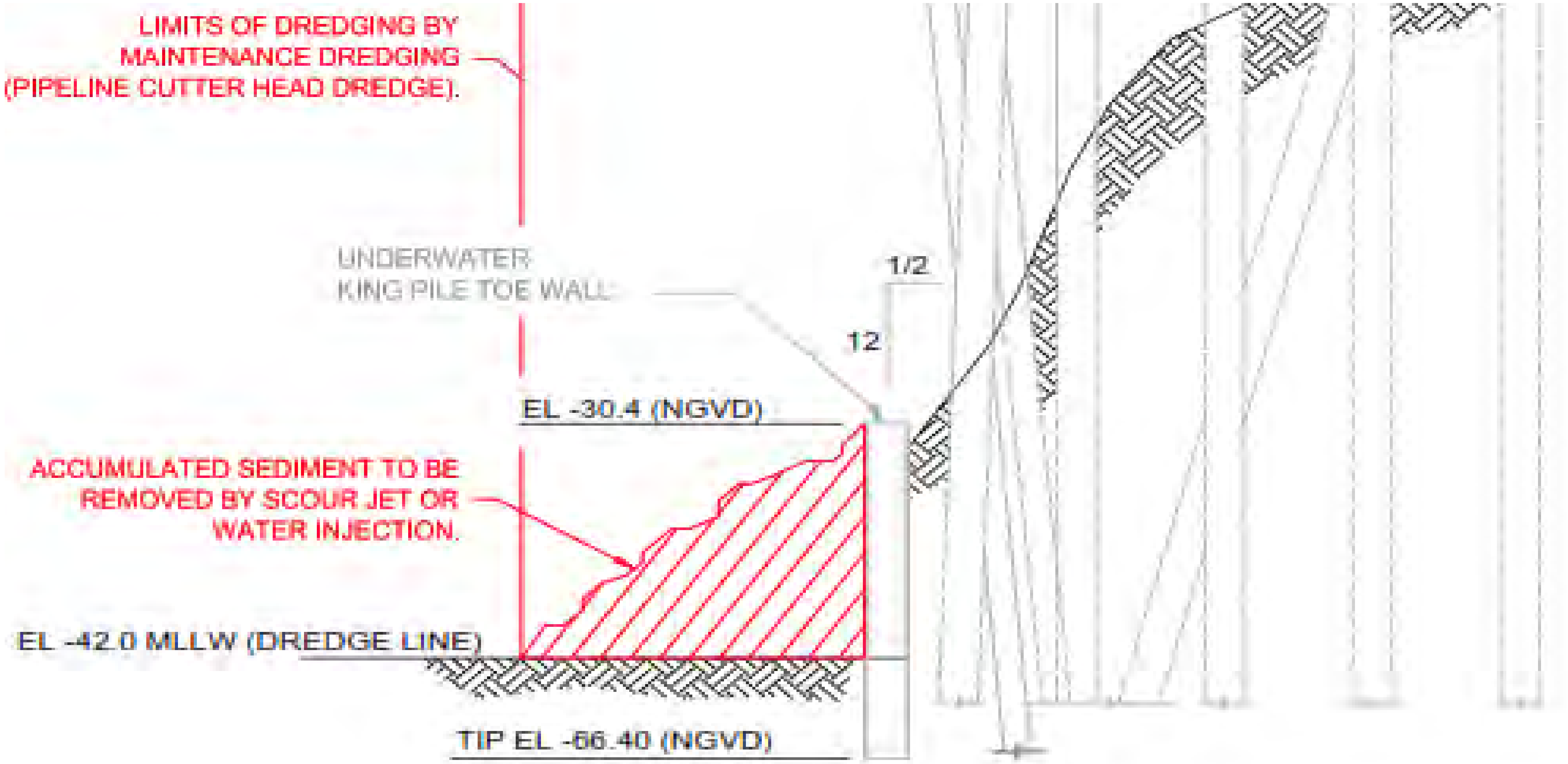
Kentucky
North Carolina
Tennessee
South Carolina
Bermuda
Georgia
Alabama
Image Landsat / Copernicus
Google Earth

Dredging Template



Project Approach

- NCSPA authorized research into acquiring a WID, hiring a WID contractor, or some other variant (Spring 2018)
- Contacted over ***70 organizations***, including 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***
- Interview roughly ***20 organizations***, with 11 of them becoming promising candidates for WID design-build teams (Fall 2018)

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:
  - Preliminary schedule
  - Time needed to fabricate & transport the dredge to the NCSPA
- Factors similar to any NCSPA purchase of large, expensive equipment
  - Maintenance
  - Warranties
  - Operation manuals
- Unique factors included:
  - Proof of concept demonstrations
  - Training requirement

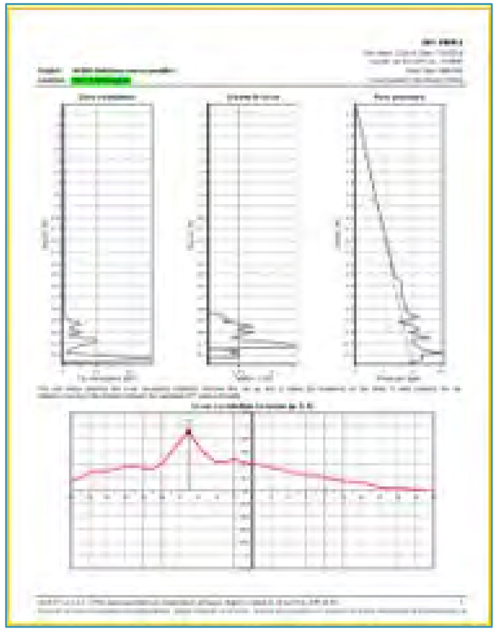
Request for Pre-Qualifications

Project sequence:

- 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

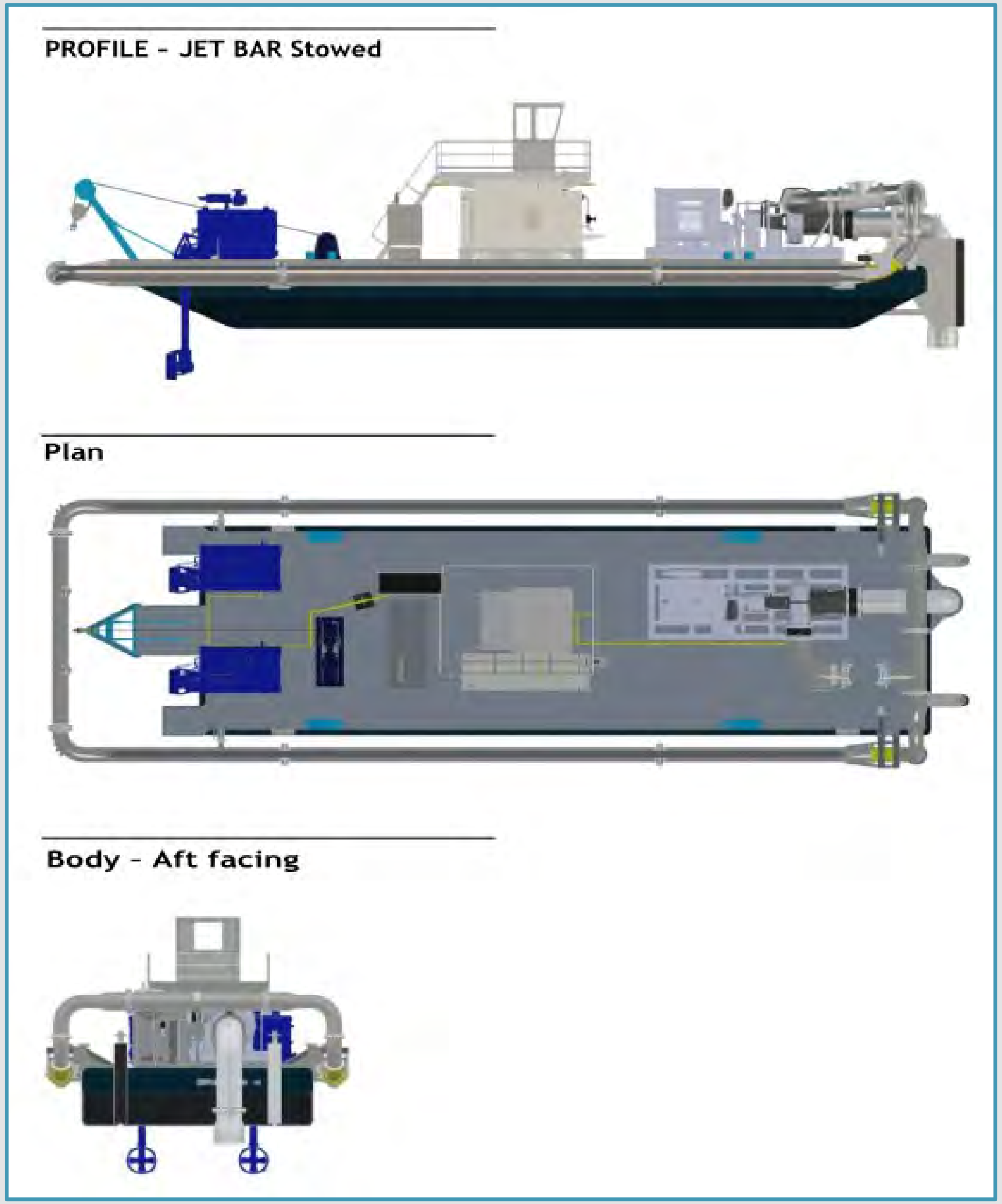
Request for Information & Geotechnical Data Collection

- Sediment characterization fieldwork at both ports
- Ponar grab & cone penetrometer test (CPT)
- Several unique sediment parameters
  - CPT Testing
    - Tip resistance
    - Sleeve resistance
    - Pore water pressure
  - Measuring ability to 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**
  - NCSPA Board of Directors Meeting
    - Recommend Selection
    - Final Selection
  - Contract Execution



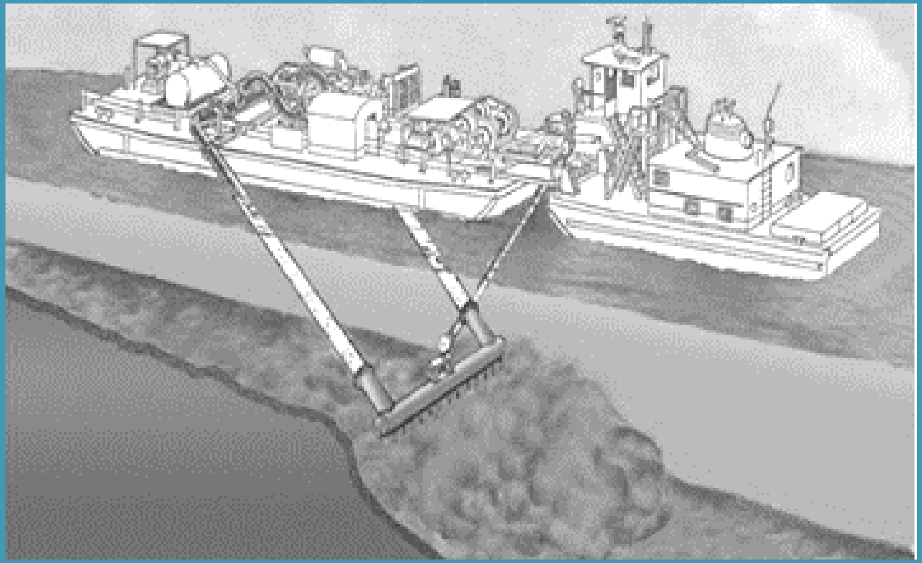
Contracting Summary

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

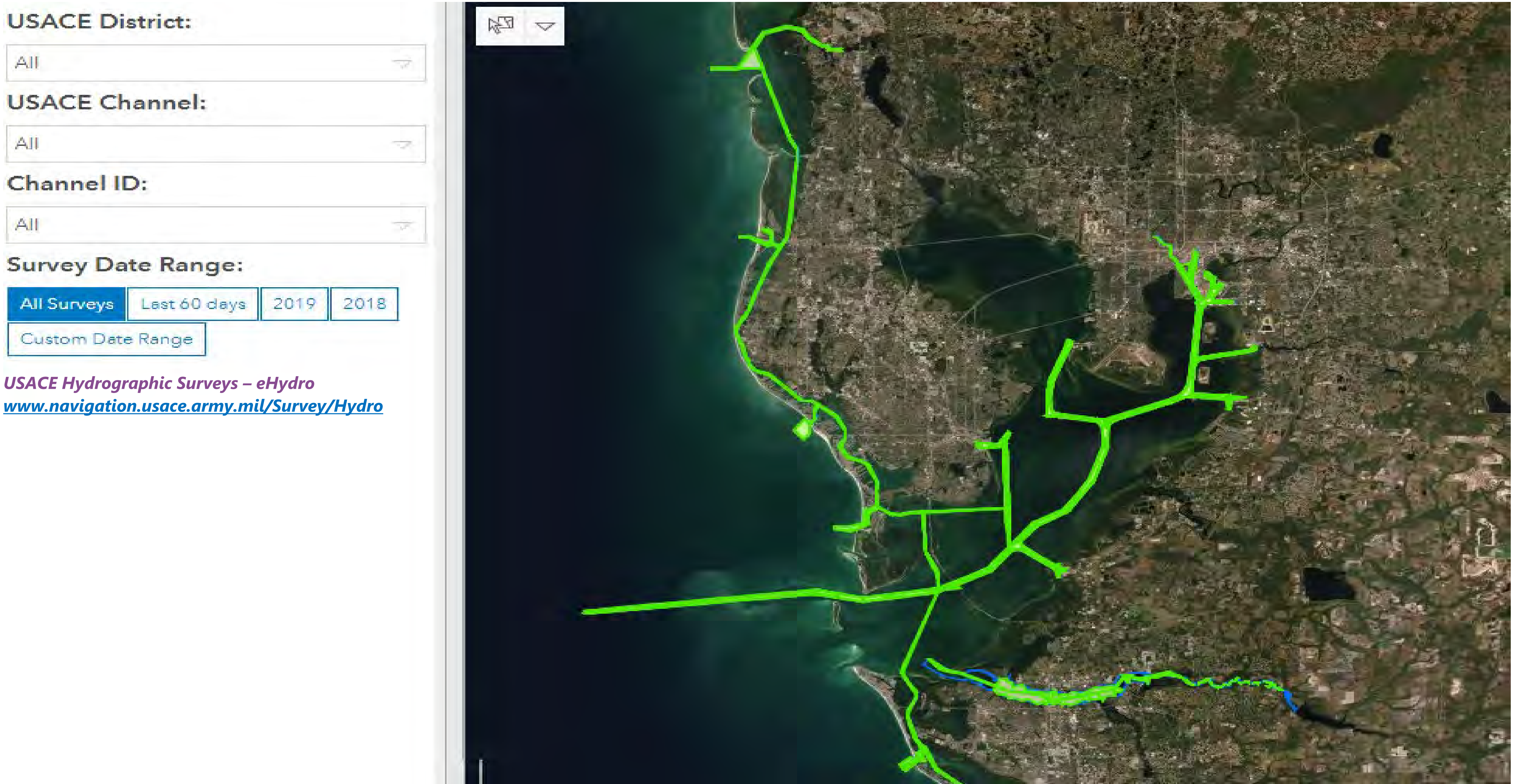
- USACE-ERDC is developing a dredging monitoring plan, with hopes of mobilizing in January 2022
- Compare pre- & post-dredging hydrographic surveys ‘upstream’ & ‘downstream’ of the WID
- Establish production rates for the WID
- Develop baseline dredging efficiencies for the WID, which the NCSPA will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

Dredging Efficiencies Investigation

Port Tampa Bay (PTB)

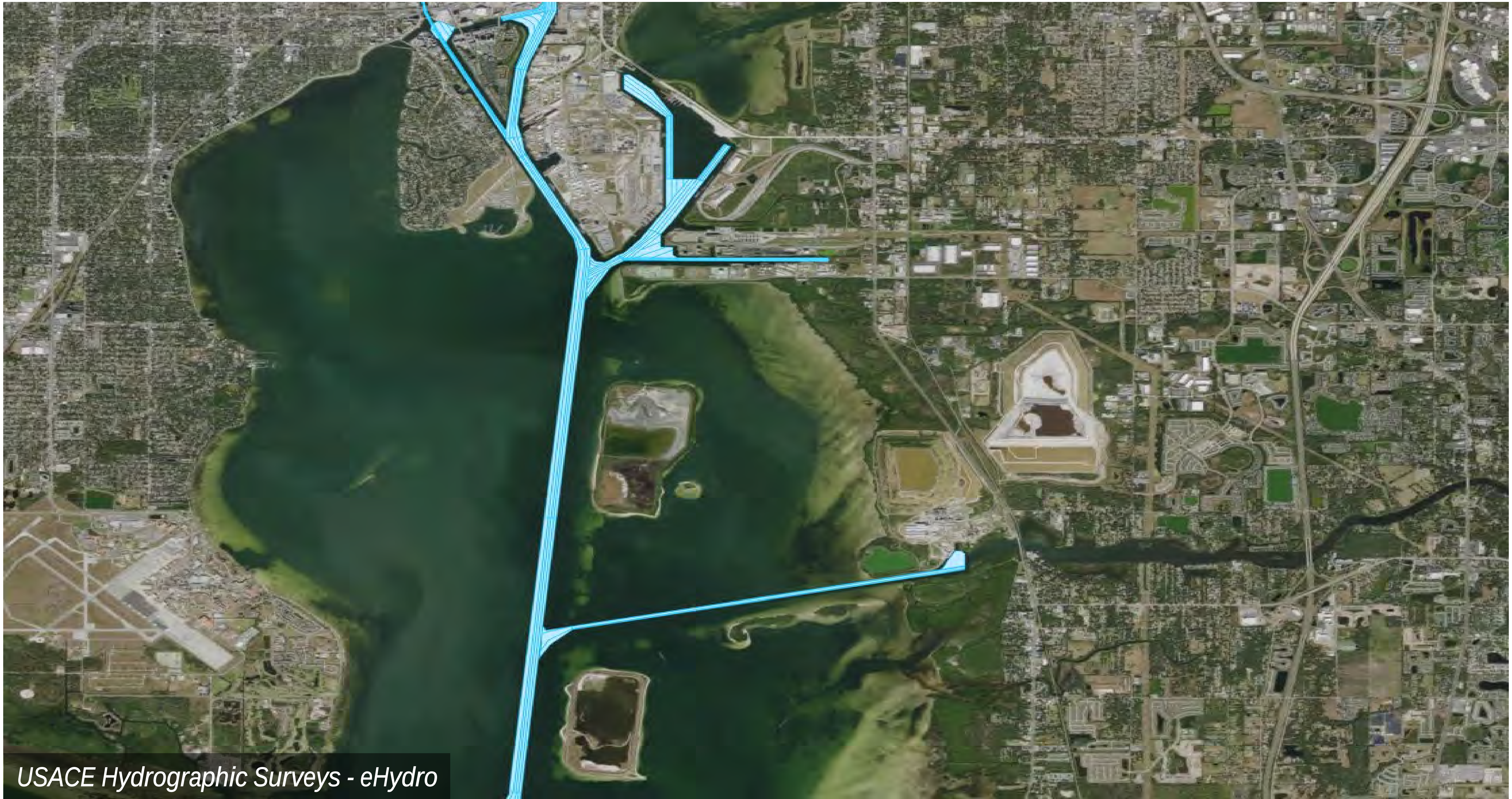
PORT TAMPA BAY™

Tampa Bay's Federal Waterways



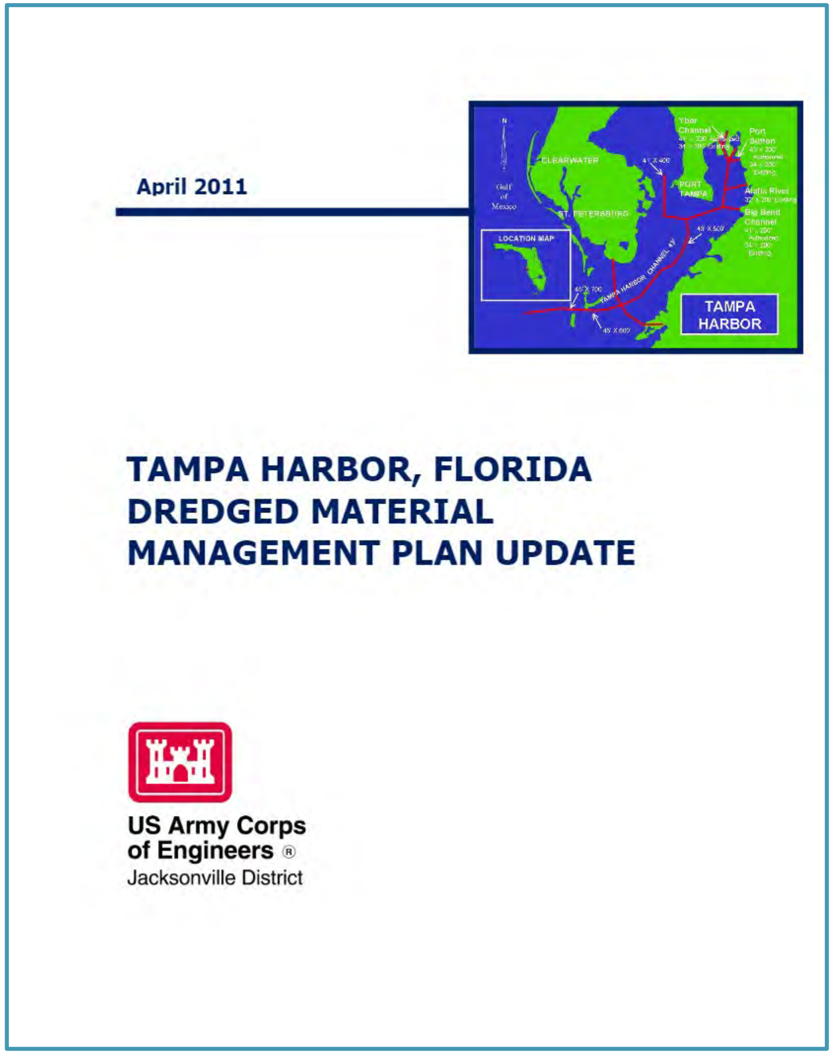
USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro

Tampa Harbor



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


April 2011

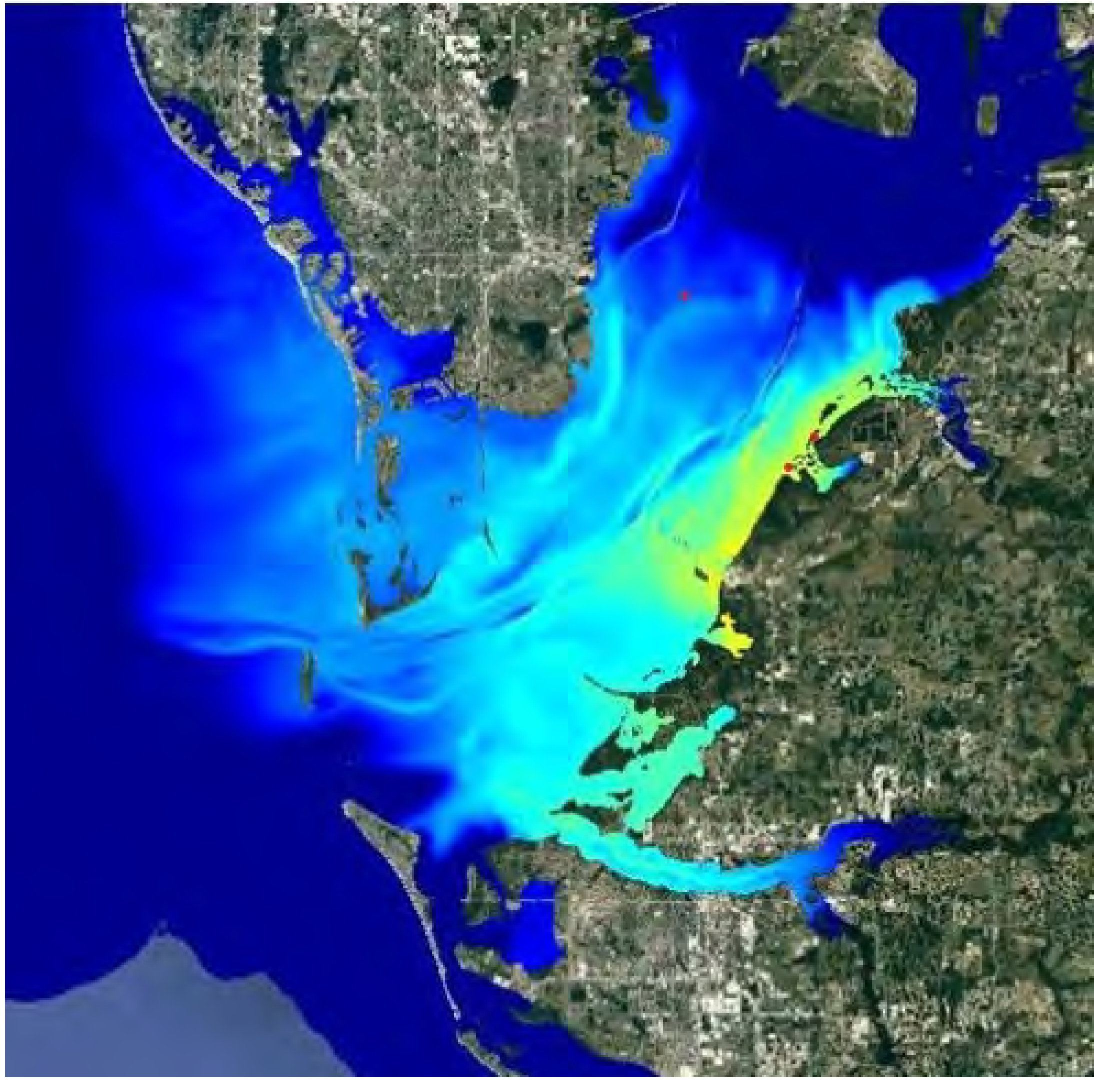
TAMPA HARBOR

TAMPA HARBOR, FLORIDA
DREDGED MATERIAL
MANAGEMENT PLAN UPDATE

US Army Corps of Engineers ®
Jacksonville District

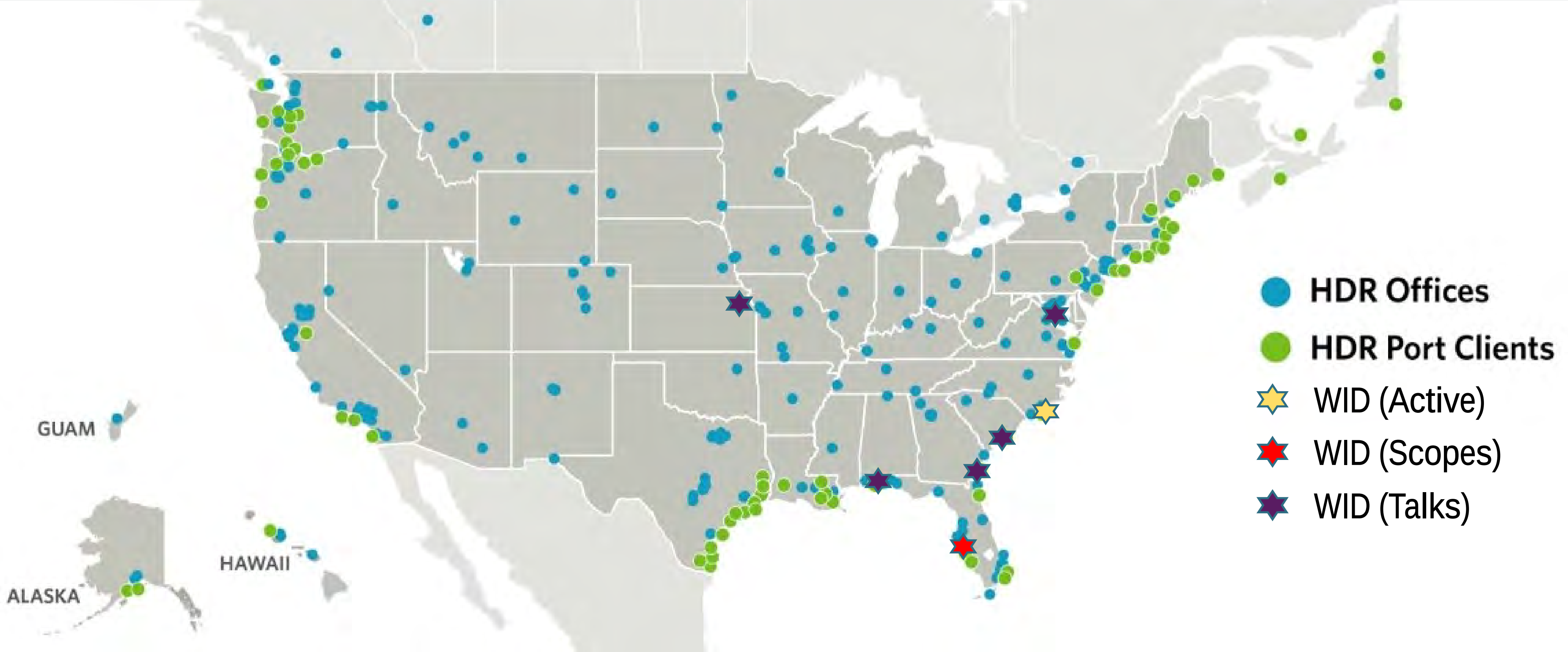
Discussion Summary & Feasibility Study Outline

- $3 M maintenance dredging annual budget
  - Includes PTB’s federal responsibilities
  - Does not include any new infrastructure
- Feasibility study outline evaluation:
  - Current dredging methods efficiency
  - 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



Summary – Case Studies and Conversations

- North Carolina State Ports Authority (NCSPA)
- Port Tampa Bay (PTB)
- Kansas Water Office (KWO)
- Georgia Ports Authority (GPA)
- South Carolina Ports Authority (SCPA)
- Maryland Port Administration (MPA)
- Alabama State Port Authority (ASPA)



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:

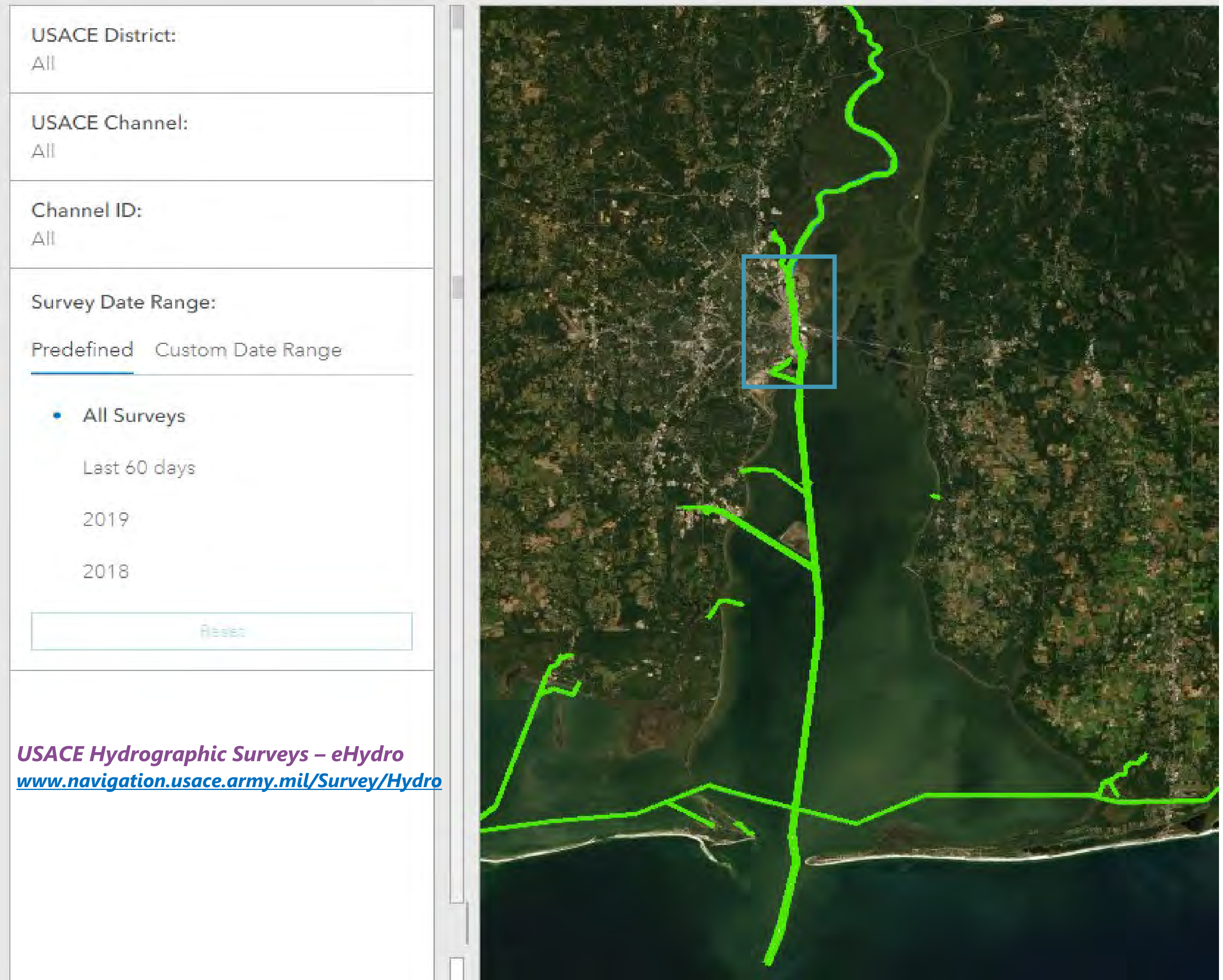
- Site conditions (sediment & hydrodynamic forces)
- Technical feasibility
- Legal & regulatory concerns
- Economics (benefits/costs ratio vs cost only)

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

Water Injection Dredge (WID)

Alabama State Port Authority (ASPA)

ASPA Waterways



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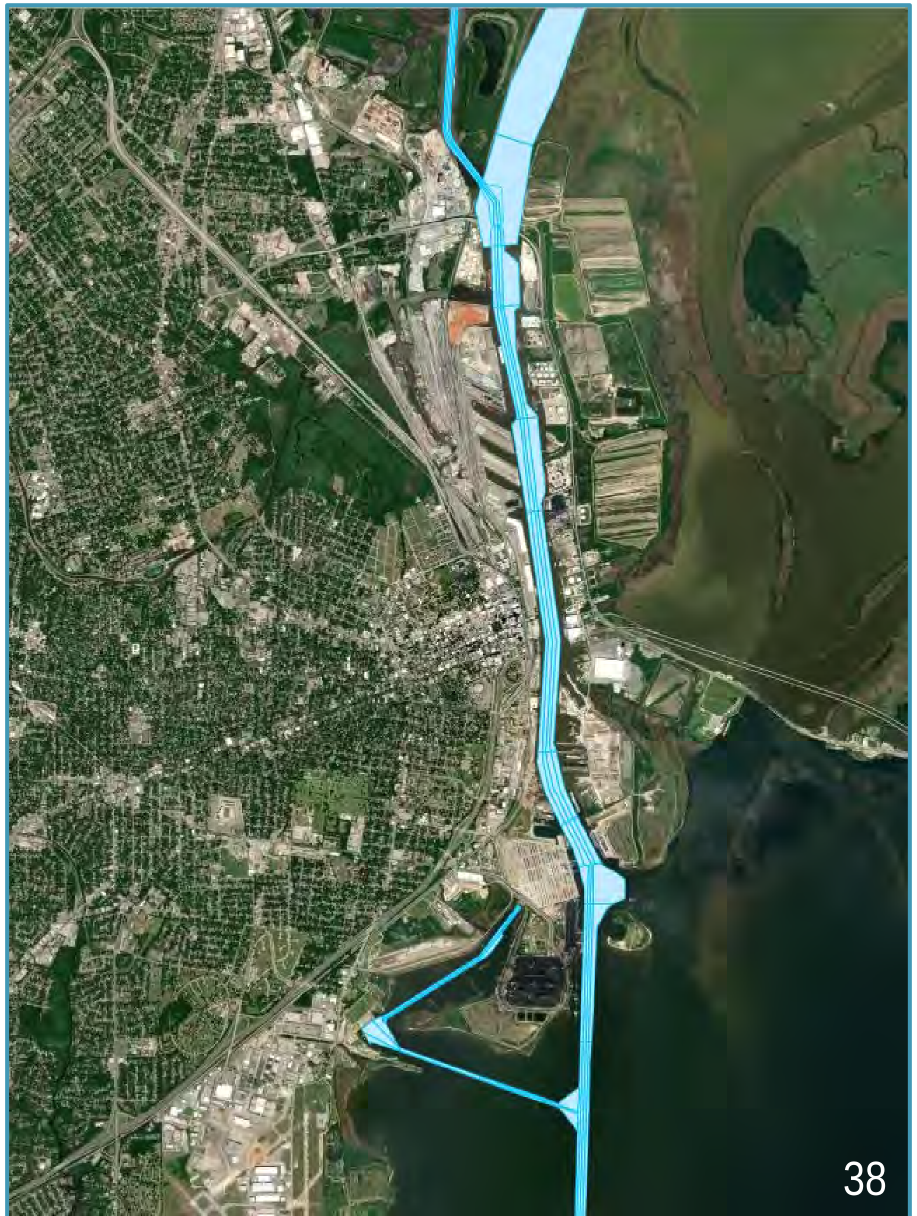


Mobile Bay Regional Sediment Management (RSM) Strategy

- Mobile Bay Ship Channel was primarily the 45-feet-deep & 400-feet-wide extending northward from the mouth of Mobile Bay for 29 miles to the mouth of the Mobile River
- About 4 MCY per year annual maintenance dredged material is removed by hopper dredges from Mobile Bay Ship Channel & placed in the ODMDS
- ODMDS is roughly 4 miles from the inlet & over 4.75 square miles, but ~40 miles from the north end of Mobile Bay
- Requirement to use hopper dredges for Mobile Bay dredging limited by USACE-SAM access to a smaller percentage of the available hopper dredging fleet

US Army Corps of Engineers®

ERDC/CHL CHETN-XIV-41
April 2015

Regional Sediment Management (RSM) Strategy for Mobile Bay, Alabama

by Larry Parson, Nathan Lovelace, Elizabeth Godsey, Kevin Reine, and Joseph Gailani

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) reviews the development of a Regional Sediment Management (RSM) implementation strategy for Mobile Bay, AL. The objective of this strategy is to bring lessons learned through application of RSM and Engineering With Nature (EWN) principles and practices in the coastal environment to a broader perspective for sediment and related environmental management planning for Mobile Bay, specifically the placement within Mobile Bay of maintenance material dredged from the Mobile Harbor navigation channel. The Northern Gulf of Mexico (NGOM) RSM demonstration project concluded in 2003 (Rosati et al. 2001 [rev. 2004]). The U.S. Army Corps of Engineers (USACE), South Atlantic Division (SAD), Mobile District (SAM), continues to implement into District practice the RSM lessons learned from those NGOM studies. RSM is a systems-based approach for collaboratively addressing sediment-related issues within a regional context. RSM seeks to support sustainable solutions for more effective use of littoral, estuarine, and riverine sediment resources in an environmentally sensitive and economically efficient manner.

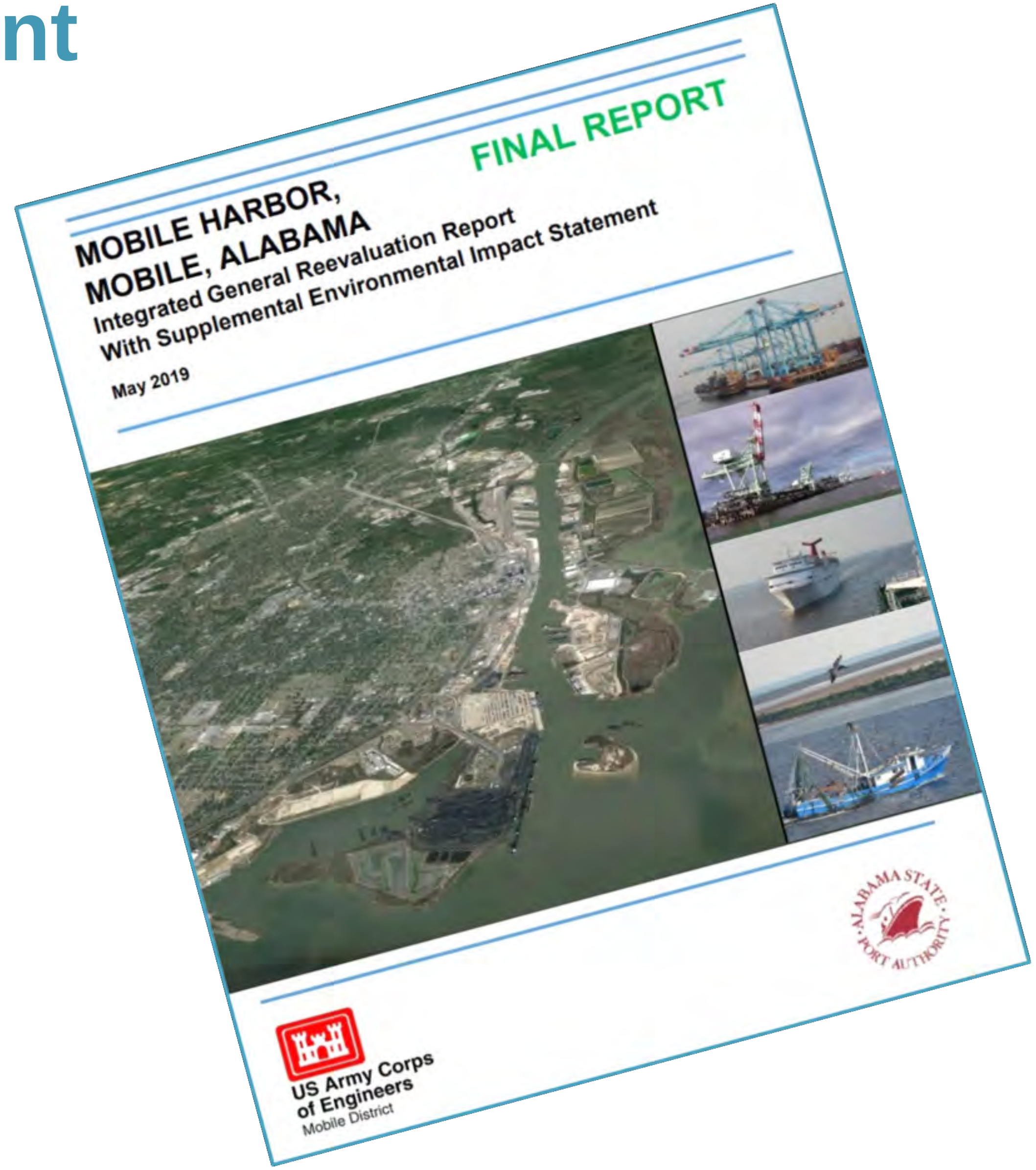
BACKGROUND: Mobile Bay is the terminal repository of sediments transported downstream from several riverine systems. SAM maintains the federally authorized Mobile Harbor Navigation Project (MHNP). The majority of the MHNP consists of the 45-feet-deep by 400-feet-wide Mobile Bay ship channel extending northward from the mouth of Mobile Bay for 29 miles to the mouth of the Mobile River (Figure 1). Material in the Mobile Bay channel consists of fine grain sediments, with some sand located in the upper channel reaches near the lower end of the Mobile River.

From its conception in the early 1800s, the majority of material dredged from the Mobile Bay channel was placed in the adjacent waters using mechanical dredges that side casted the material alongside the channel. In the late 1800s, this practice was changed to the use of hydraulic cutterhead dredges. The majority of the side-casting and earlier adjacent open-water hydraulic placements of material resulted in dredge material mounds in the shallow water just outside and parallel to the channel limits. As positioning technology advanced and overall

Figure 1. Mobile Bay ship channel, Weeks Bay, and Ocean Dredged Material Disposal Site (ODMDS).

Mobile Harbor Construction, Engineering & Design Agreement

- Six-phase project – anticipated completion by late 2024 or early 2025. Total estimated cost for the project is $365.7 M
- Project will deepen the bar, bay & river channels in Mobile Harbor to 50 feet
  - o Bend easing at the double bends of the bar channel
  - o Widening of the bay channel from 400 feet to 500 feet from the mouth of Mobile Bay northward for three miles
  - o Expanding the Choctaw Pass Turning Basin by 250 feet to the south at a 50-foot depth.
- In April 2021, Great Lakes Dredge & Dock (GLDD) awarded a ~$54 M contract to deepen & widen portions of the Mobile Harbor with an estimated completion date of October 18, 2022



Mobile Harbor Deepening Project

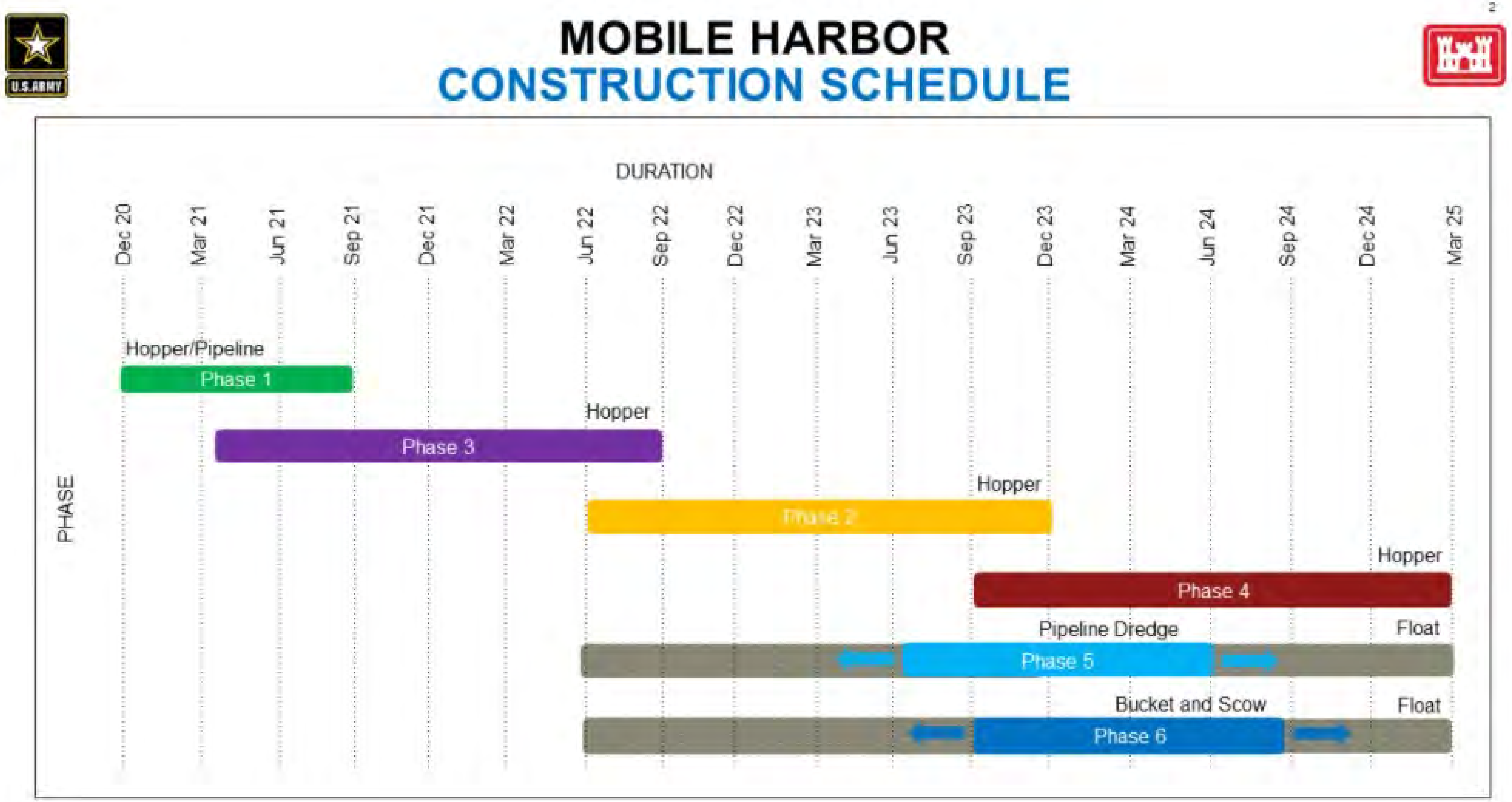
MOBILE HARBOR
APPROVED PLAN

- Channel Deepening: 50 feet Bay/ 52 feet Bar
- Channel Widening: 3 mi. long, 100 ft wide* A
- Turning Basin Modification B
- Bar Channel Bend Easing C

FULLY FUNDED COSTS: $365.7M	
*Federal Share:	$274.3M
*Non-Federal Share:	$91.4M

CONSTRUCTION PHASING	
Phase 1	Bar Channel Deepening
Phase 2	Bar Channel & Bend Easings to 52' plus Widener
Phase 3	Deepening Lower Bay Channel
Phase 4	Deepening remainder of Lower Bay Channel and portion of Upper Bay Channel
Phase 5	Deepen Upper Bay Channel (Relic Shell)
Phase 6	Turning Basin

Mobile Harbor Deepening Project



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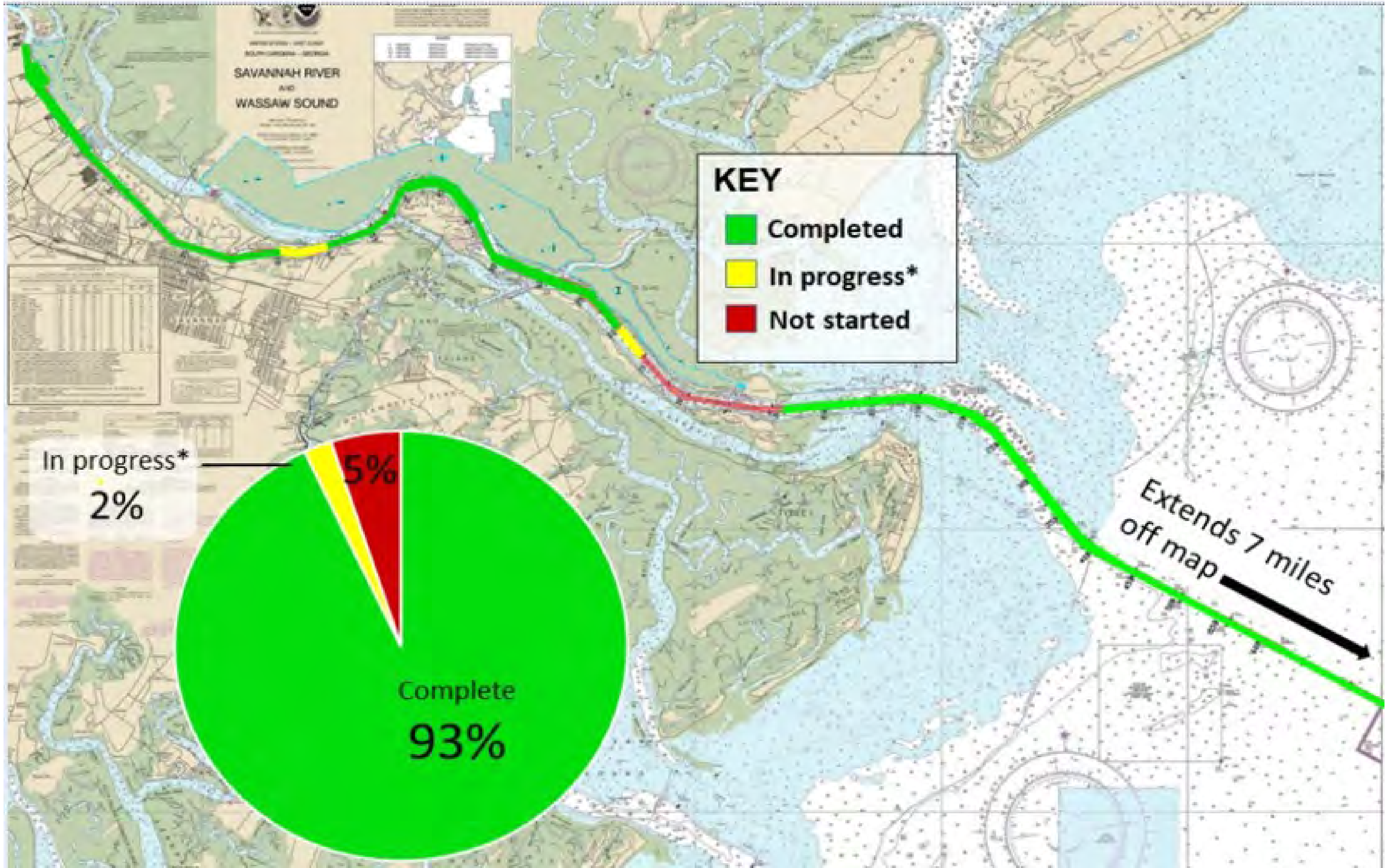
Water Injection Dredge (WID)

Georgia Ports Authority (GPA)

Savannah Harbor Expansion Project (SHEP)



GPA Waterways – Savannah Harbor

USACE District:
Savannah - SAS

USACE Channel:
All

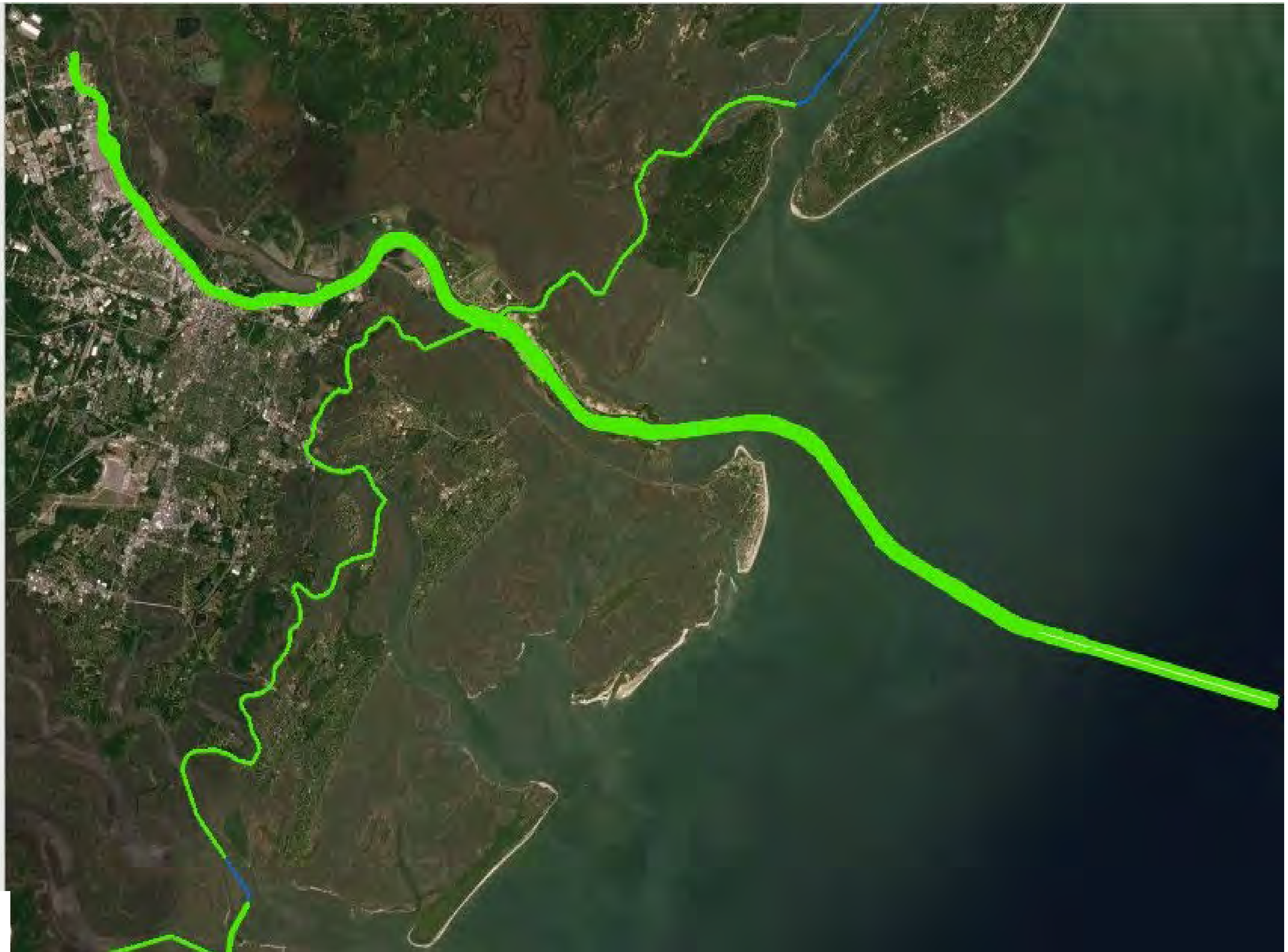
Channel ID:
All

Survey Date Range:

Predefined | Custom Date Range

- All Surveys
- Last 60 days
- 2019
- 2018

Reset



USACE Hydrographic Surveys – eHydro
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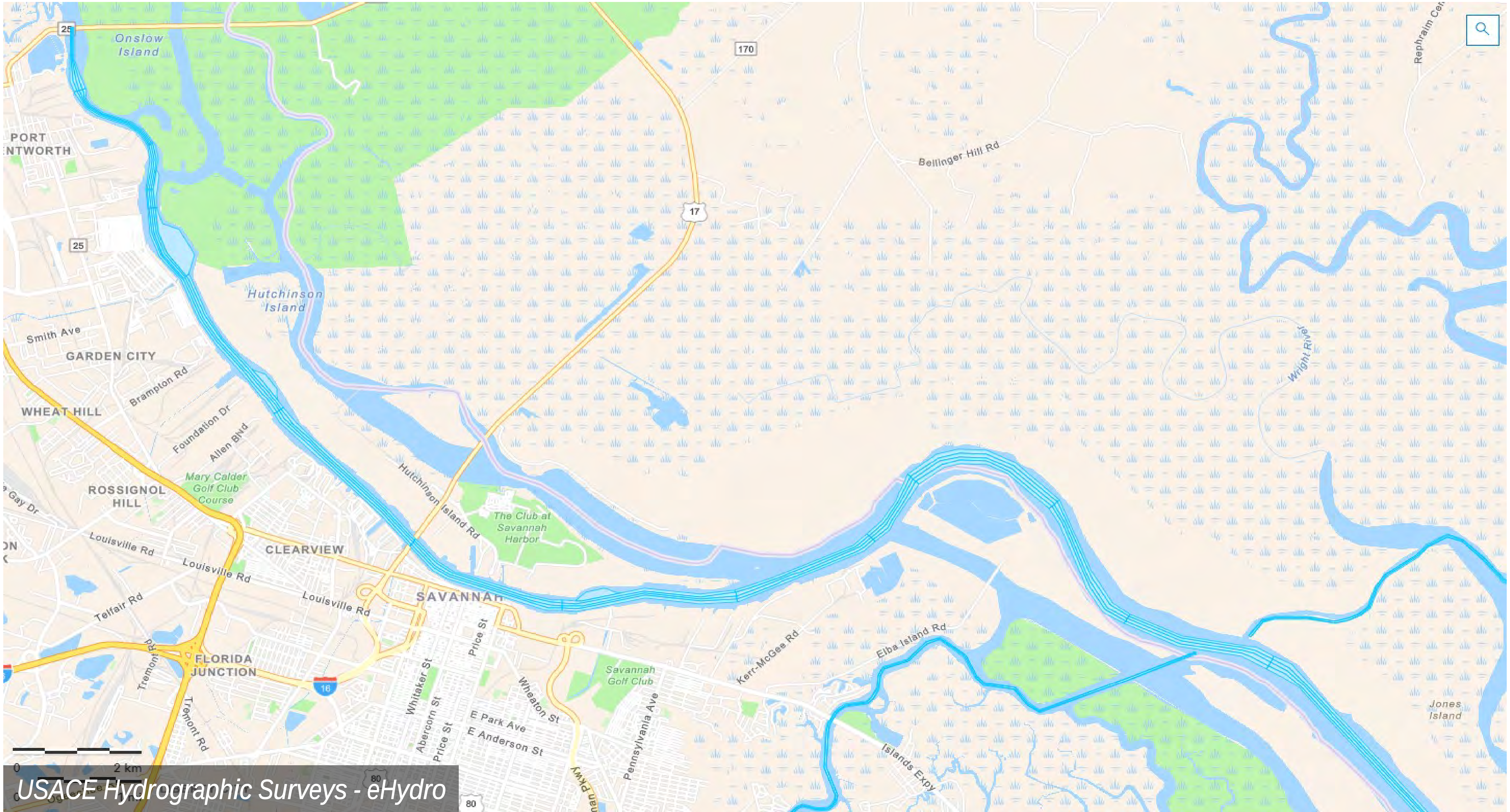
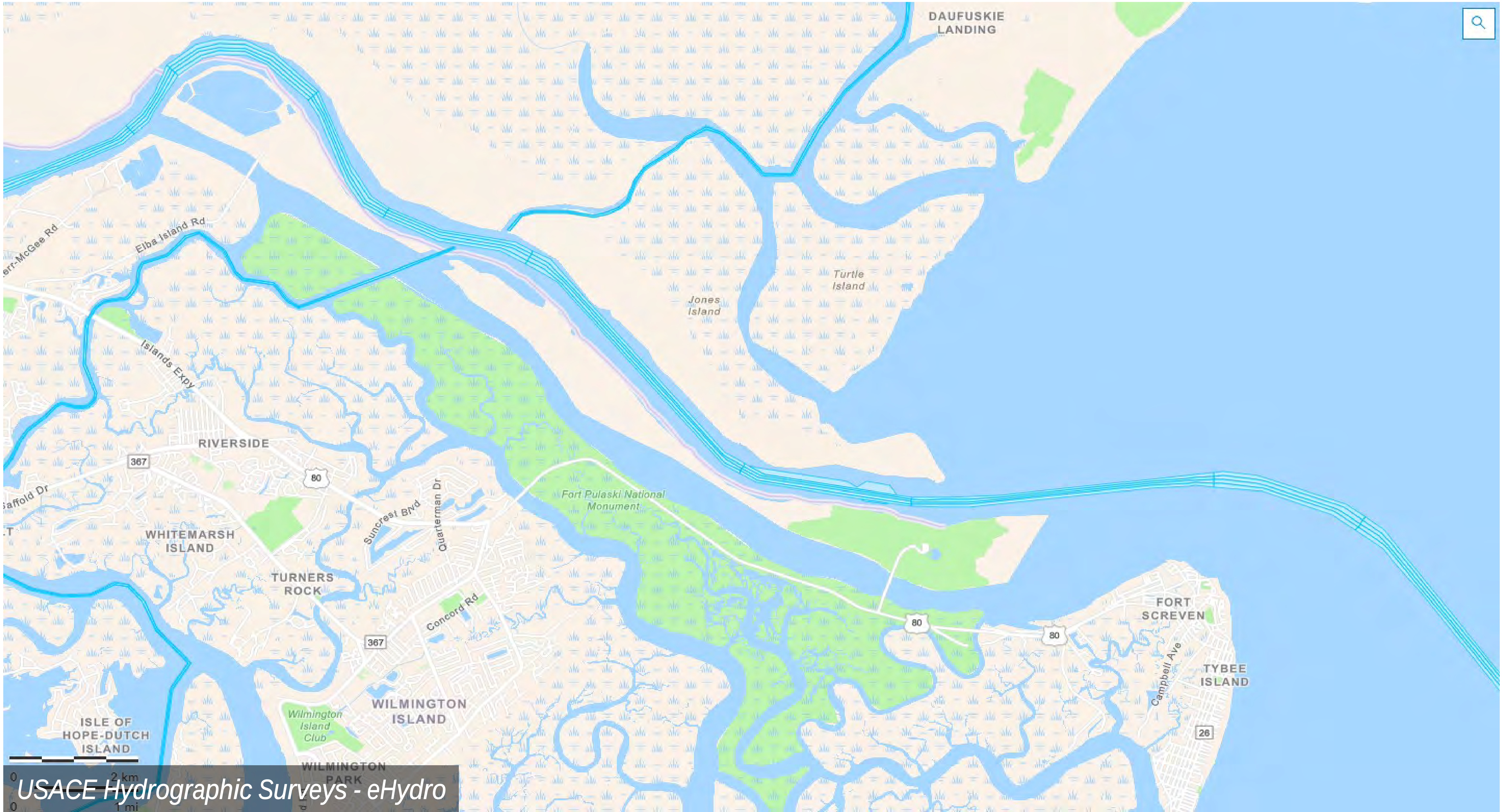
Savannah Harbor (West)



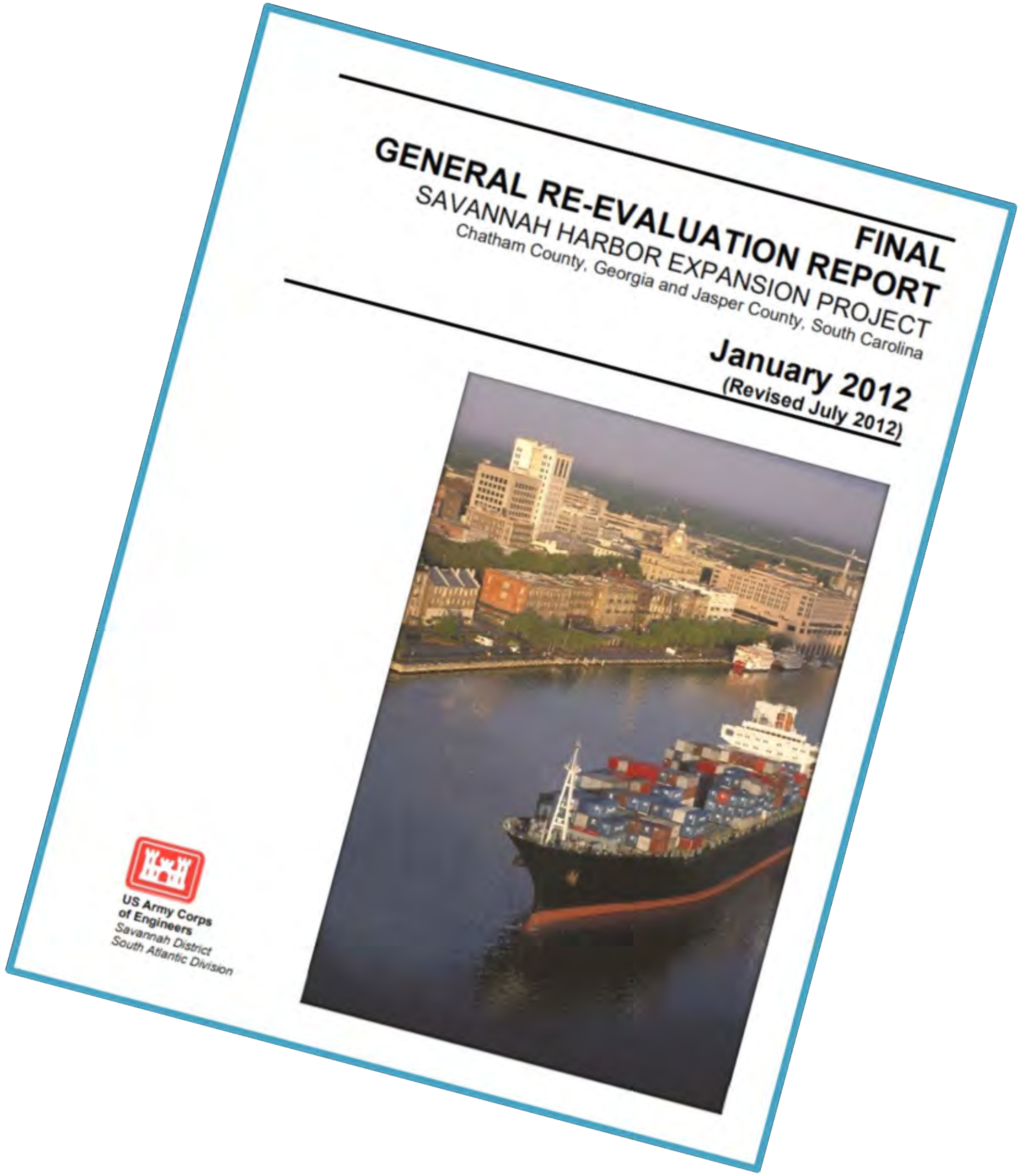
Savannah Harbor (East)



USACE Hydrographic Surveys - eHydro

Savannah Harbor Expansion Project (SHEP) General Re-evaluation Report (GRR)

- Savannah Harbor Bar Channel is 11.5 miles long, 44 feet deep & 600 feet wide, & an Inner Harbor Channel 21 miles long, 42 feet deep & 500 feet wide
- Ongoing deepening will result in 47 feet depths
- Up to 7 MCY of sediments (sand, silt & clay) removed each year from the Inner Harbor into ~8 DMCA
- Up to 800 KCY of sediment from the Entrance Channel from December through March



GPA Waterways – Brunswick Harbor

Brunswick Harbor

USACE District:
Savannah - SAS

USACE Channel:
All

Channel ID:
All

Survey Date Range:

Predefined   Custom Date Range

- All Surveys

Last 60 days

2019

2018

Reset

USACE Hydrographic Surveys – eHydro
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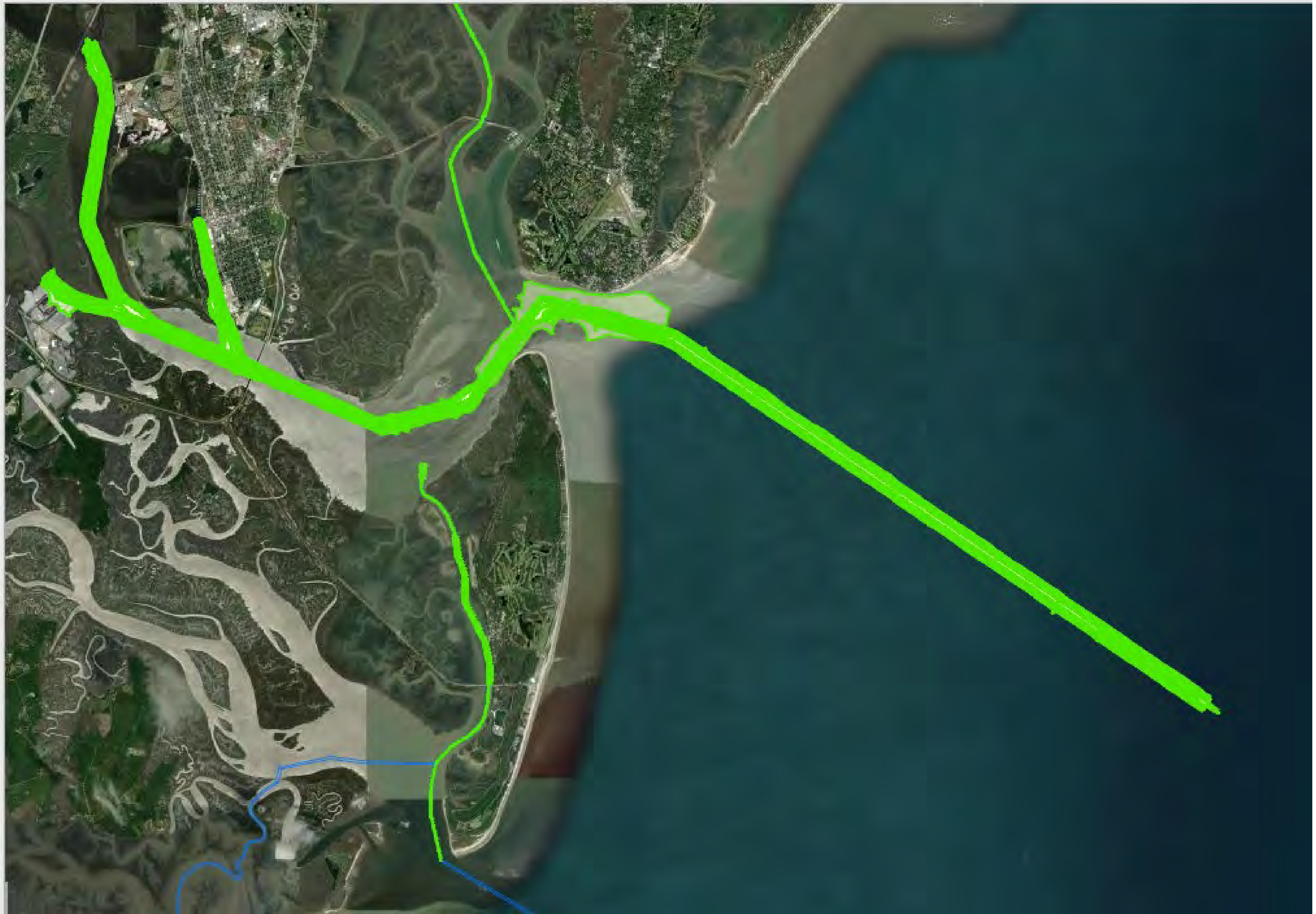
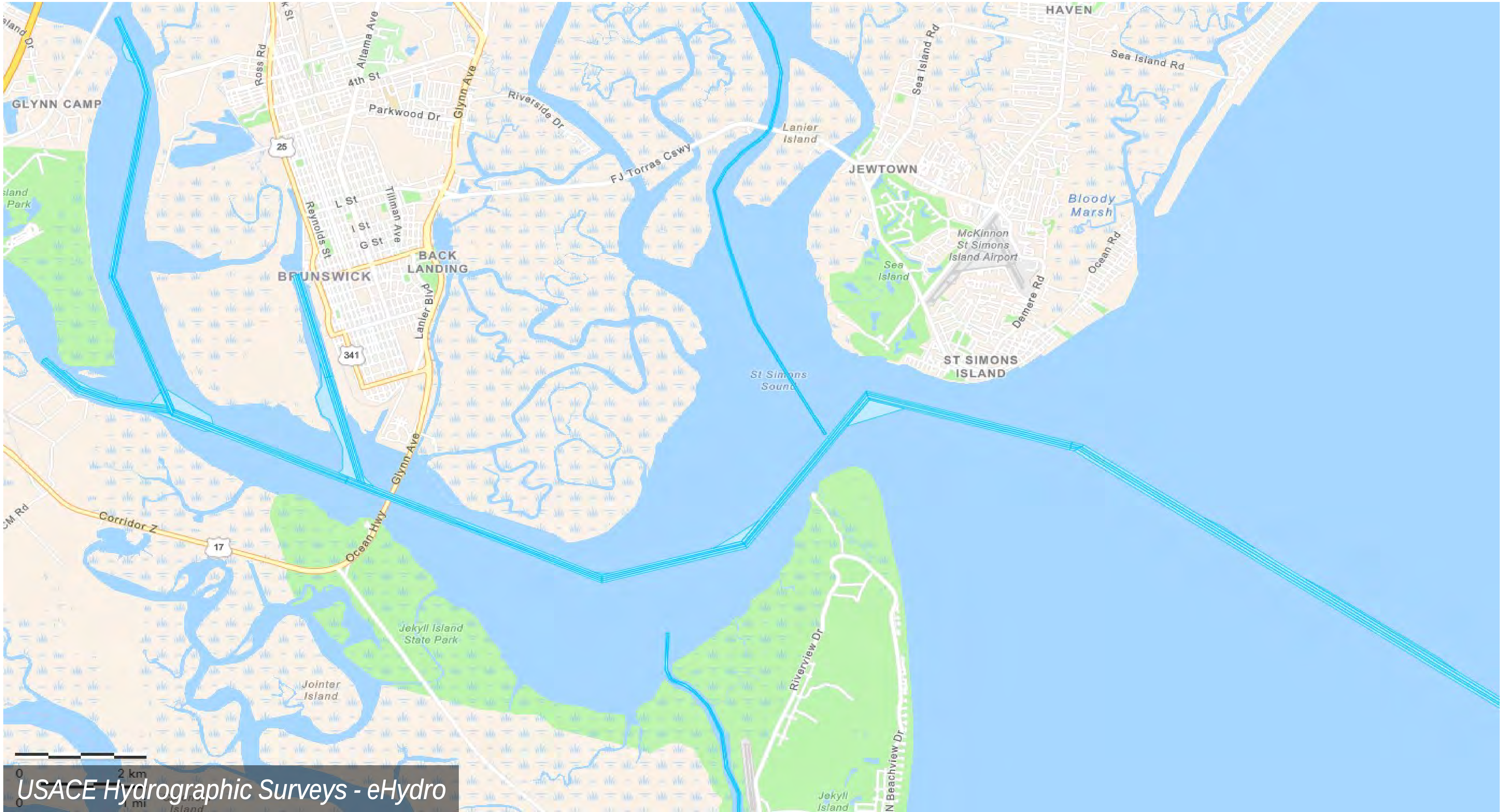


Brunswick Harbor



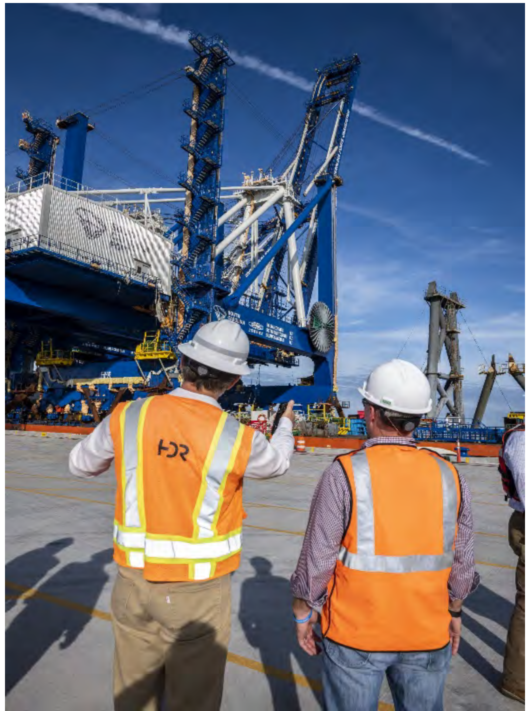
Brunswick Harbor Modification Study Draft FONSI

- Brunswick Harbor Bar Channel is 38 feet deep, 500 feet wide, & 10.7 miles long & an Inner Harbor Channel 36 feet deep, 400 feet wide, & 15.3 miles long through St. Simon's Sound, Brunswick River & East River
- Inner Harbor has two turning basins – East River & Turtle River
- Inner Harbor dredged material placed in Andrews Island, the sole upland DMCA
- Brunswick Harbor has not been dredged to authorized project dimensions since 2010 due to funding shortfalls, a limited number of hopper dredges, & environmental hopper dredging windows

Water Injection Dredge (WID)

South Carolina Ports Authority (SCPA)

SOUTH CAROLINA PORTS
THE WORLD CONNECTS HERE SM



SCPA Waterways

USACE District:

All

USACE Channel:

All

Channel ID:

All

Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

Custom Date Range

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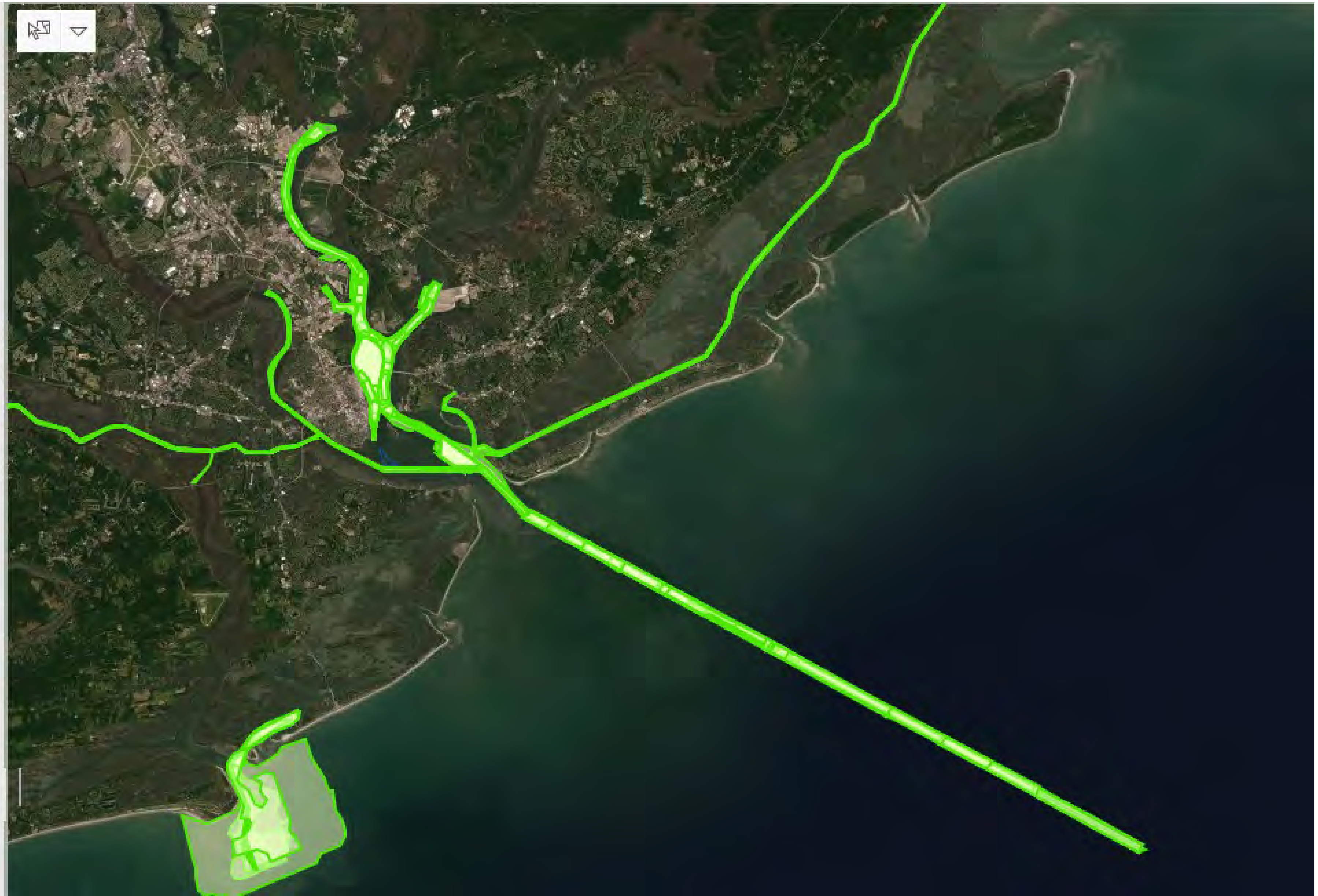
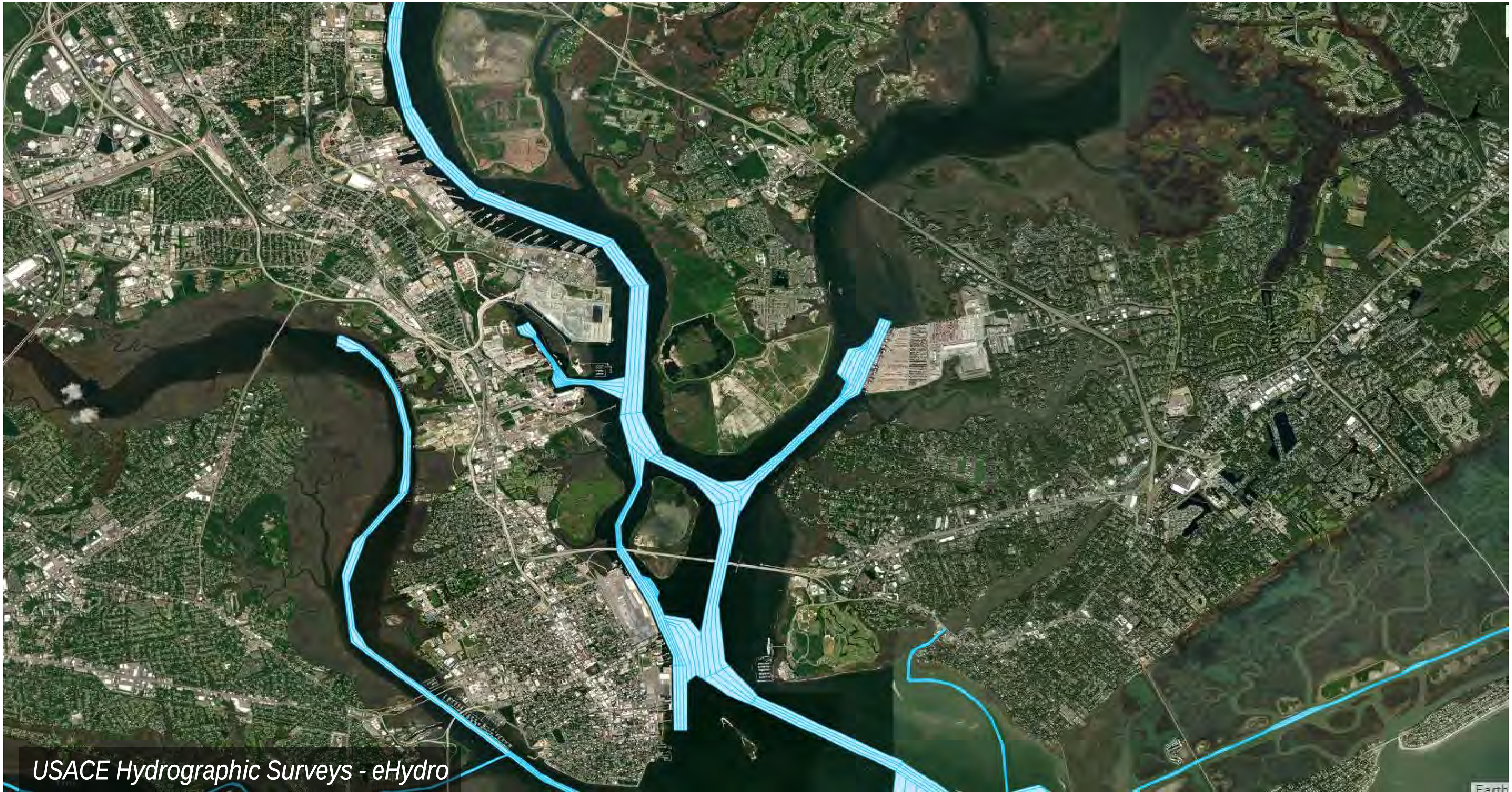


Cooper River & HLT

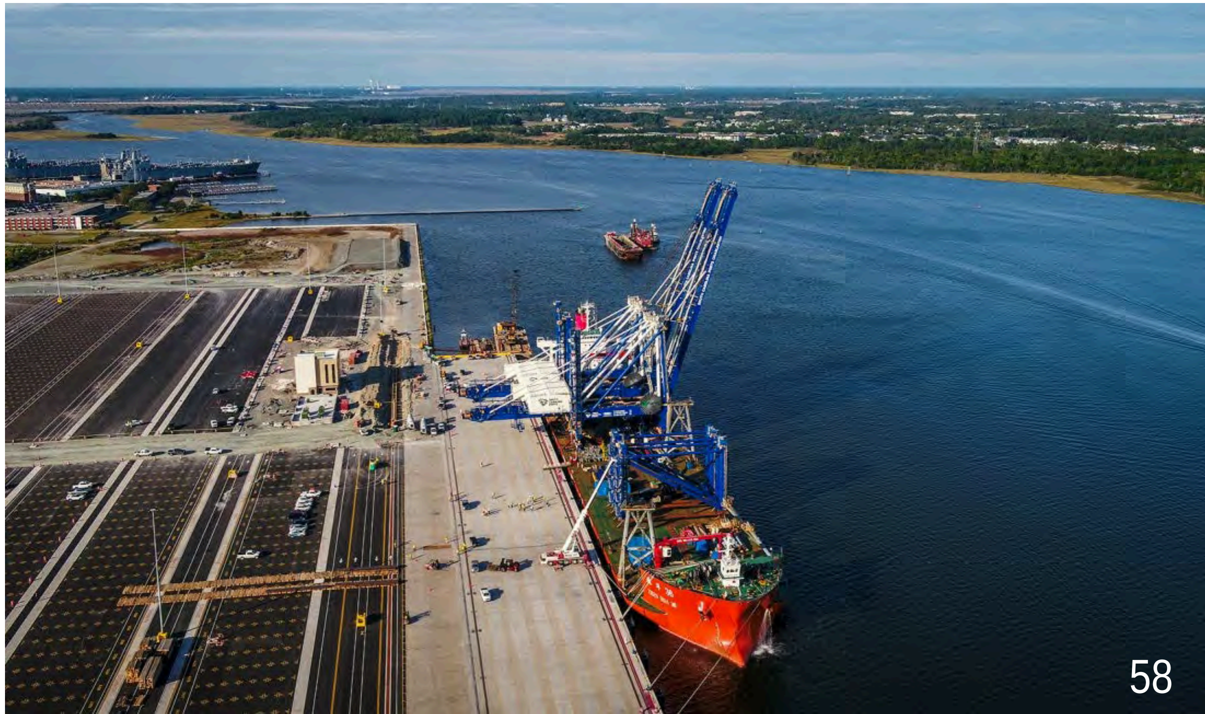


Charleston Harbor Regional Sediment Management (RSM) Update

- 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)

MARYLAND DEPARTMENT OF TRANSPORTATION

MPA Waterways (Northern)

USACE District:

All

USACE Channel:

All

Channel ID:

All

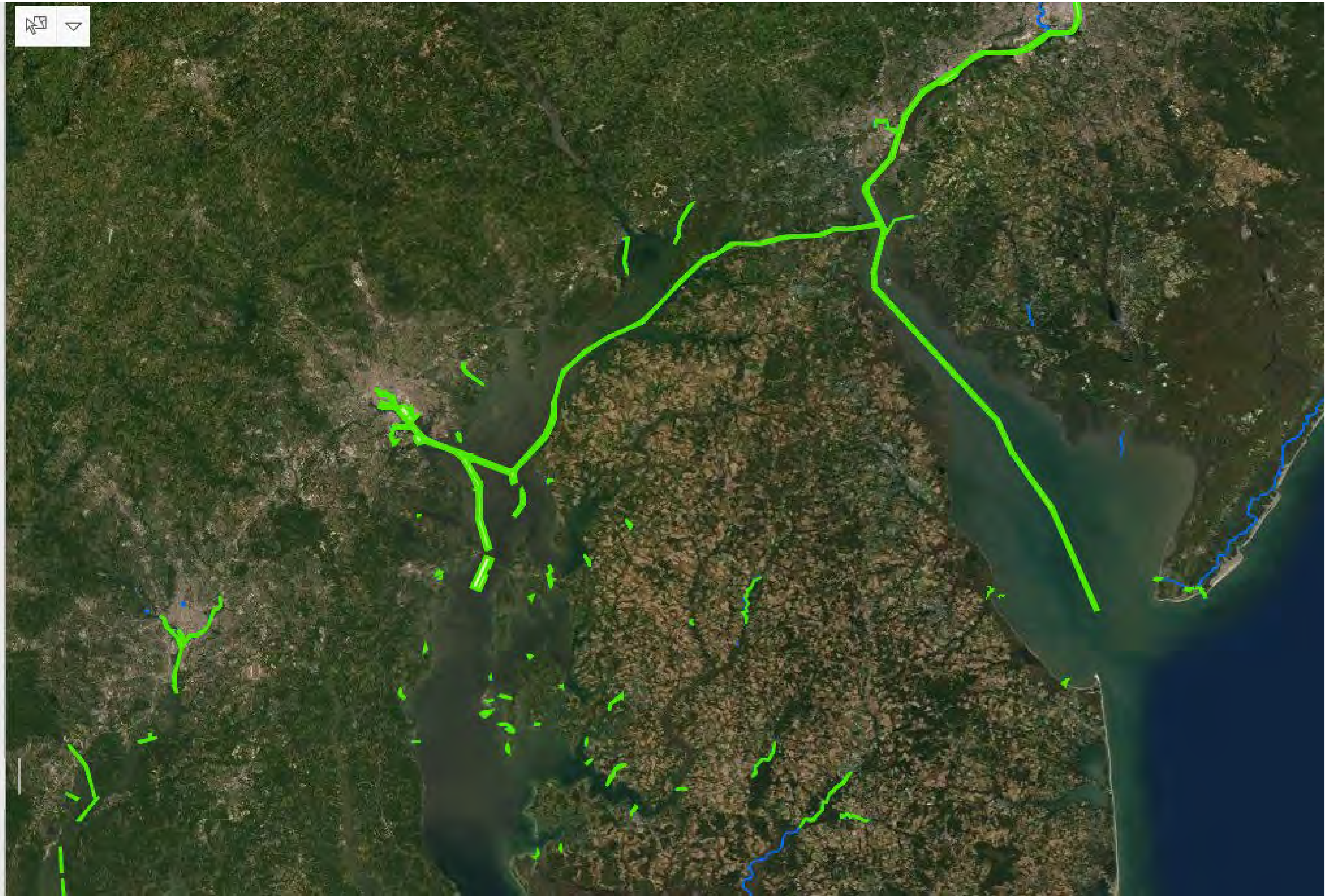
Survey Date Range:

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 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*](www.navigation.usace.army.mil/Survey/Hydro)

MPA Waterways (Southern)

USACE District:

All

USACE Channel:

All

Channel ID:

All

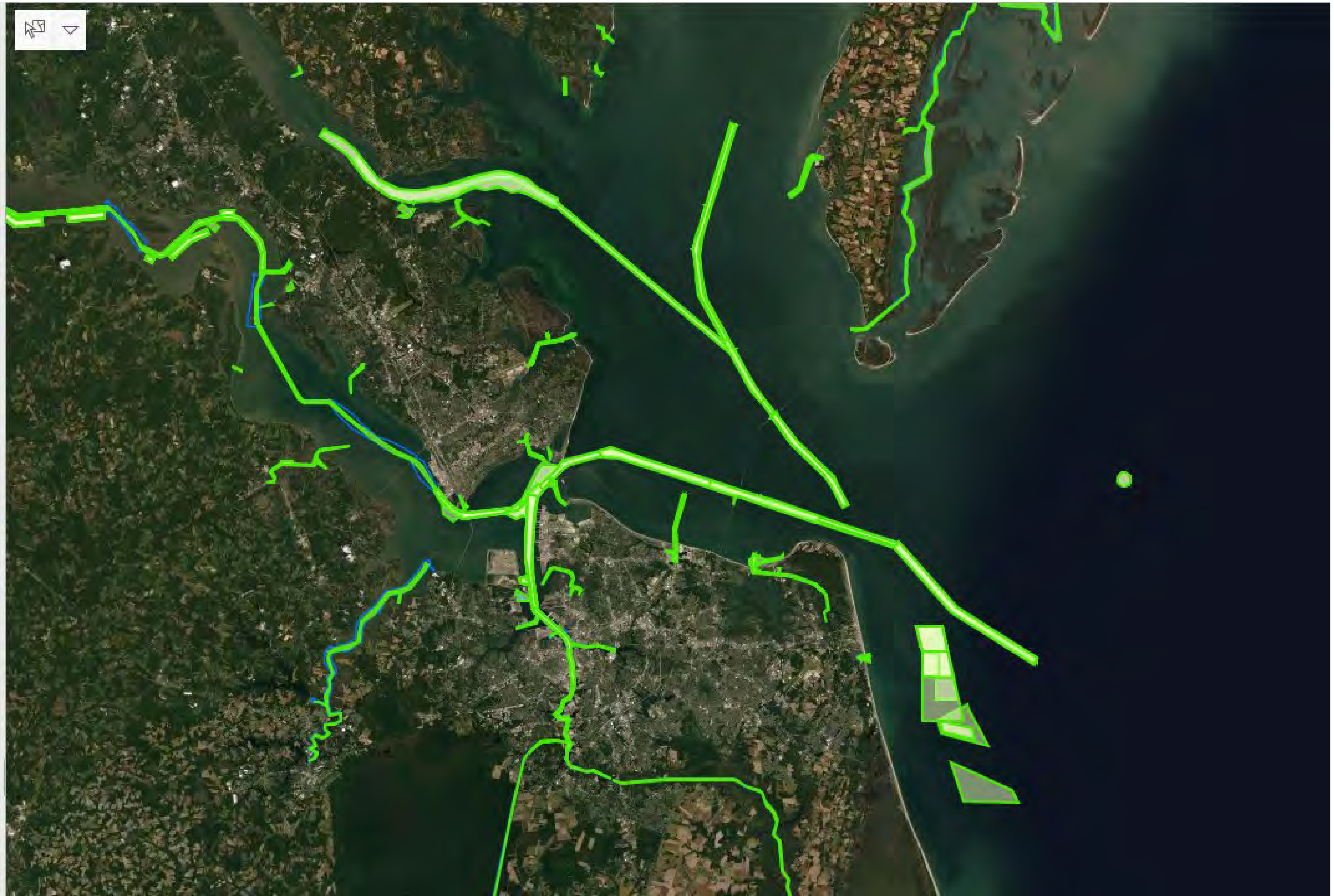
Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

Custom Date Range

USACE Hydrographic Surveys – eHydro

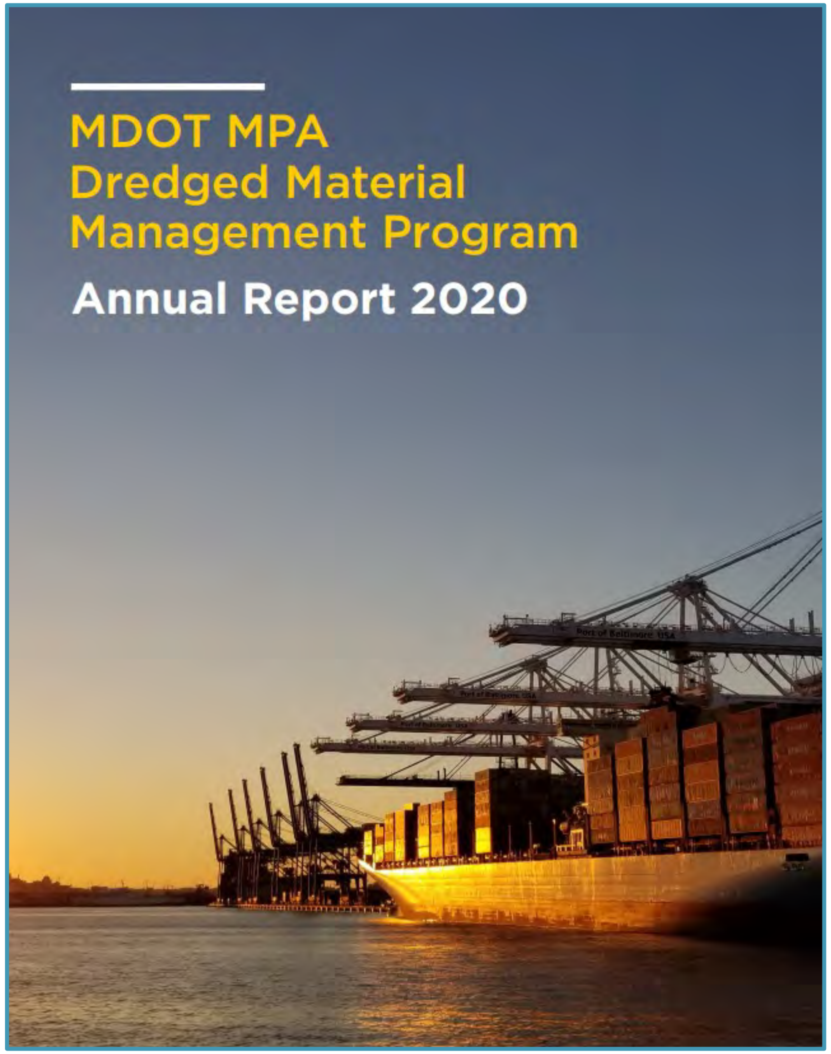
www.navigation.usace.army.mil/Survey/Hydro



Port of Baltimore

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?

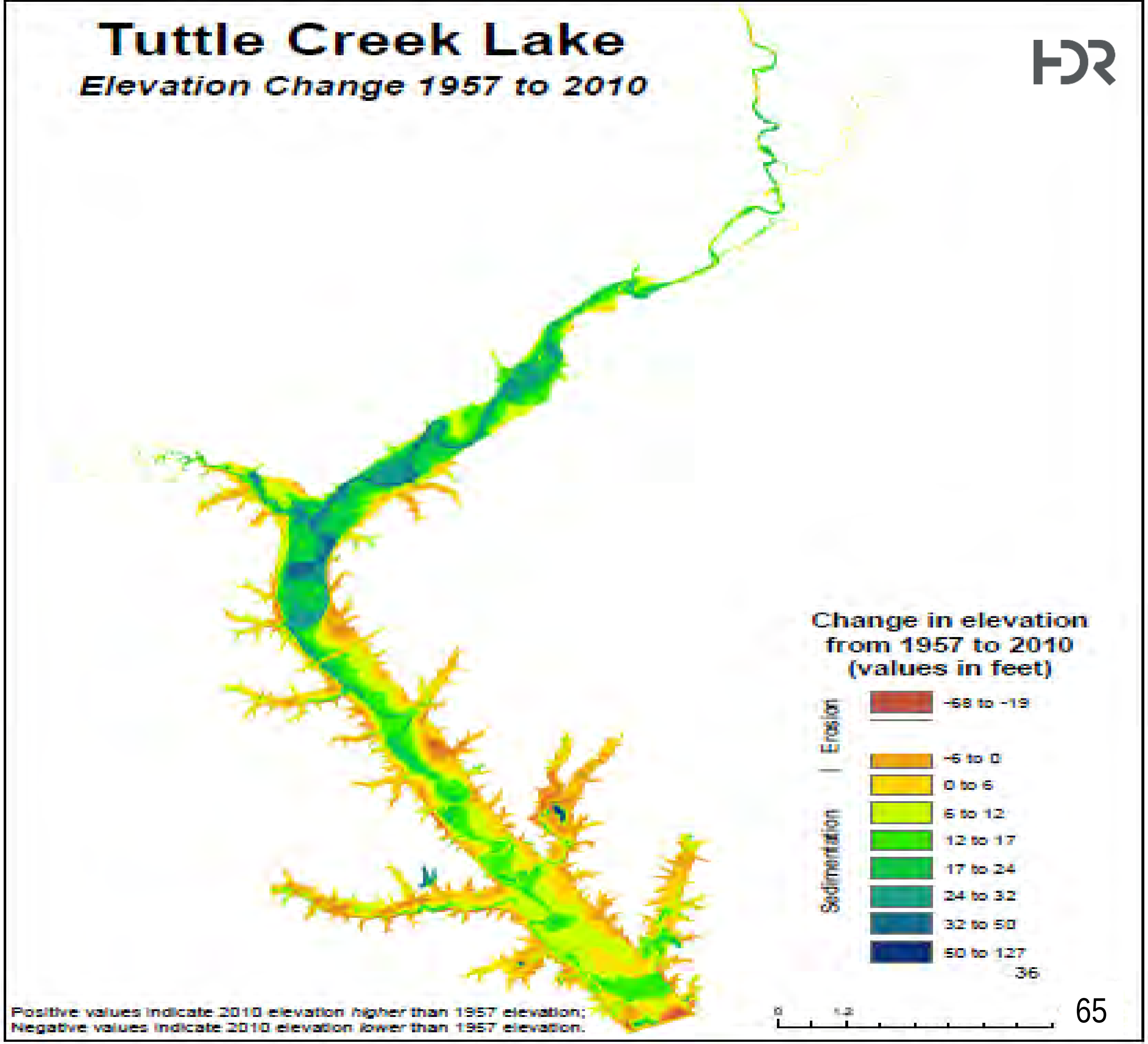


MDOT MPA DMMP 2020
www.maryland-dmmp.com

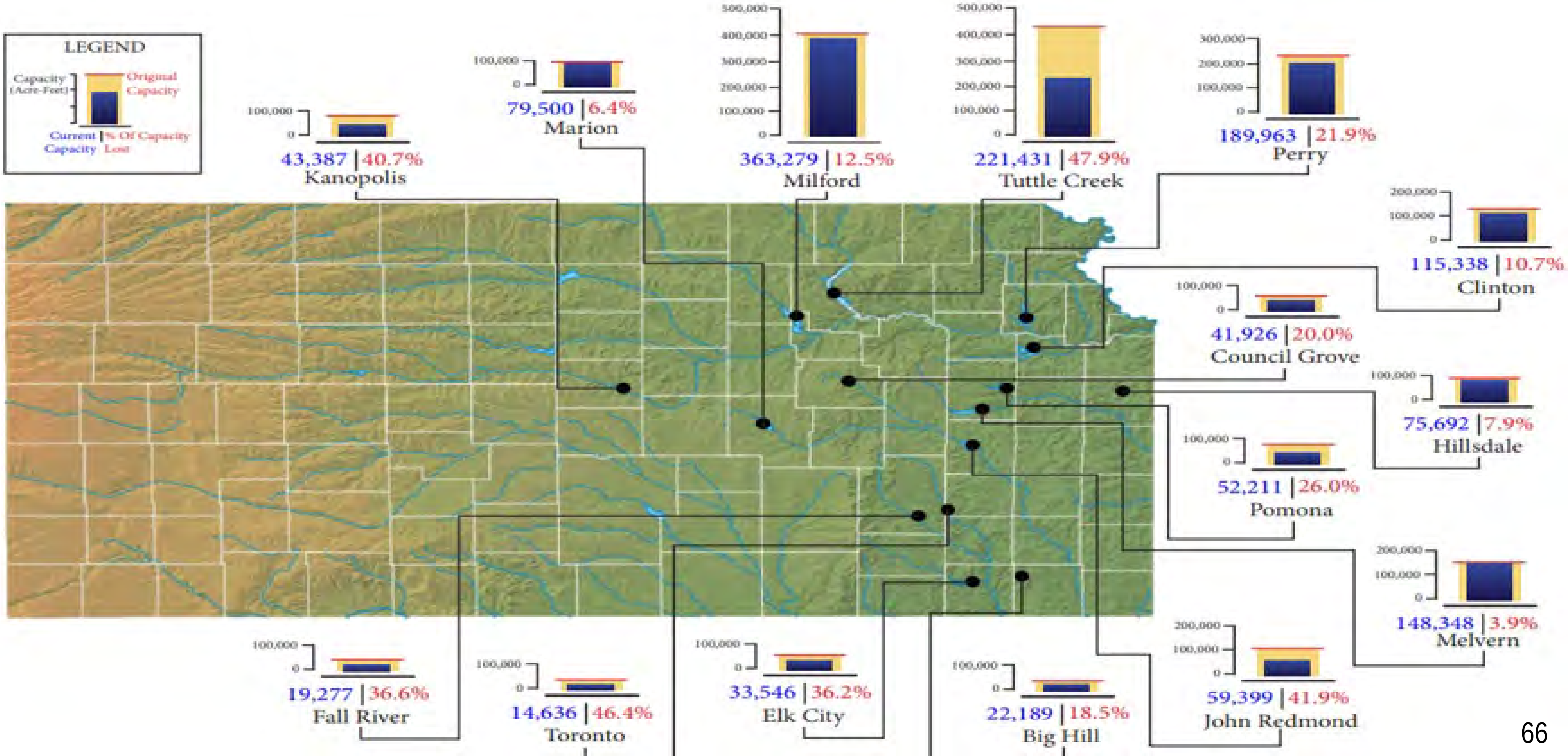
Water Injection Dredge (WID) in Reservoirs

Kansas Water Office (KWO)

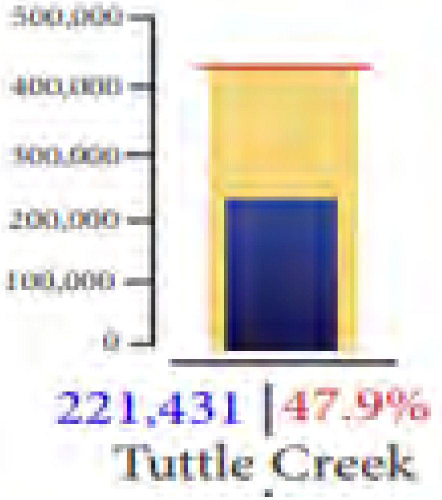
Tuttle Creek Lake

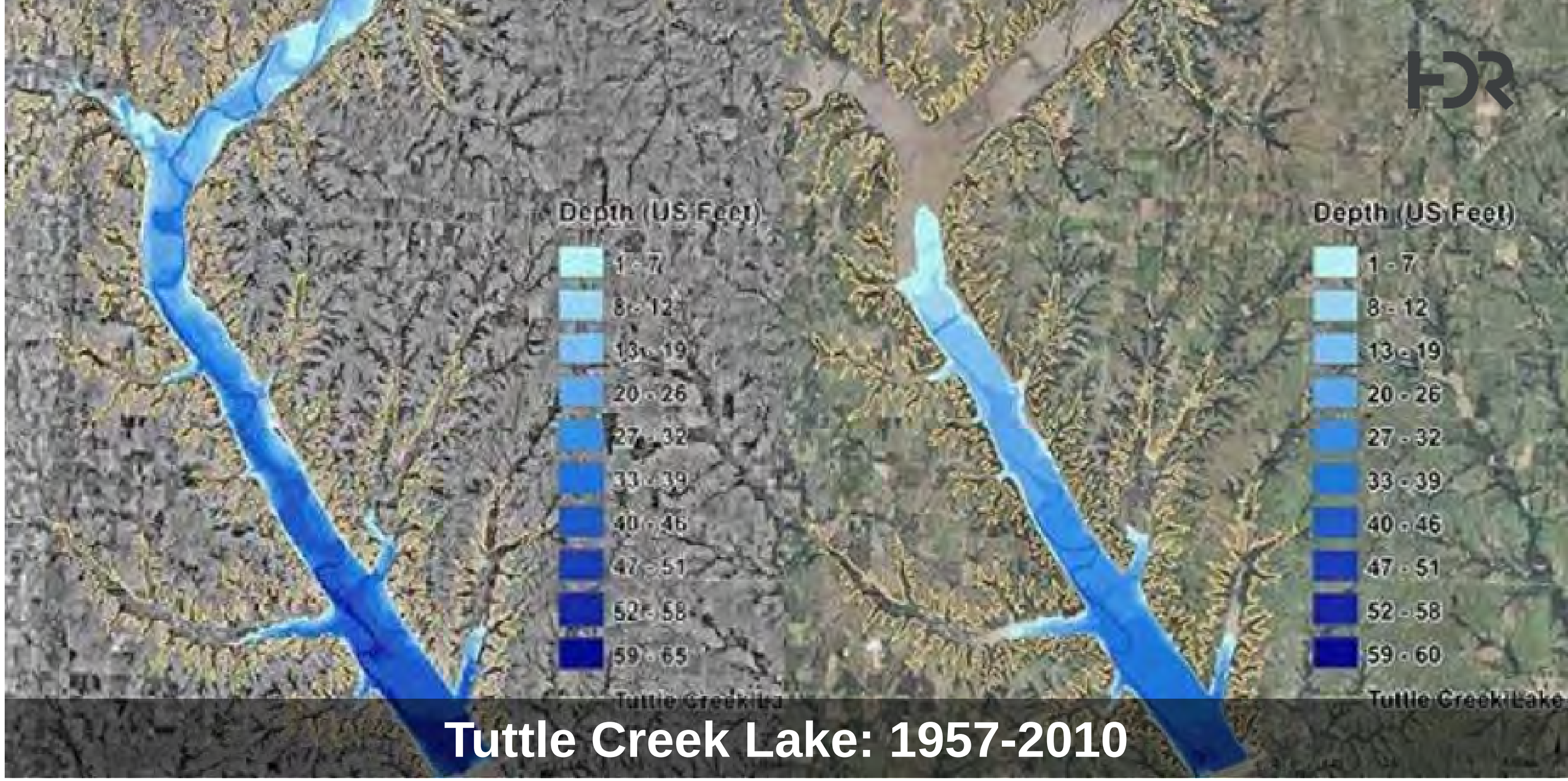


WID Kansas Water Office (KWO) Tuttle Creek Lake

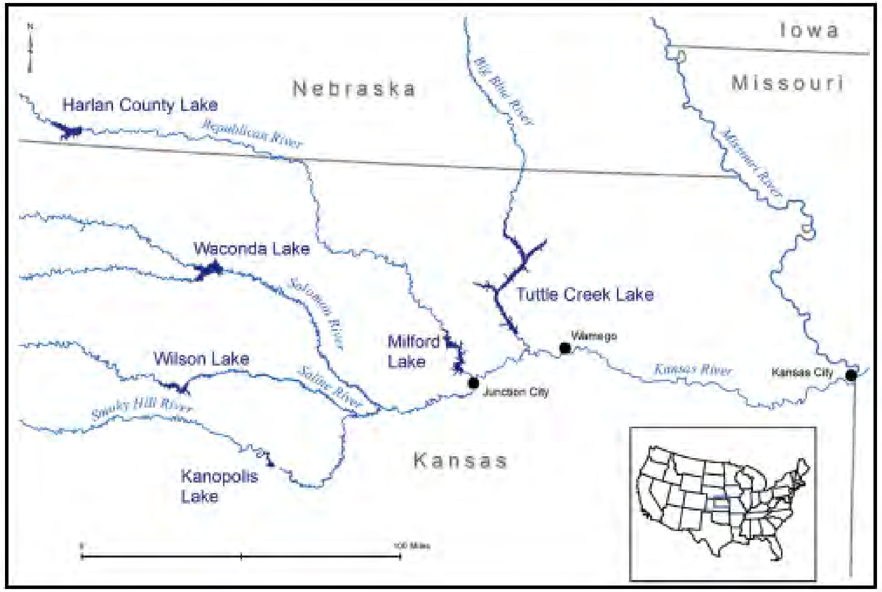


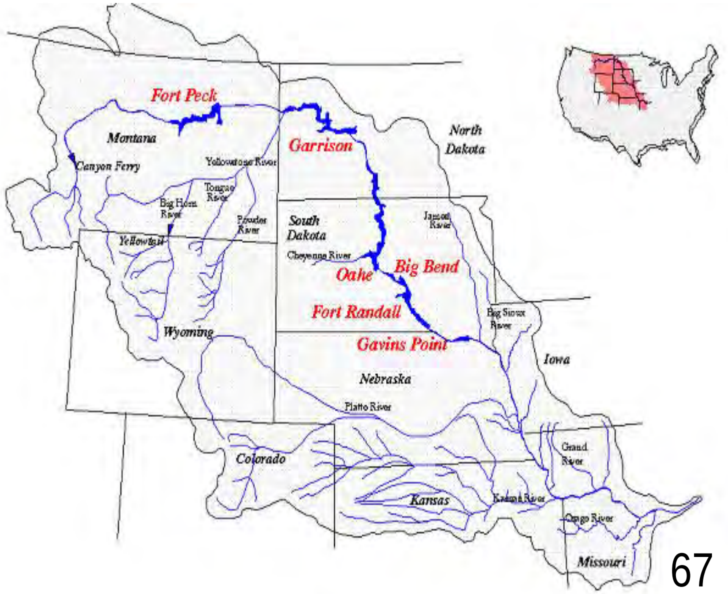
WID KWO – Tuttle Creek Lake (Cont.)



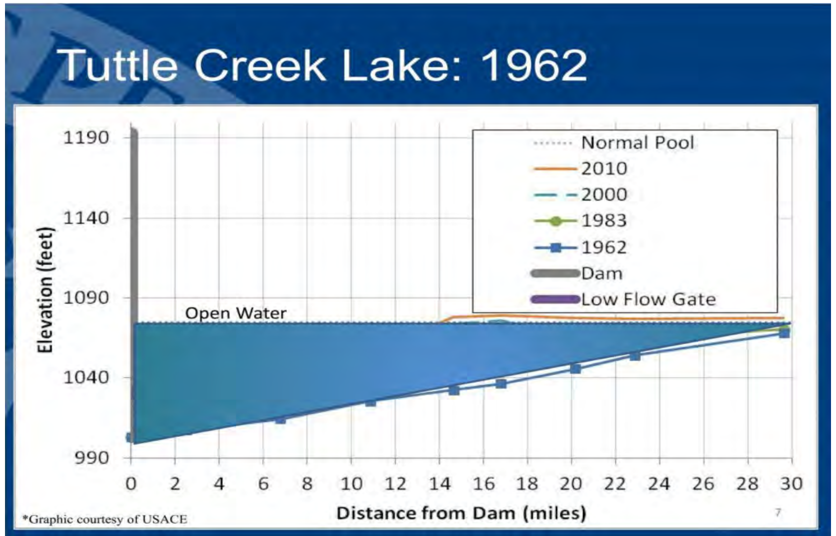


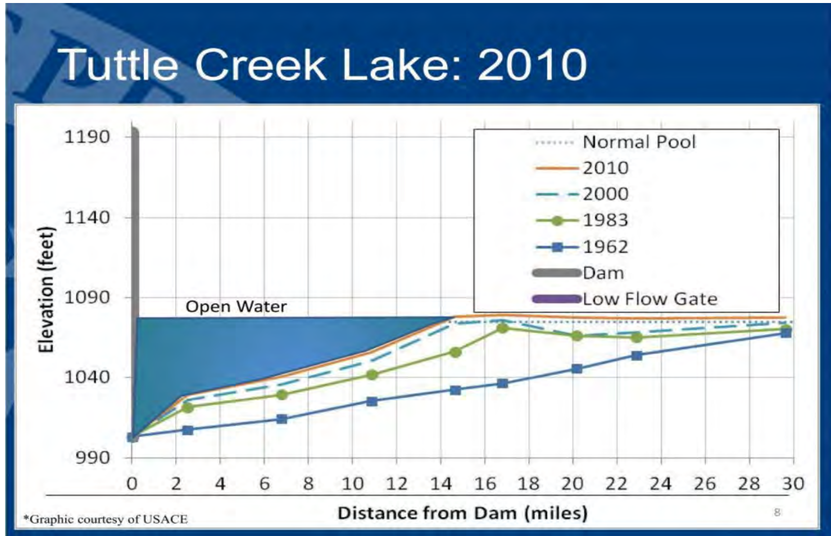
Tuttle Creek Lake: 1957-2010





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

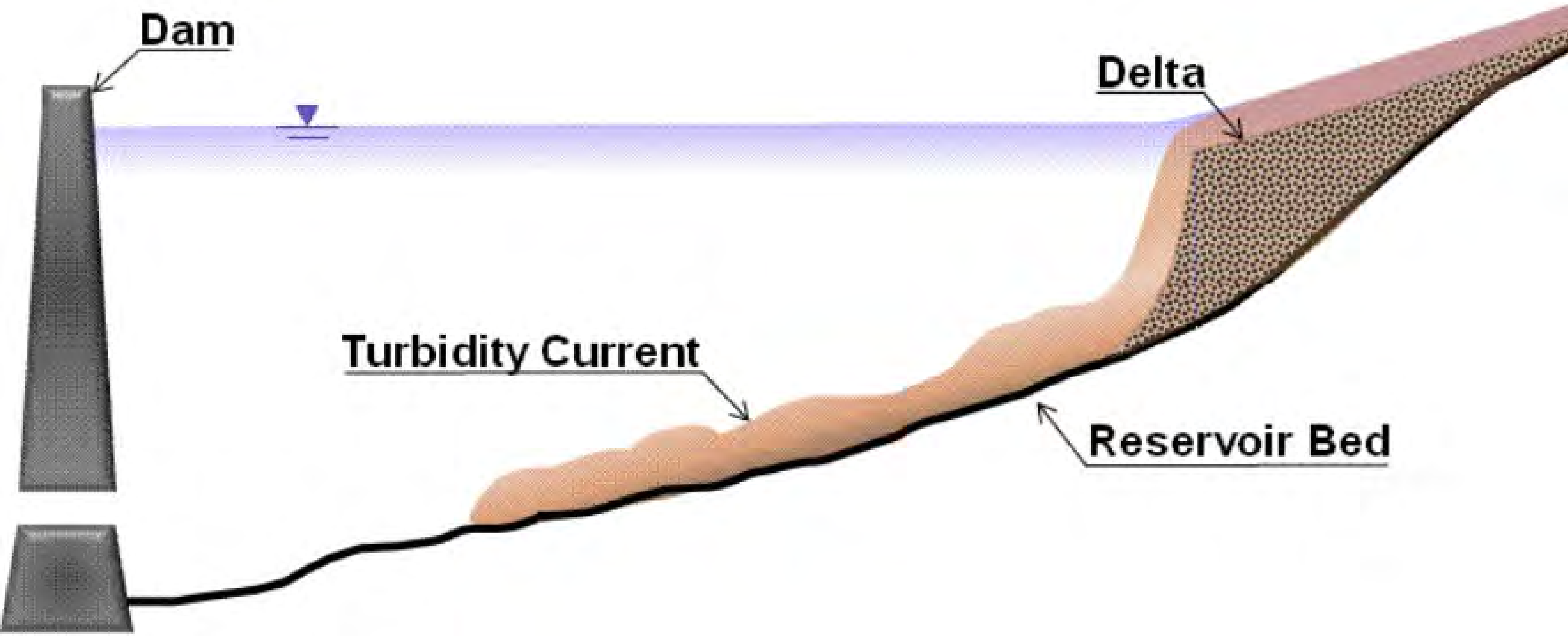
Water Injection Dredging

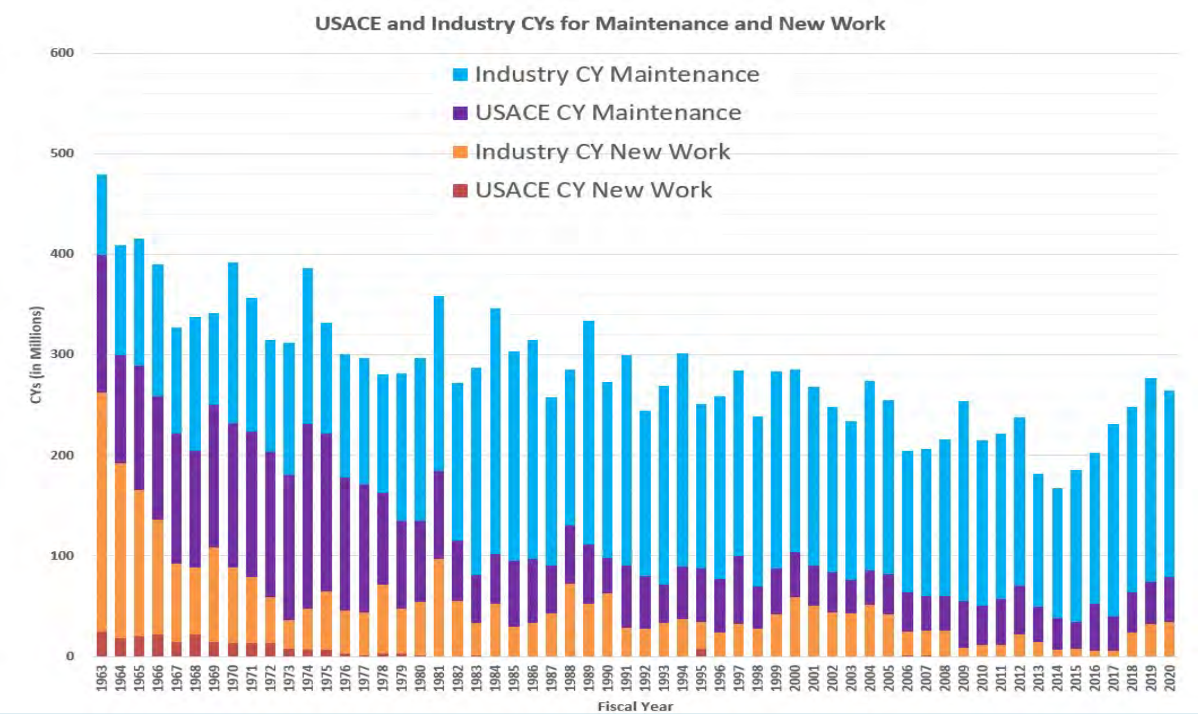
Inject water into the sediment deposits to induce a *density current*

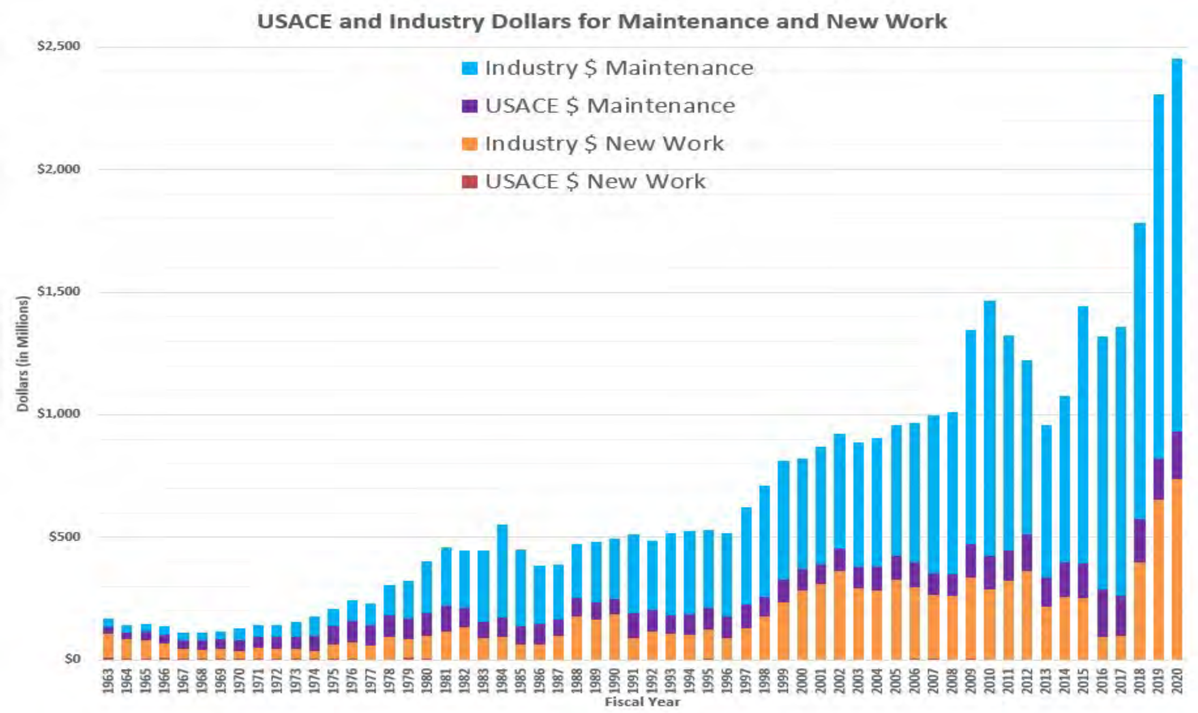
Open the sluice gates & release the sediment through the existing low elevation discharge conduit under the forces of:

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

WID KWO – Tuttle Creek Lake (Cont.)







USACE NDC Dredging Costs (1963-2020)

- Overall US dredging volumes decreased
  - o USACE CY has decreased by ~377%
  - o Industry CY has decreased by ~125%
  - o Overall CY has decreased by ~170%
- Overall US dredging costs increased
  - o USACE $/CY has increased by ~178%
  - o Industry $/CY has increased by ~250%
  - o Overall $/CY has increased by ~255%
- Overall US dredging volumes by type have decreased
  - o New Work CY has decreased by ~773%
  - o Maintenance CY has decreased by ~121%
- Overall US maintenance dredging responsibility has shifted to Industry
  - o USACE portion has decreased by ~17%
  - o Industry portion has increased by ~43%

USACE NDC Dredging Costs (1963-2020)

https://publibrary.planusace.us/#/series/Dredging%20Information

	CORPS OF ENGINEERS								
	DOLLARS			CUBIC YARDS			2020 $$/CY		
	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	WEIGHTED AVG.
First Ten Years	$37	$6	$44	131	17	149	$2.16	$2.79	$2.24
Last Ten Years	$157	$0.01	$157	39	0.002	39	$3.98	$3.78	$3.98
				333%	966667%	377%	184%	135%	178%

	INDUSTRY								
	DOLLARS			CUBIC YARDS			2020 $$/CY		
	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	WEIGHTED AVG.
First Ten Years	$37	$53	$90	118	110	228	$2.36	$3.68	$3.00
Last Ten Years	$1,028	$339	$1,367	166	16	182	$6.20	$20.55	$7.49
				140%	667%	125%	262%	558%	250%

	USACE & INDUSTRY								
	DOLLARS			CUBIC YARDS			2020 $$/CY		
	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	WEIGHTED AVG.
First Ten Years	$74	$60	$134	249	127	377	$2.26	$3.56	$2.70
Last Ten Years	$1,185	$339	$1,524	205	16	222	$5.77	$20.55	$6.87
				121%	773%	170%	256%	578%	255%