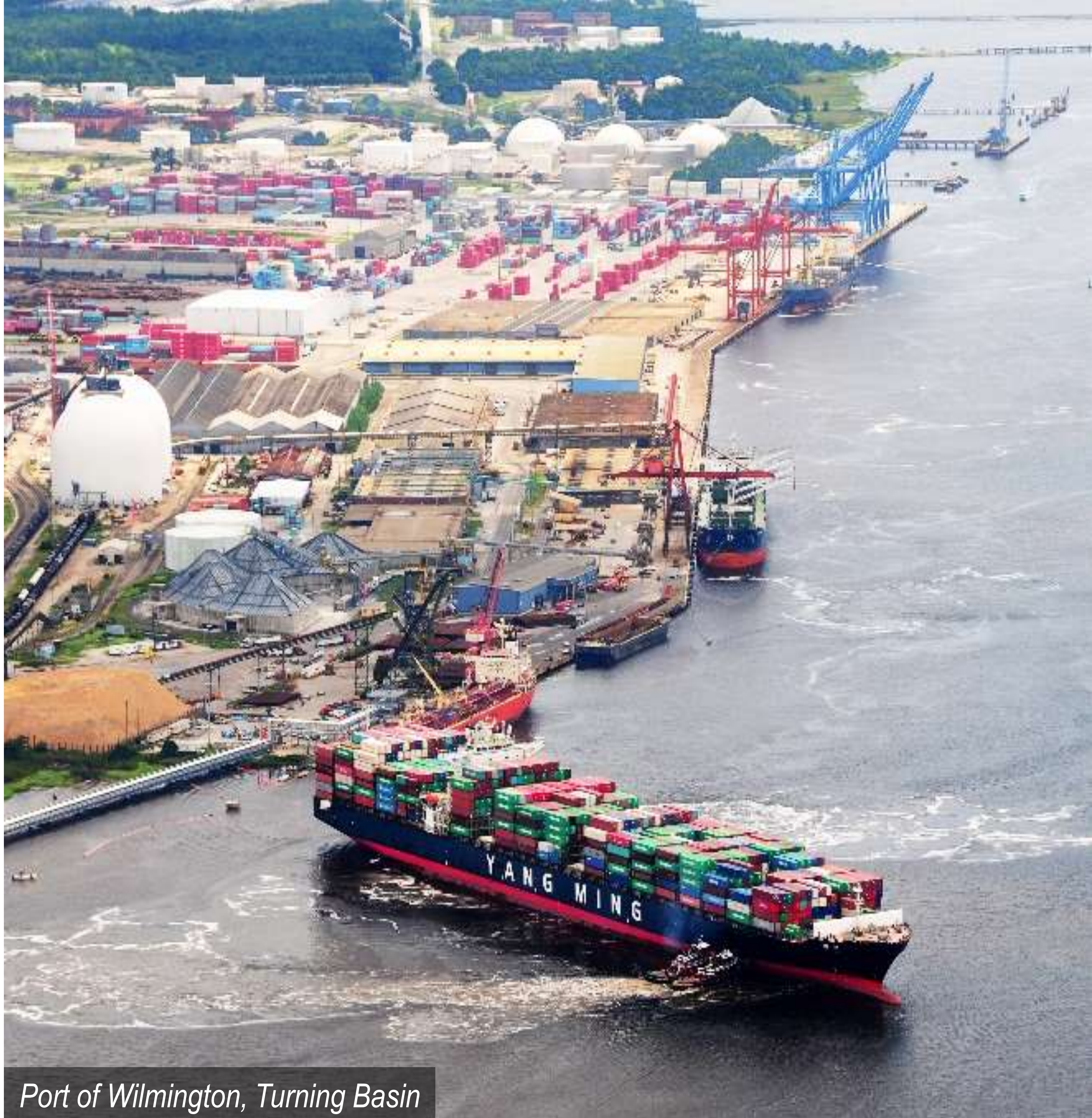
Water Injection Dredging (WID) in the US, Challenges & Solutions

Joe Wagner, PE, D.NE, BCEE | Joe.Wagner@HDRInc.com

Robert Lewis, EIT | Robert.Lewis@HDRInc.com

Dredging Summit & Expo 2022

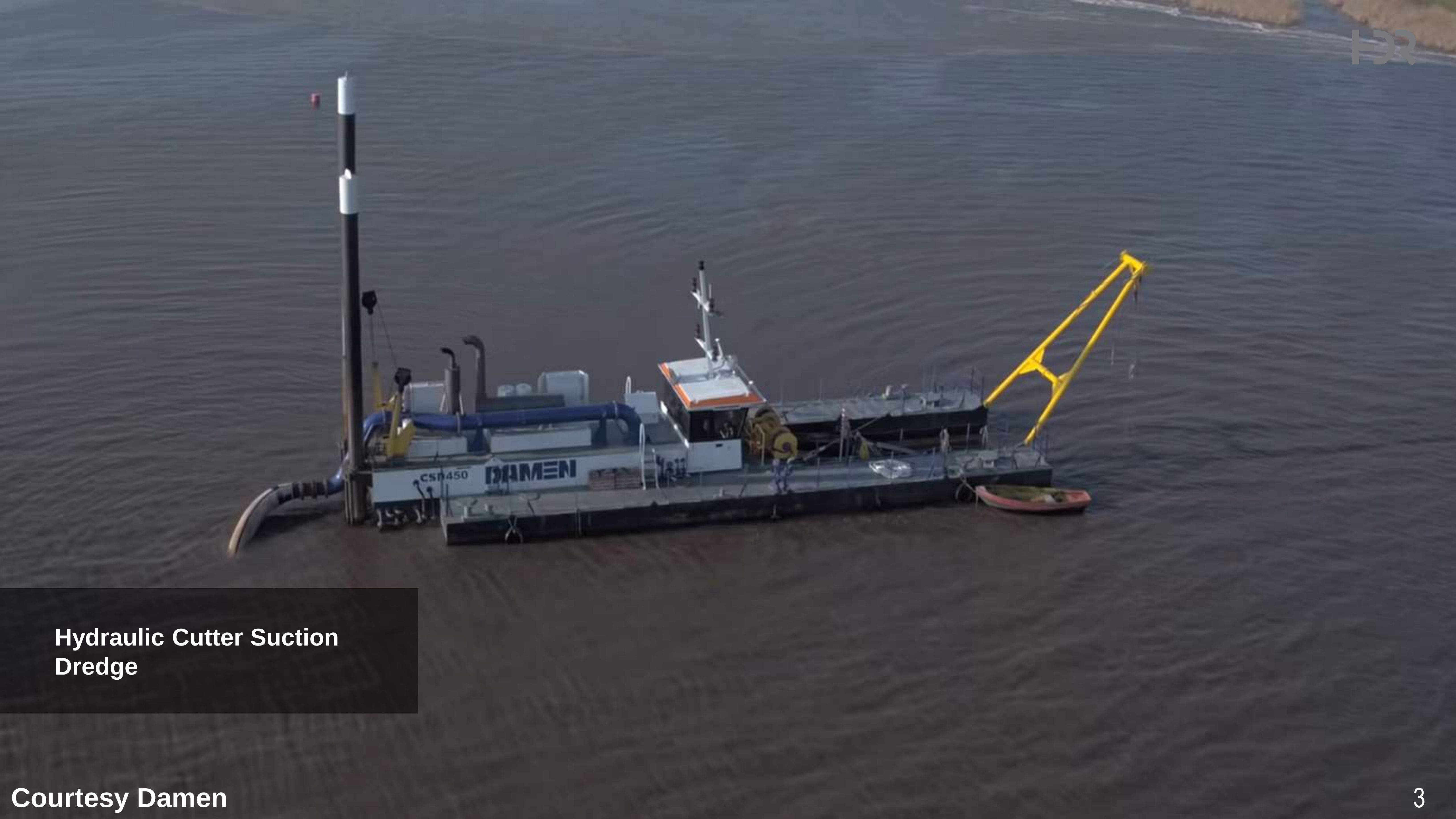


Port of Wilmington, Turning Basin

Outline

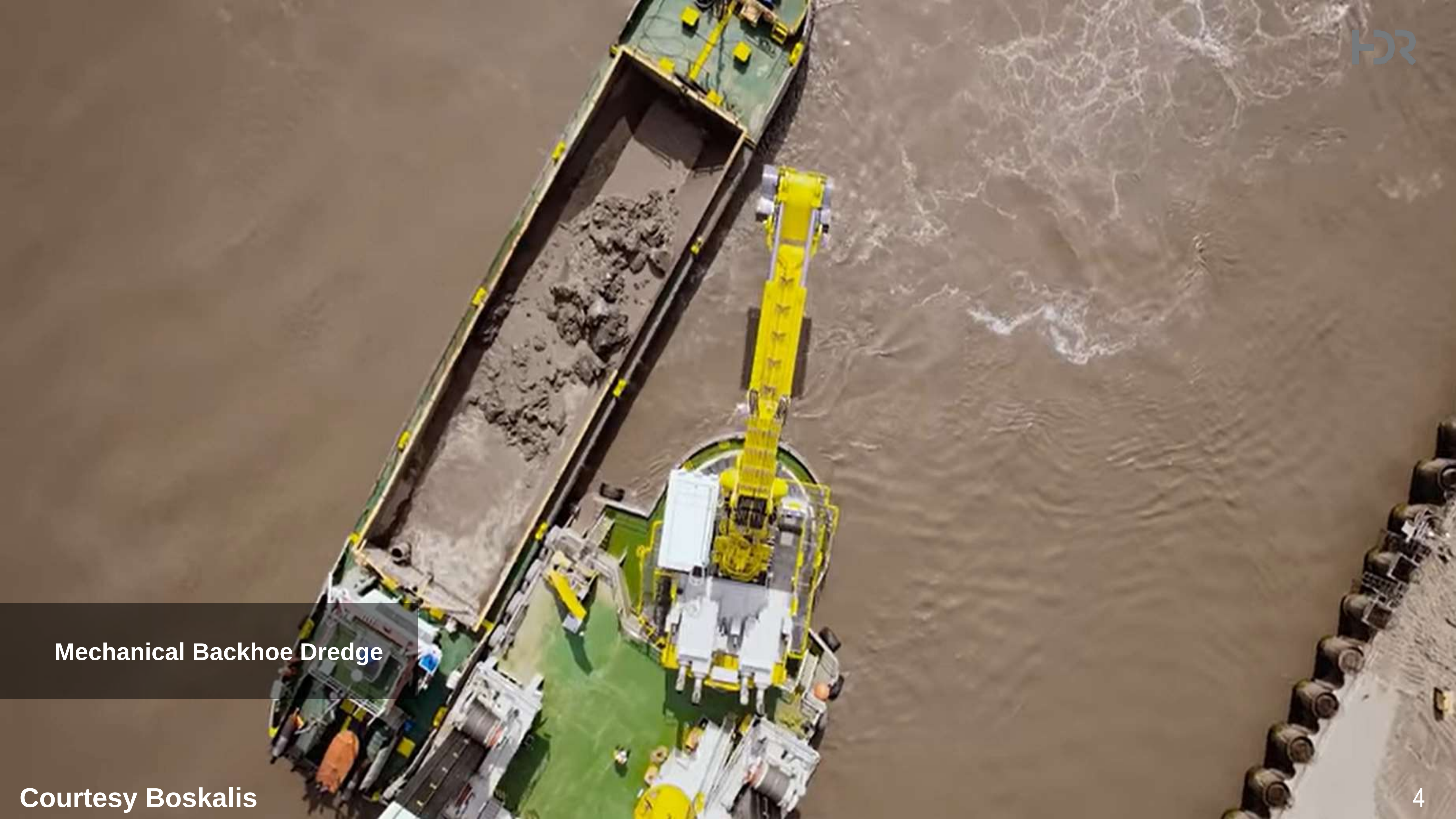
- **Traditional Dredging Methods**
- **Hydrodynamic Dredging**
  - **Agitation & Plow**
    - **Tiamat Harwich Haven Authority (HHA)**
  - **Water Injection Dredge (WID)**
    - **Environmental Considerations**
    - **Economic Benefits**
- **Case Study**
  - **North Carolina State Ports Authority (NCSPA)**
- **The Future**
  - **NCSPA Federal Turning Basin**
  - **USACE-NAO (Norfolk District & Virginia Port Authority (VPA)**
  - **Kansas Water Office (KWO)**

Port of Morehead City, Ocean Inlet



Hydraulic Cutter Suction Dredge

Courtesy Damen



Mechanical Backhoe Dredge

Courtesy Boskalis

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

Water Injection Dredge, Damen, Netherlands

Dredging Methods - Hydrodynamic Dredges

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


ML RORO
M

Osprey WID, IHC-America, NCSPA

Hydrodynamic Dredges – Water Injection Dredges

Osprey WID, IHC-America, NCSPA

Water Injection Dredging

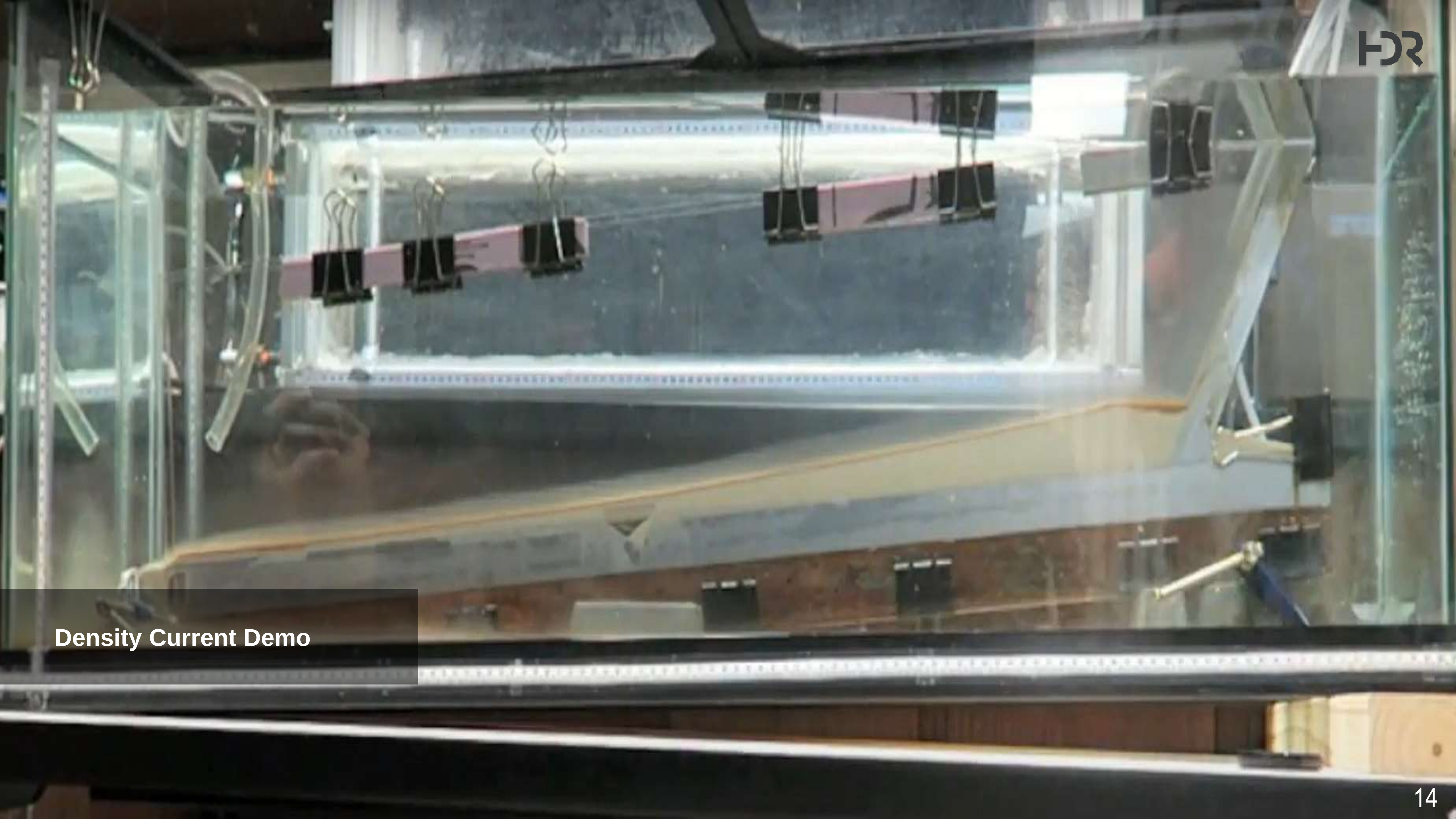
WID pumps water into channel bottom sediments at relatively ***high-volume & low pressure***

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



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 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

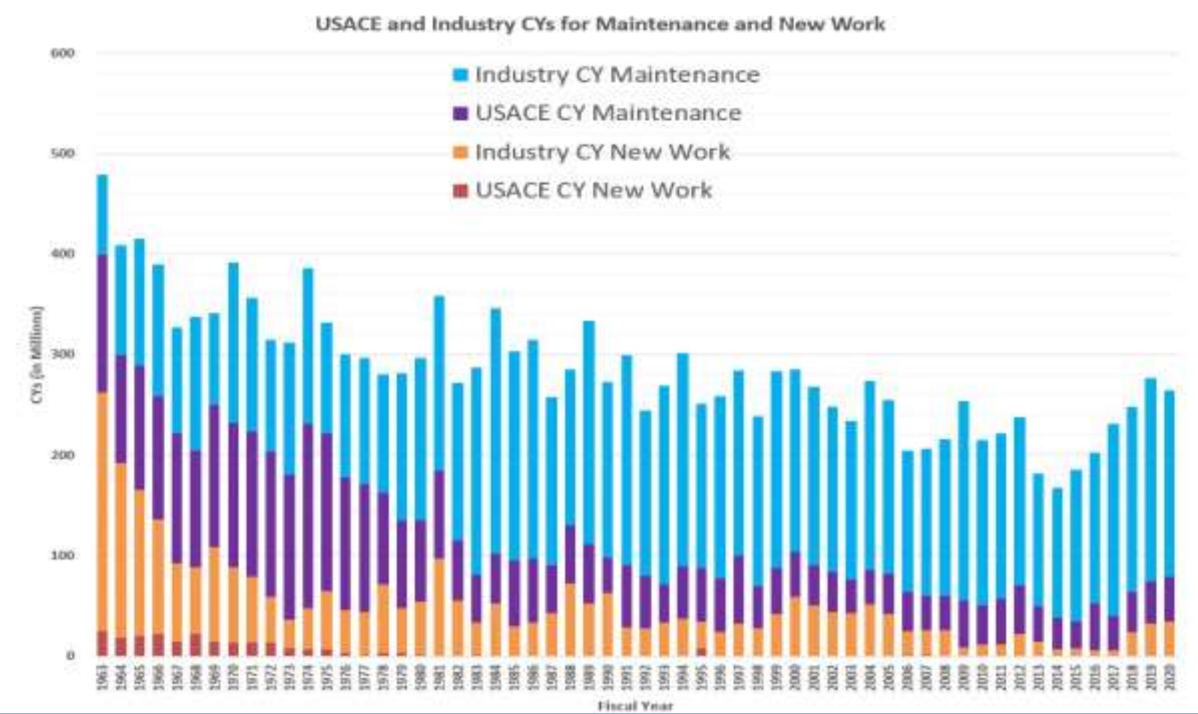
In comparison, for all ***hydrodynamic dredging*** (including WID) techniques the sediments ***flow through water***

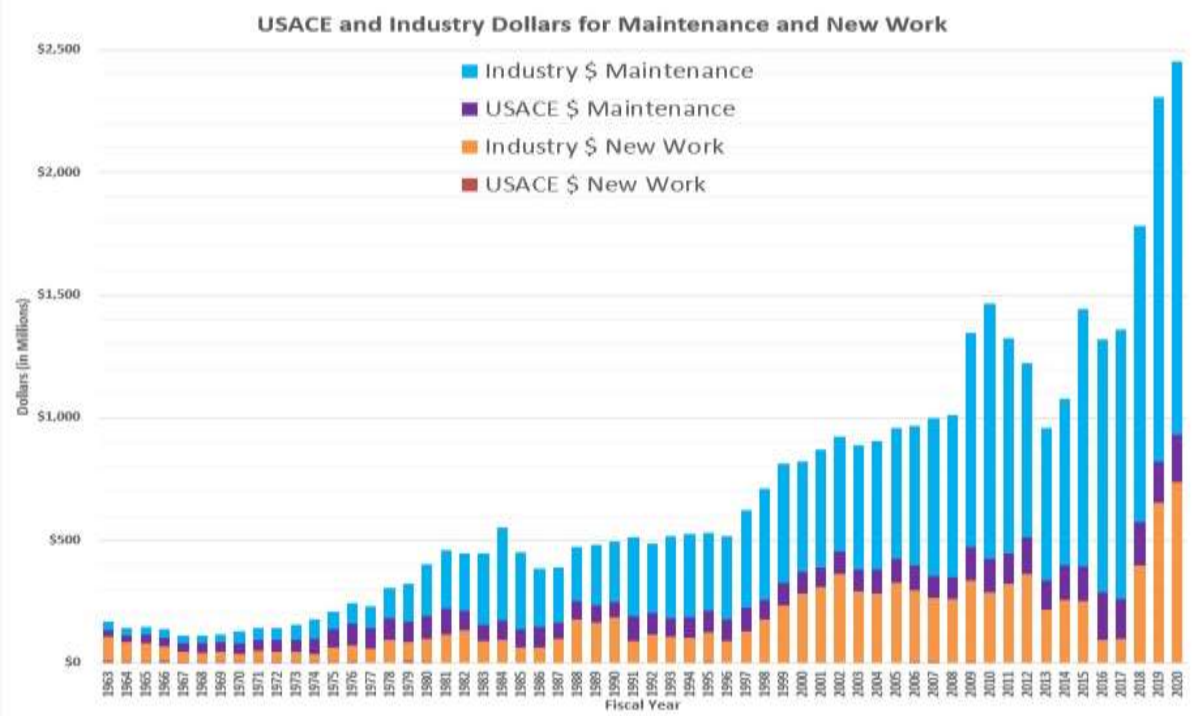
Traditional dredging costs:

- 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)

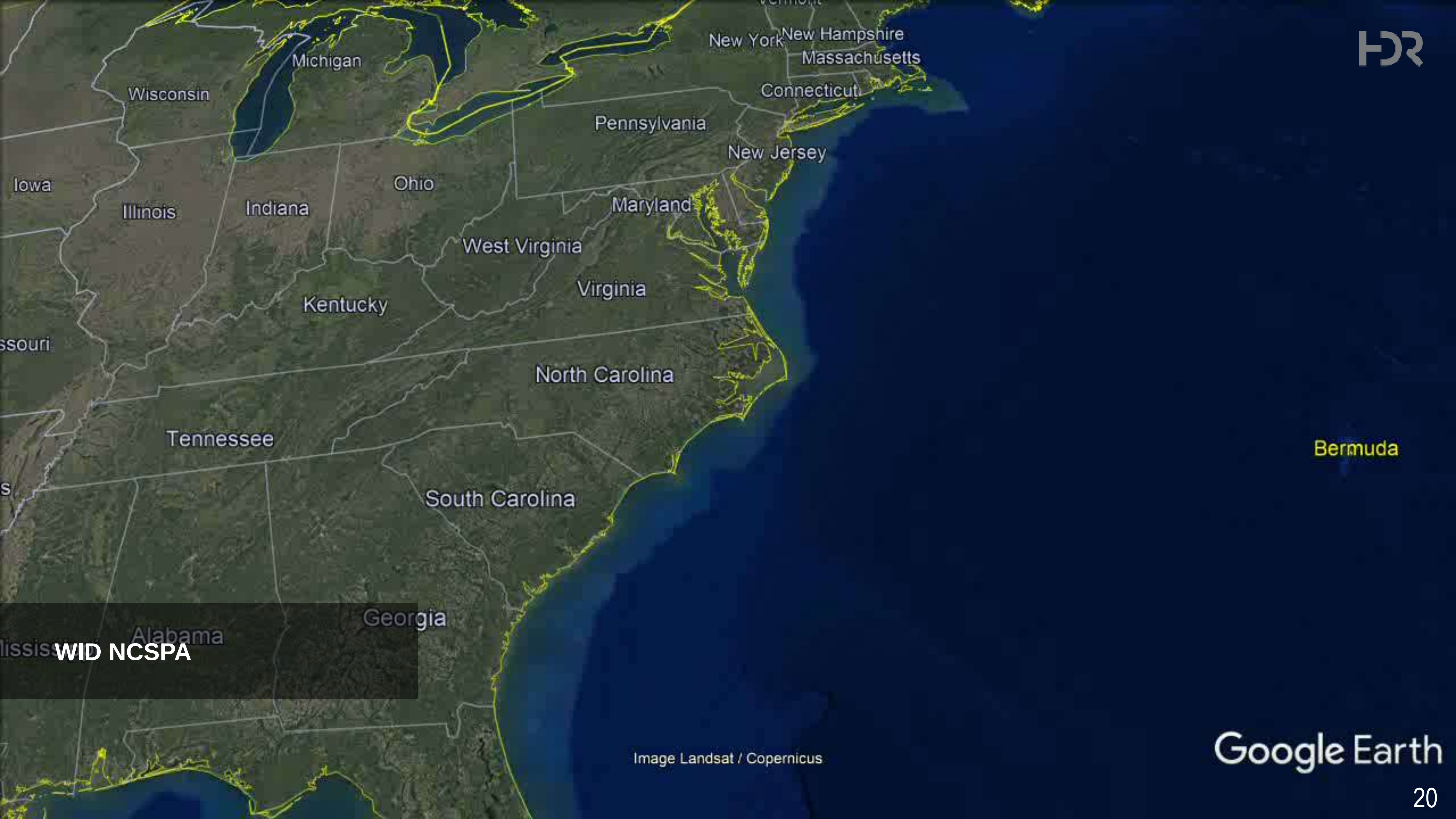
- Overall US dredging volumes decreased:
  - USACE CY has decreased by ~277%
  - Industry CY has decreased by ~25%
  - Overall, CY has decreased by ~70%
- Overall US dredging costs (adjusted for inflation) increased:
  - USACE $/CY has increased by ~78%
  - Industry $/CY has increased by ~150%
  - Overall $/CY has increased by ~155%
- Overall US dredging volumes by type have decreased:
  - New Work CY has decreased by ~673%
  - Maintenance CY has decreased by ~21%
- Overall US maintenance dredging responsibility has shifted to Industry:
  - USACE portion has decreased by ~17%
  - Industry portion has increased by ~43%

Water Injection Dredge (WID)

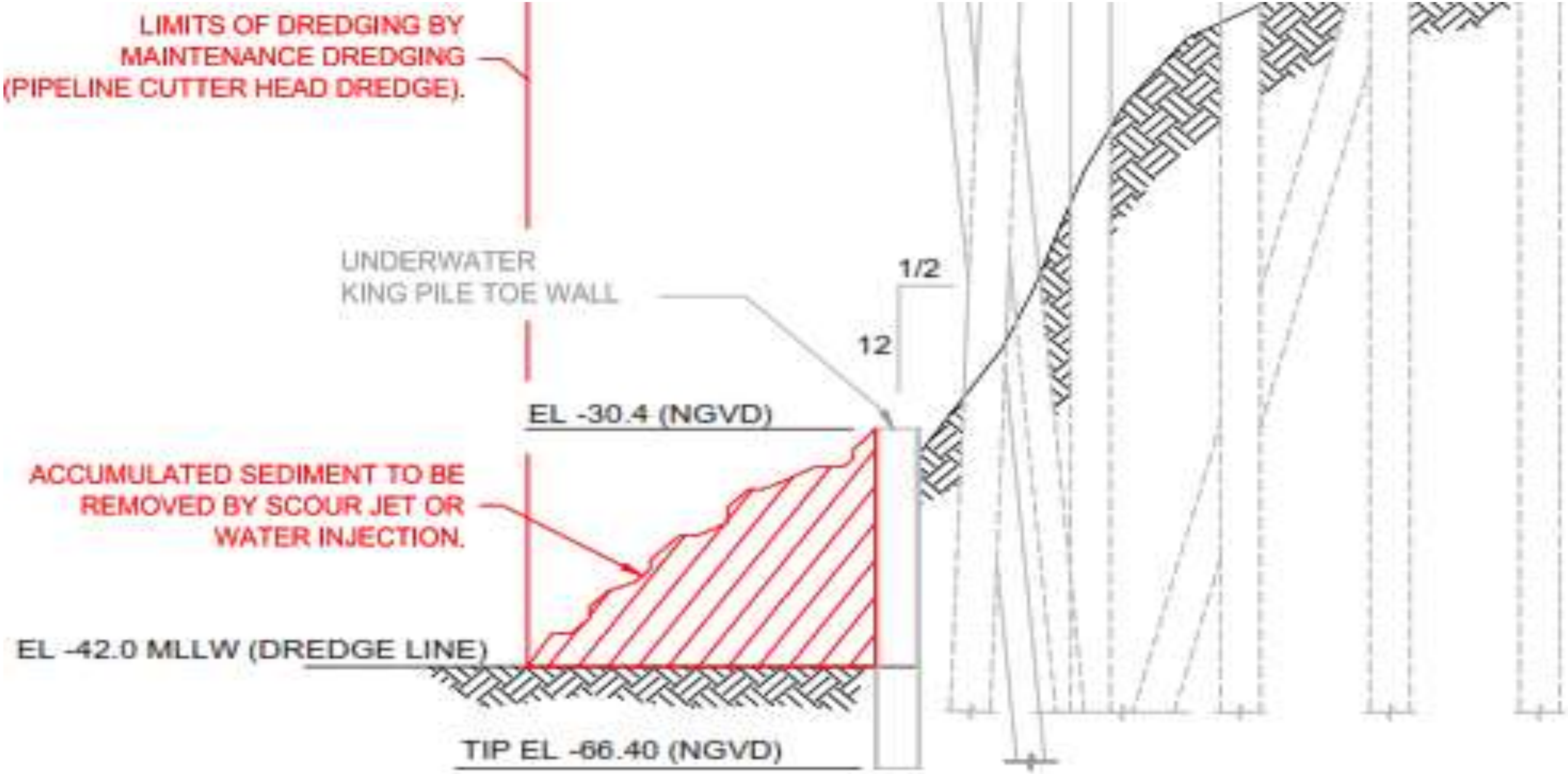
North Carolina State Ports Authority (NCSPA)

NORTH CAROLINA PORTS

WID NCSPA

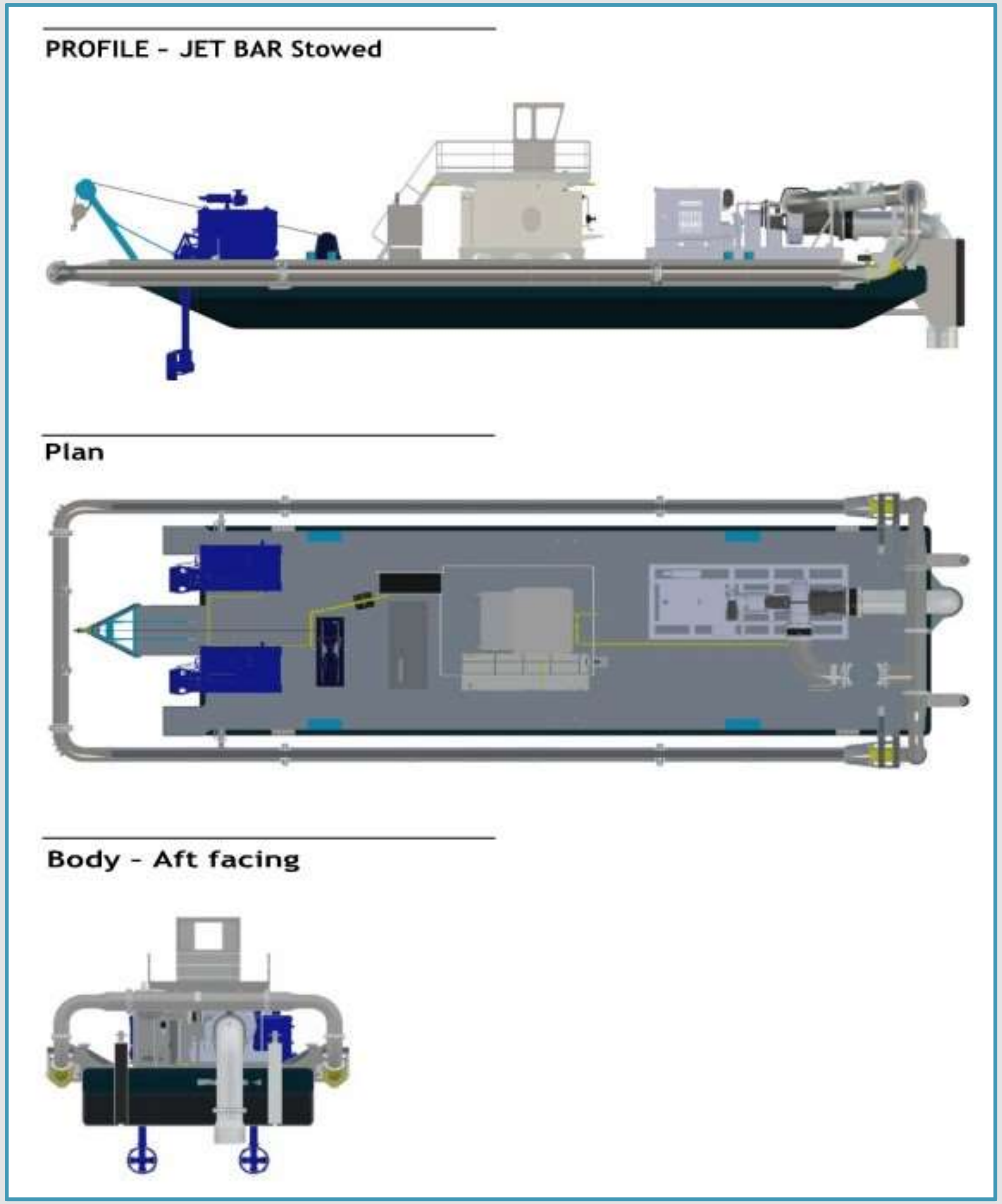

New York
New Hampshire
Massachusetts
Connecticut
Michigan
Wisconsin
Pennsylvania
New Jersey
Iowa
Illinois
Indiana
Ohio
Maryland
West Virginia
Virginia
Kentucky
ssouri
North Carolina
Tennessee
Bermuda
South Carolina
Georgia
Alabama
lississ
Image Landsat / Copernicus
Google Earth

Dredging Template



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



WID NCSPA

USACE-ERDC Monitoring Event

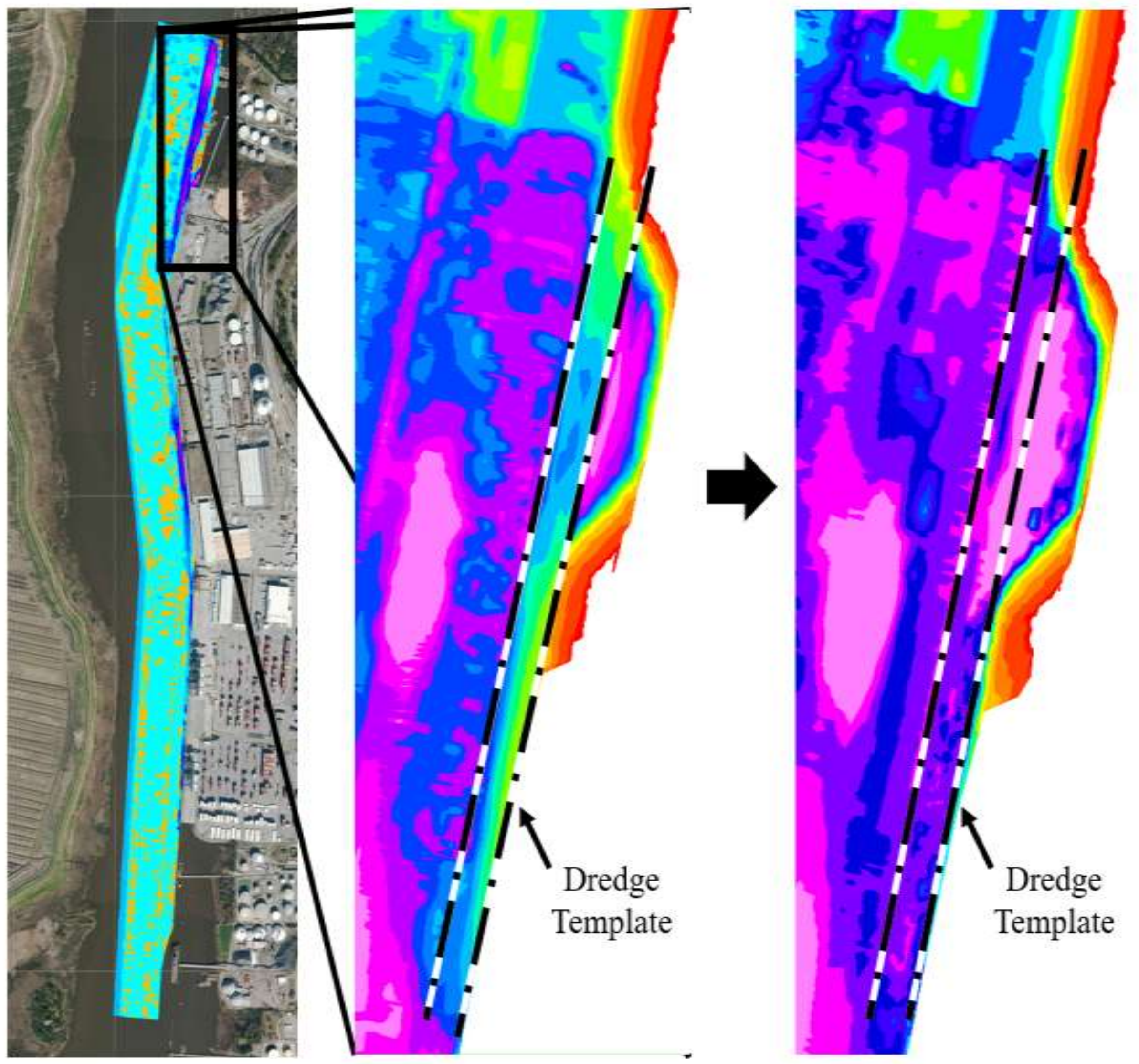
- Since June 2021
  - Dredged ~270,000 cubic yards (CY)
  - Approximately 90 hours
  - Production rate of around 3,000 CY/hr.
- NCSPA costs include:
  - Annual depreciation of the vessel
  - Annual insurance costs
  - Dredging operations costs
  - Fuel
  - Other O&M costs (repairs, parts, contract services, expendables, training not related to a dredging event, etc.)
  - Pre- & post-dredging surveying
- Estimated $1M/YR 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

Pre-Dredging & Post-Dredging Survey Results



Vicinity of Surveyed Area Before Dredging Survey After Dredging Survey

BATHYMETRY ELEVATION TABLE		
MIN. ELEVATION (ft)	MAX. ELEVATION (ft)	COLOR
-50.0	-46.0	
-46.0	-45.0	
-45.0	-44.0	
-44.0	-43.0	
-43.0	-42.0	
-42.0	-41.0	
-41.0	-40.0	
-40.0	-39.0	
-39.0	-37.0	
-37.0	-35.0	
-35.0	-33.0	
-33.0	-29.0	
-29.0	-22.0	
-22.0	-15.0	
-15.0	-5.0	
-5.0	-3.0	

WID Channel Dredging above the Chesapeake Bay Bridge-Tunnel

Virginia Port Authority (VPA)

THE PORT OF VIRGINIA

Chesapeake Bay’s Federal Waterways

USACE District:
Norfolk - NAO

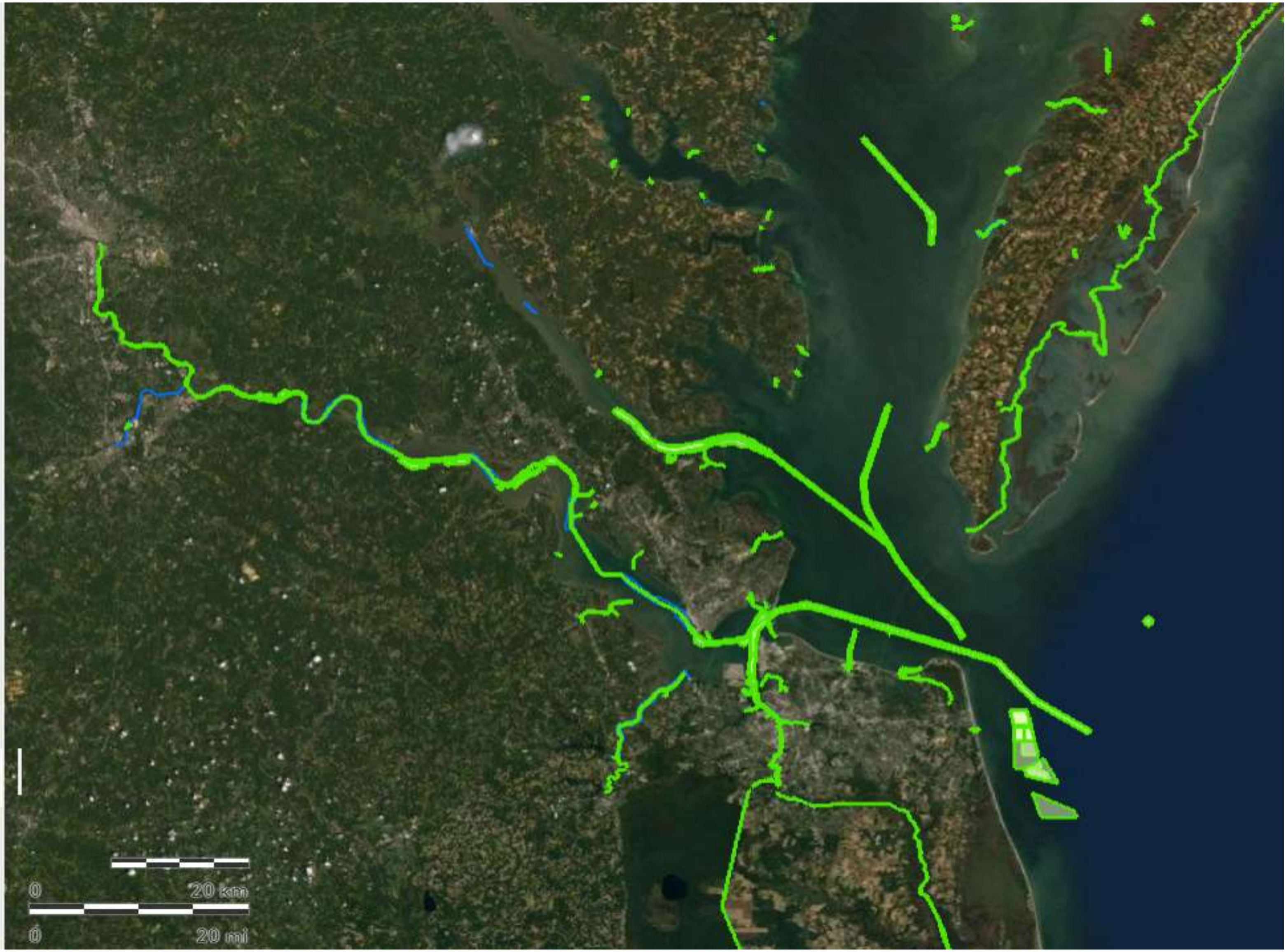
USACE Channel:
All

Channel ID:
All

Survey Date Range:

Predefined   Custom Date Range

- All Surveys



USACE Hydrographic Surveys – eHydro
[*www.navigation.usace.army.mil/Survey/Hydro*](www.navigation.usace.army.mil/Survey/Hydro)

Chesapeake Bay Bridge-Tunnel

USACE District:
Norfolk - NAO

USACE Channel:
All

Channel ID:
All

Survey Date Range:

Predefined | Custom Date Range

From

5/8/2022 | h:mm A

Until

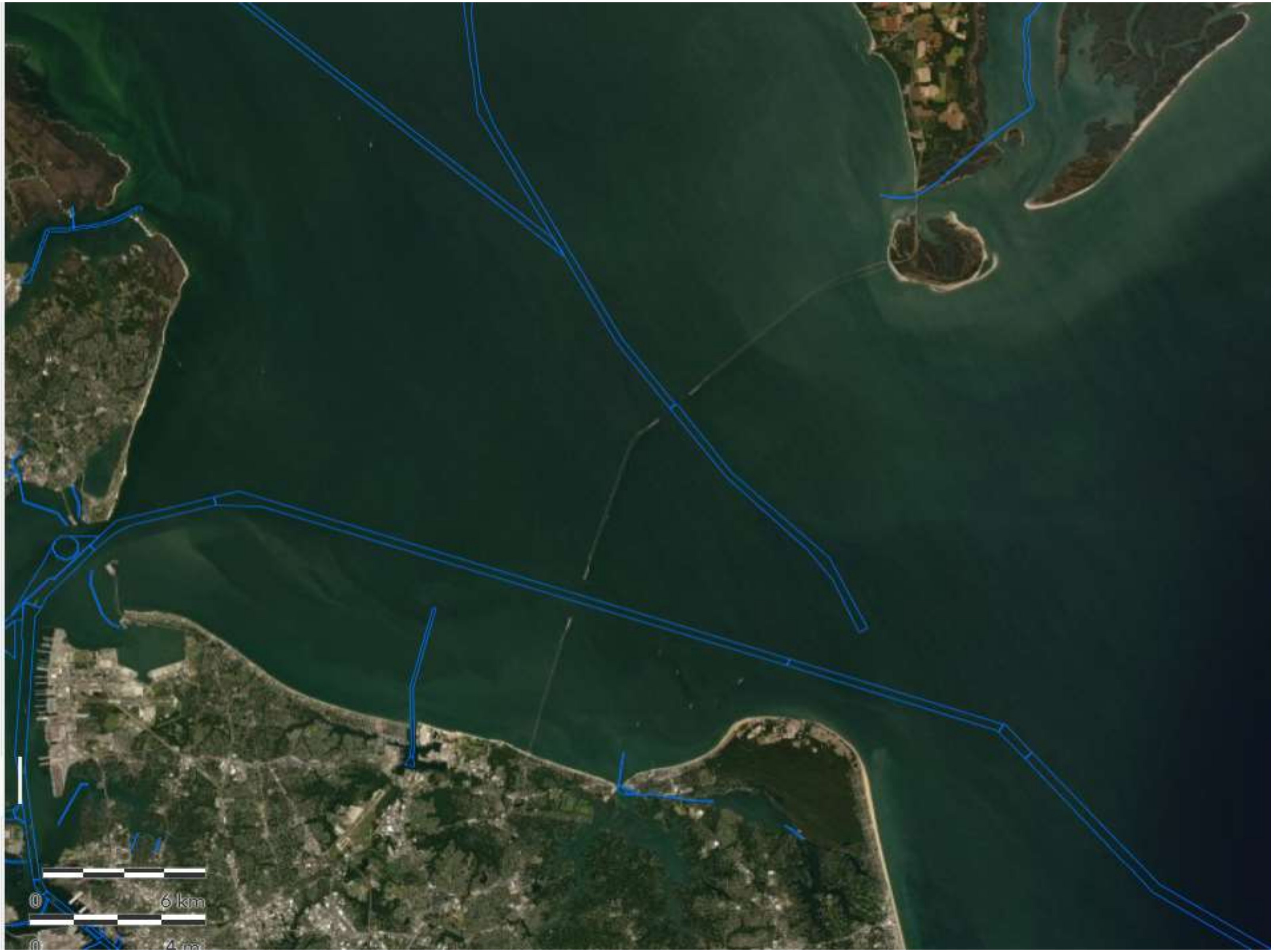
5/9/2022 | h:mm A

« ‹ May 2022 › »

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7

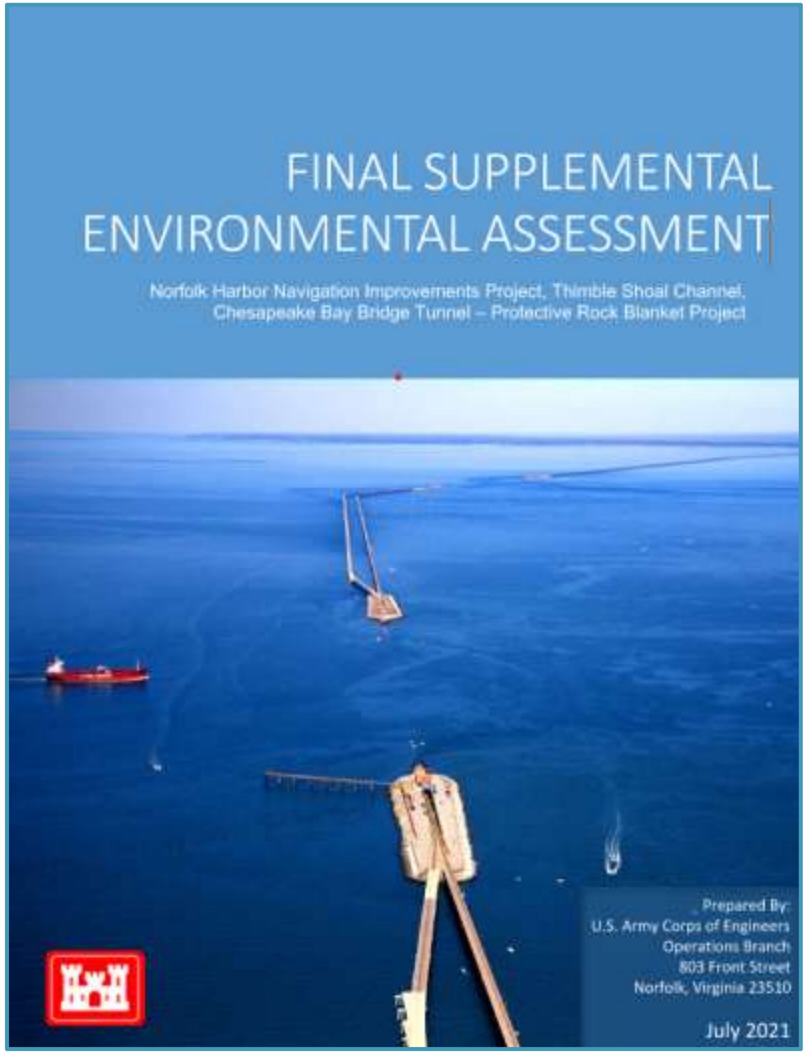
Use the dropdown menus or simply pan and zoom on the map to filter the Hydrographic Survey data.

Use any combination to drill down to



VPA FINAL SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT (SEA)

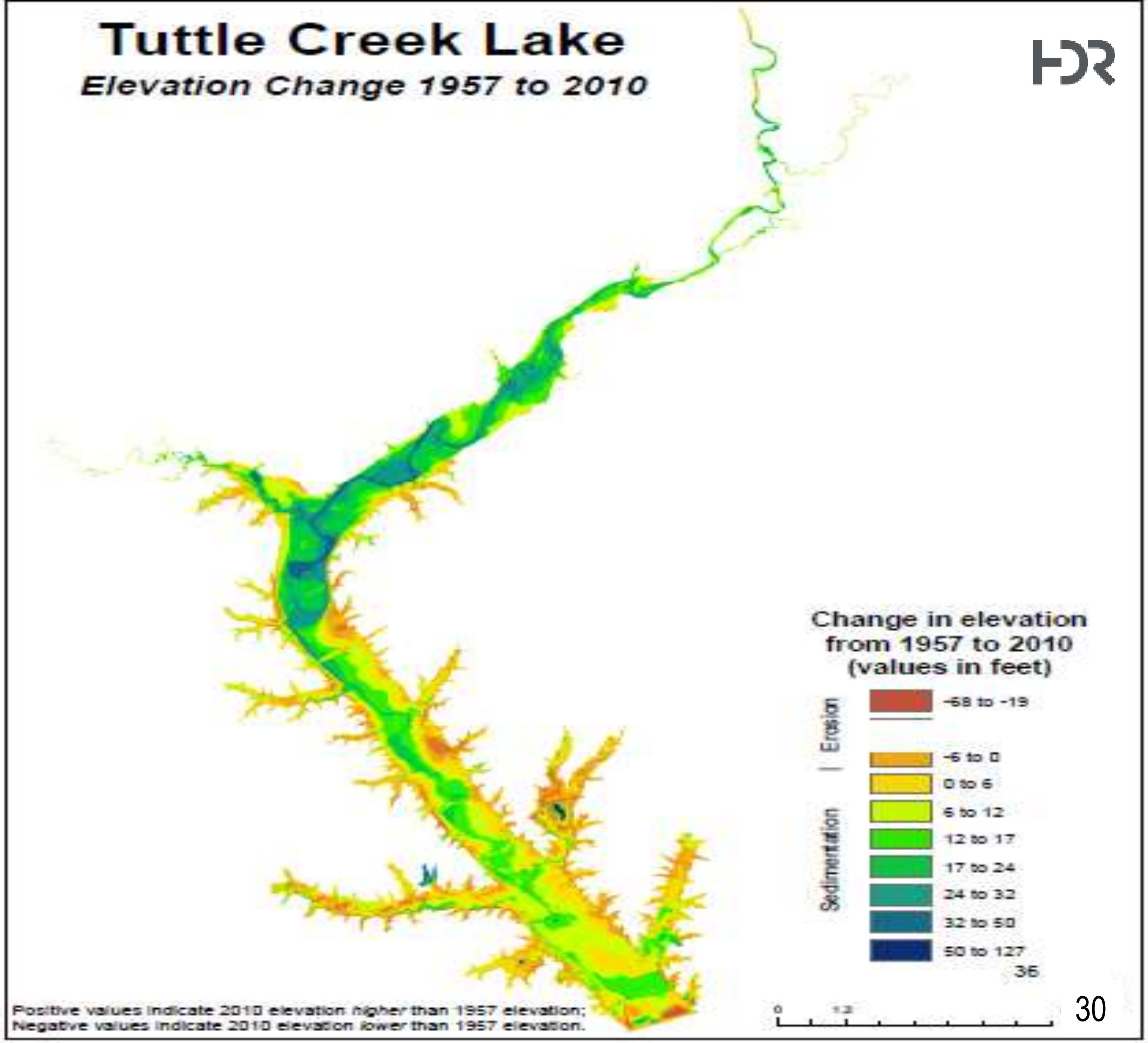
- Norfolk Harbor Navigation Improvements Project, Chesapeake Bay Bridge-Tunnel (CBBT)
- Preconstruction engineering & design efforts raised concerns about risks to the tunnel structure
- WID ⬄ chosen alternative dredging method
- US Army Corps of Engineers Norfolk District (USACE-NOA) was responsible for preparing the SEA
- Non-federal sponsor (VPA) providing input on the technical aspects of the proposed project



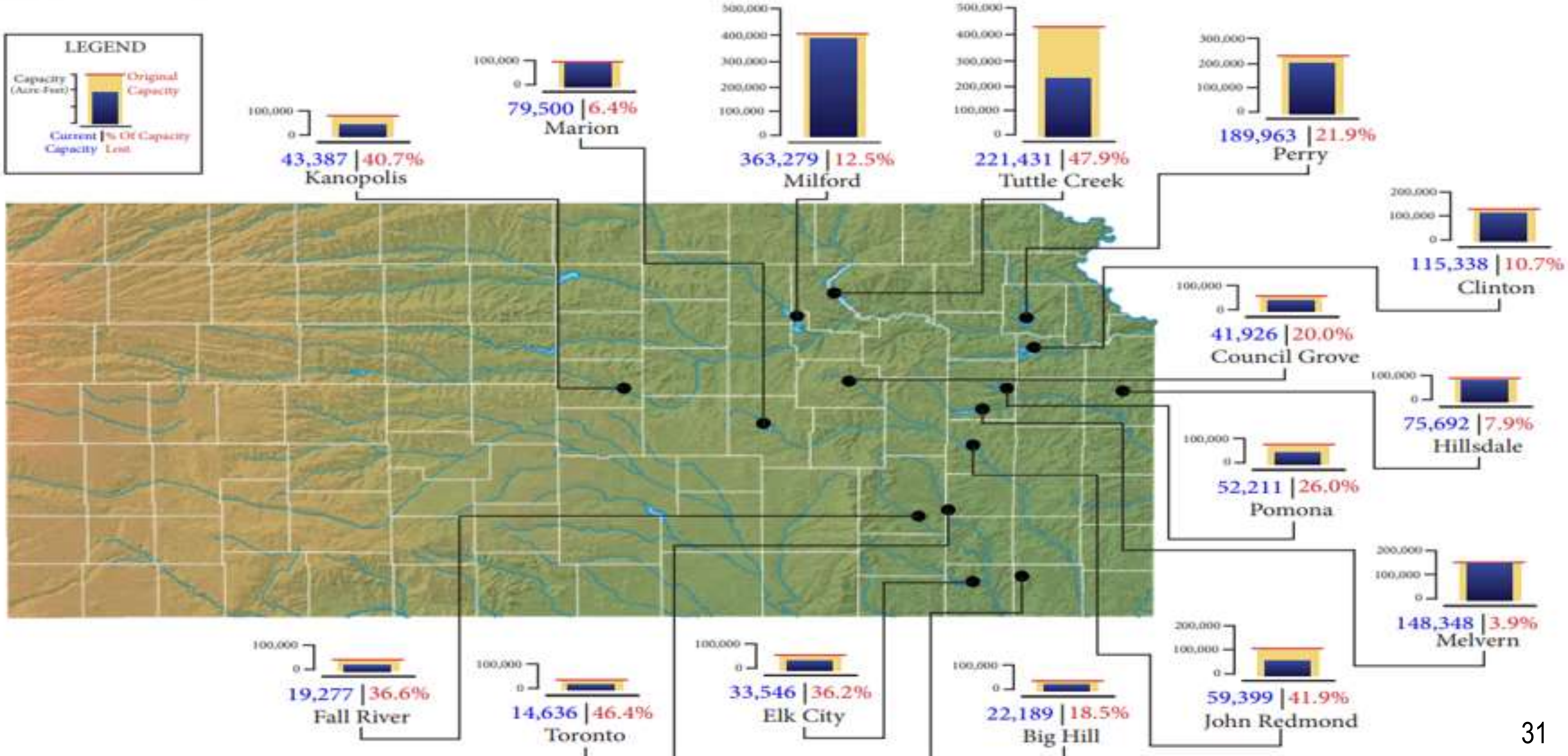
Water Injection Dredge (WID) in Reservoirs

Kansas Water Office (KWO)

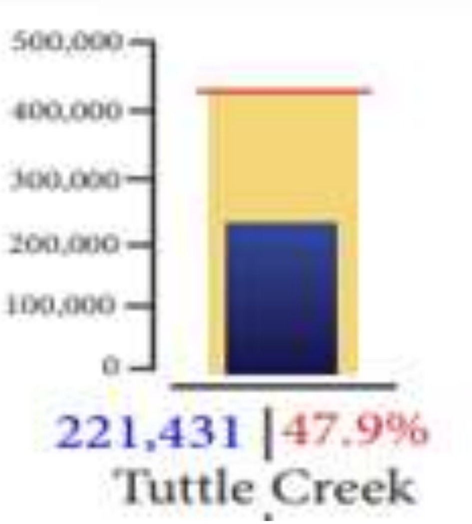
Tuttle Creek Lake

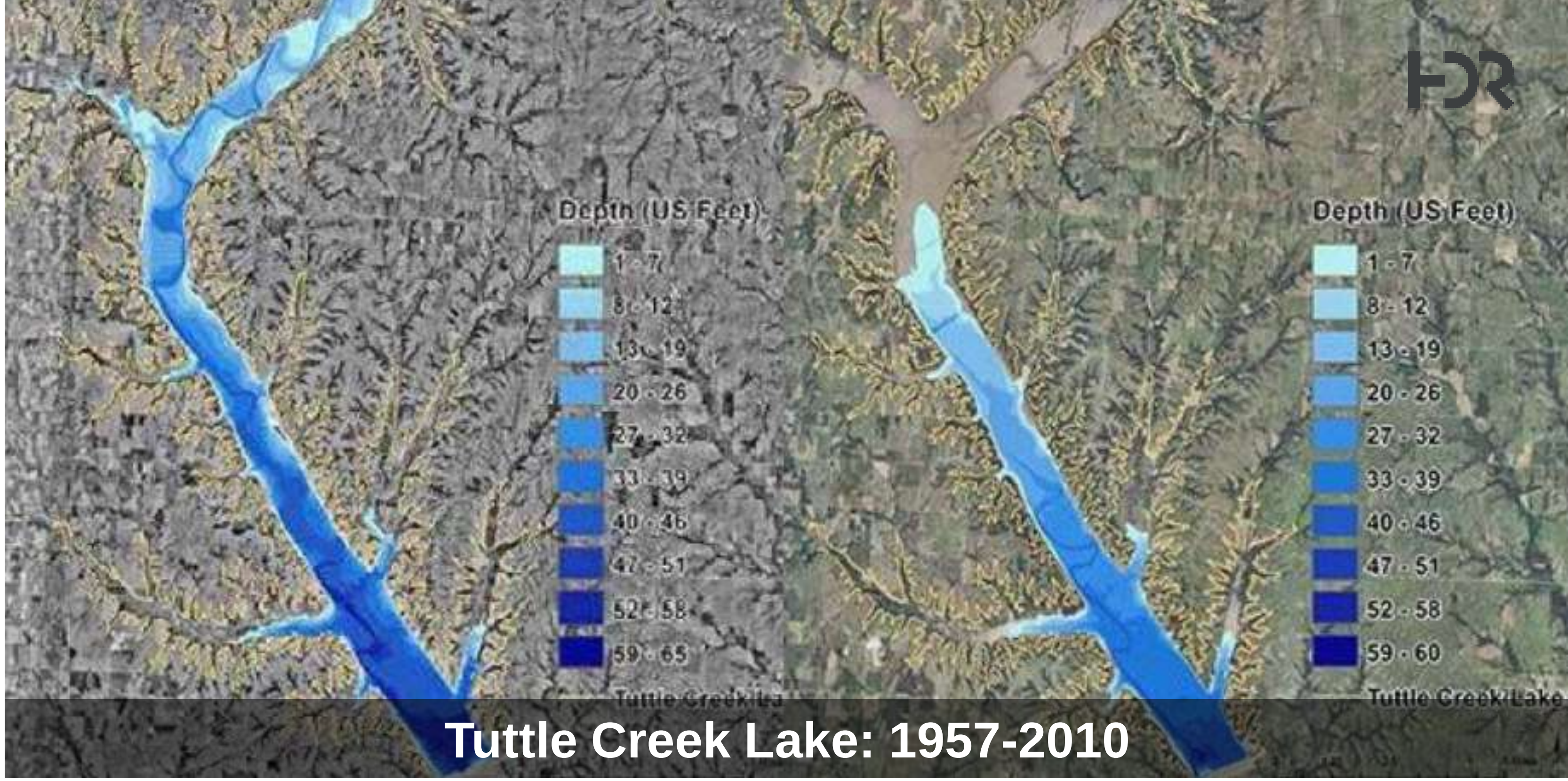


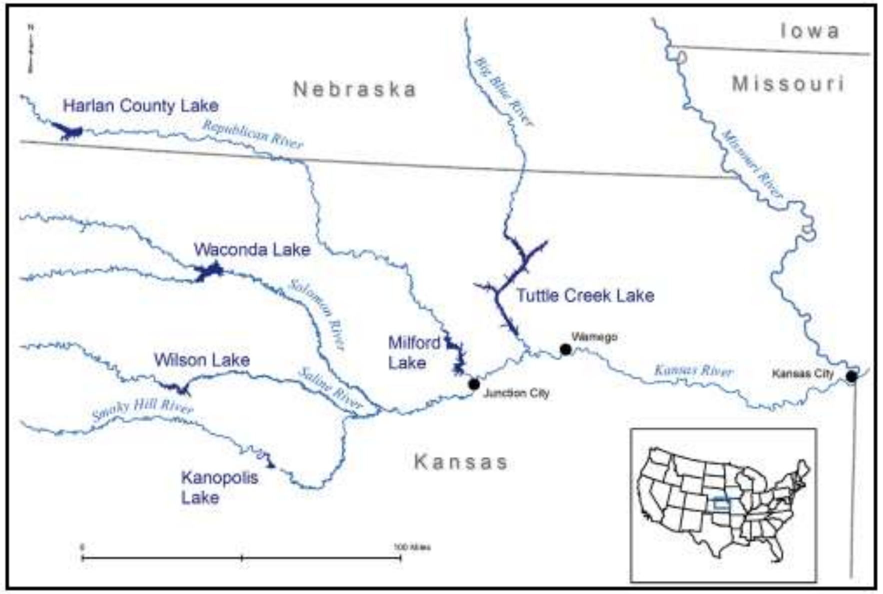
WID Kansas Water Office (KWO) Tuttle Creek Lake

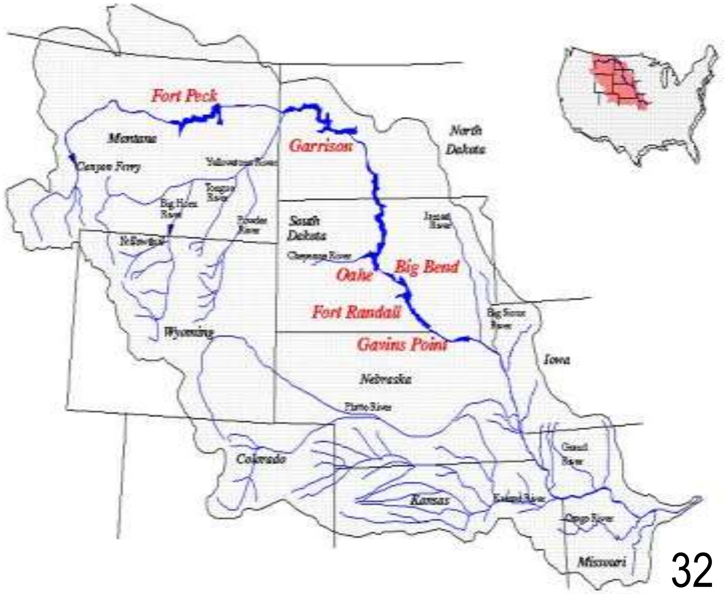


WID KWO – Tuttle Creek Lake (Cont.)

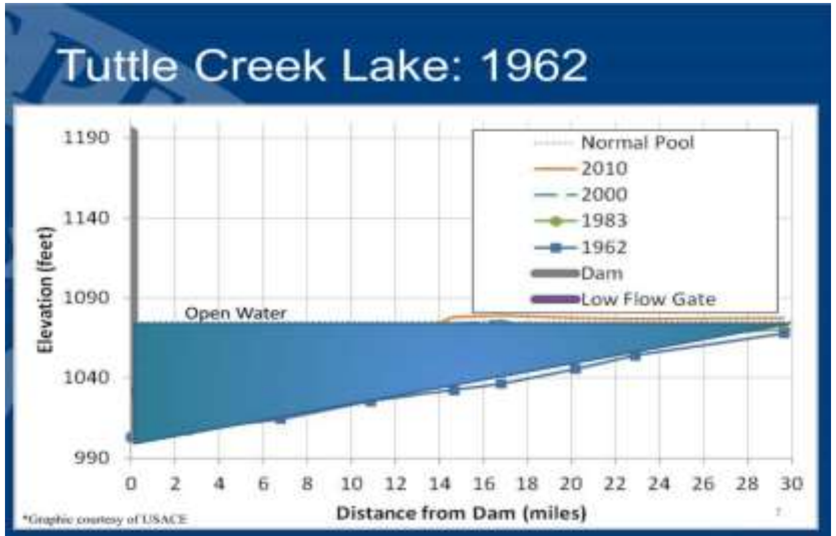


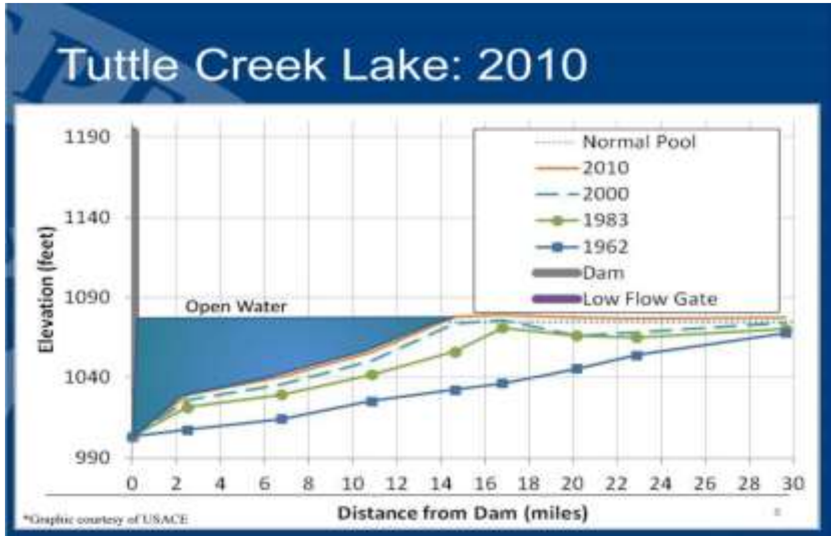






WID KWO – Tuttle Creek Lake (Cont.)





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

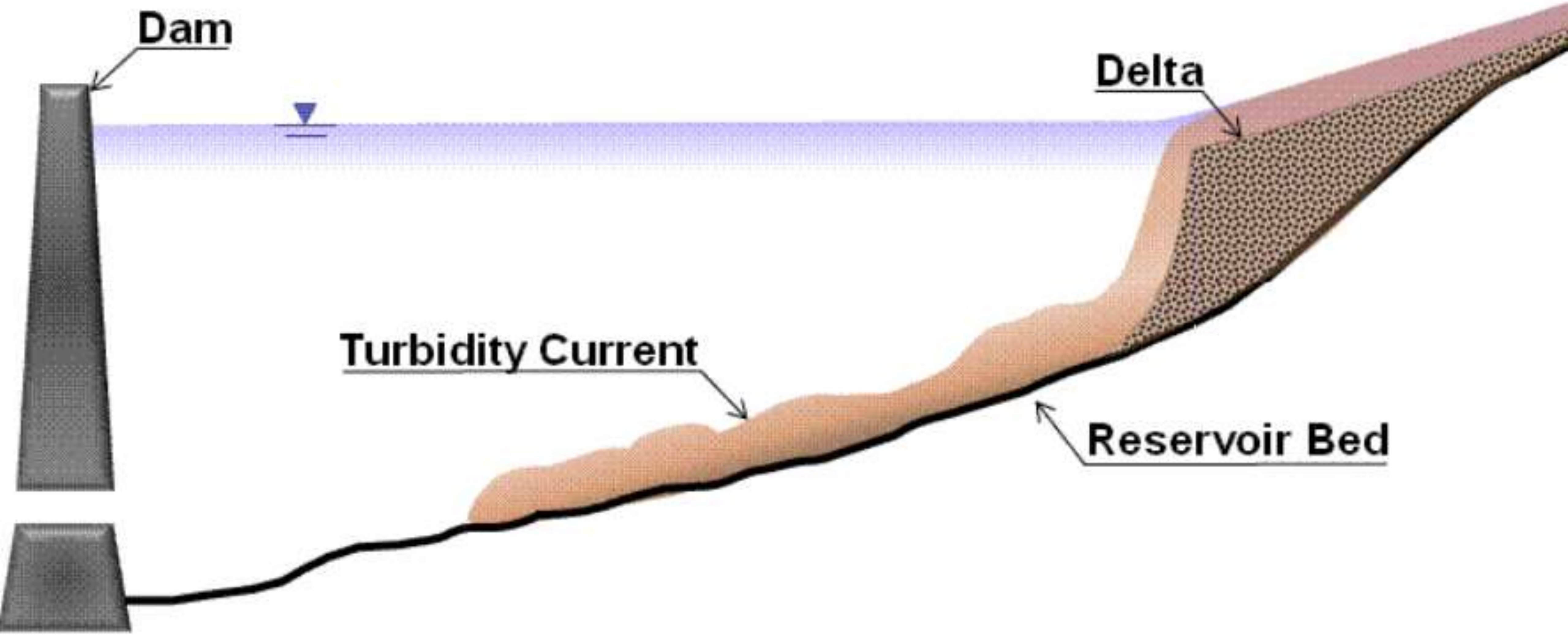
Water Injection Dredging

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:

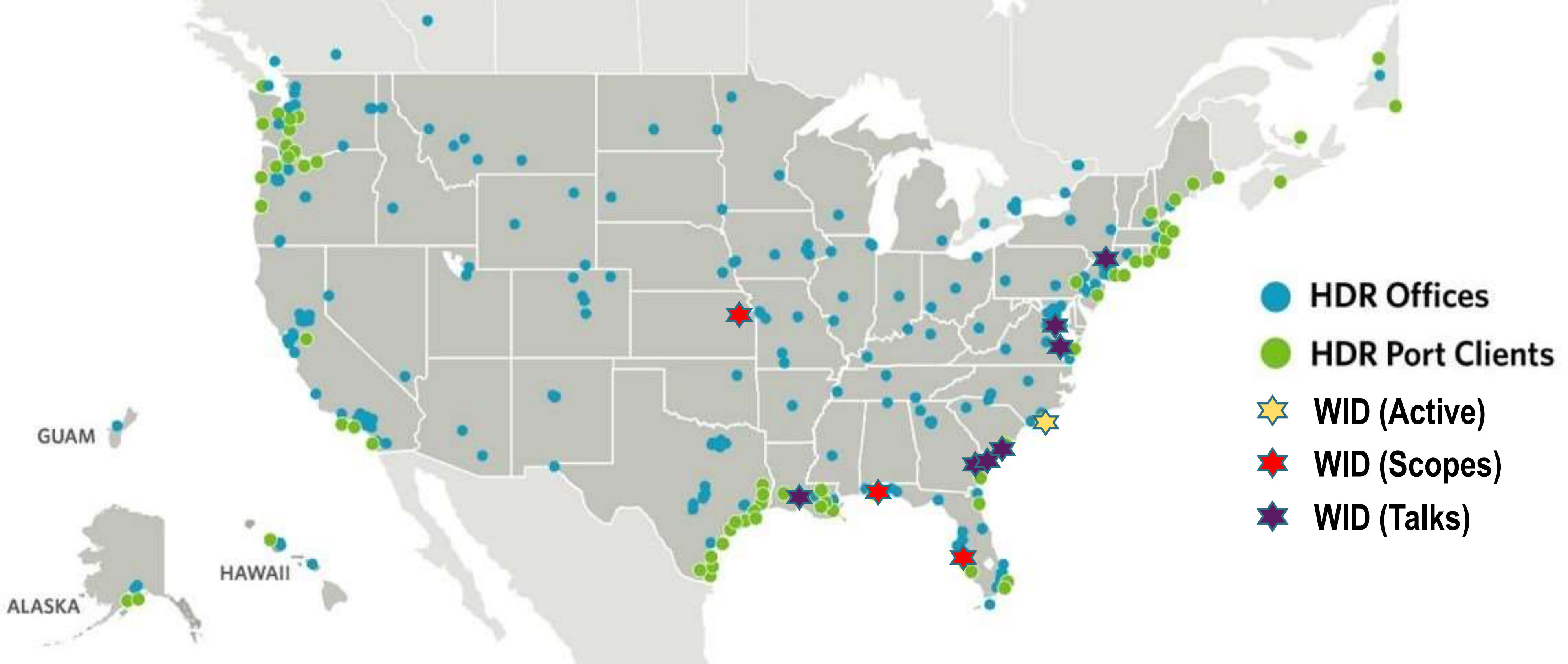
- Gravity due to elevation changes
- Current (suction) from the low elevation discharge conduit

WID KWO – Tuttle Creek Lake (Cont.)



Summary – Case Studies, Scopes, & Conversations

- North Carolina State Ports Authority
- Port Tampa Bay
- Kansas Water Office
- New York City DEP
- Virginial Port Authority
- Port of Morgan City
- Georgia Ports Authority
- Kinder Morgan LNG, Savannah
- South Carolina Ports Authority
- Maryland Port Administration
- Alabama State Port Authority
- USACE Mobile & Wilmington Districts



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

Joe Wagner, PE, D.NE, BCEE
Senior Dredging Engineer
Ports & Harbors

76 S. Laura Street, Suite 1600
Jacksonville, FL 32202
904.210.4078
joe.wagner@hdrinc.com

hdrinc.com

Water Injection Dredge (WID)

Alabama State Port Authority (ASPA)

ASPA Waterways

USACE District:
All

USACE Channel:
All

Channel ID:
All

Survey Date Range:

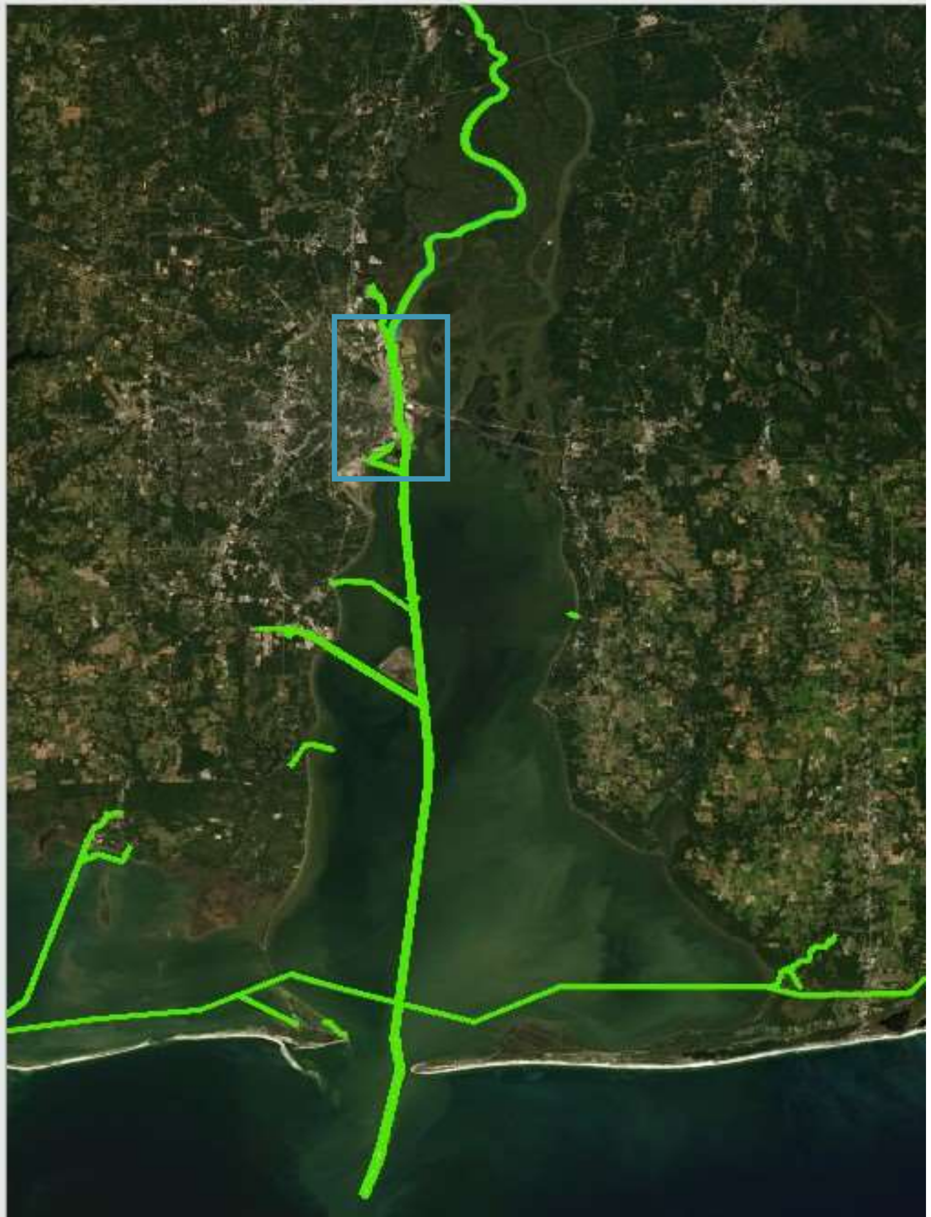
Predefined Custom Date Range

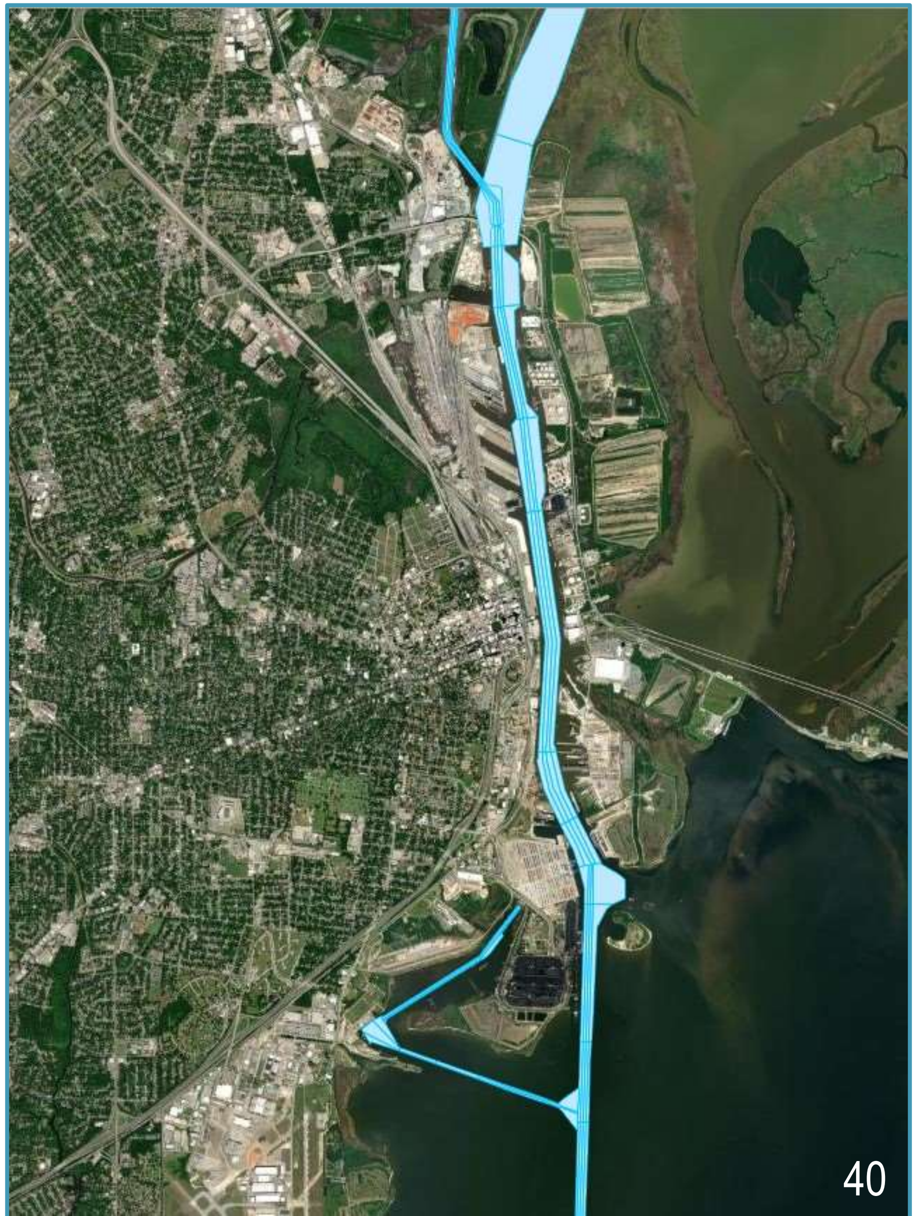
- All Surveys

Last 60 days

2019

2018





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

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

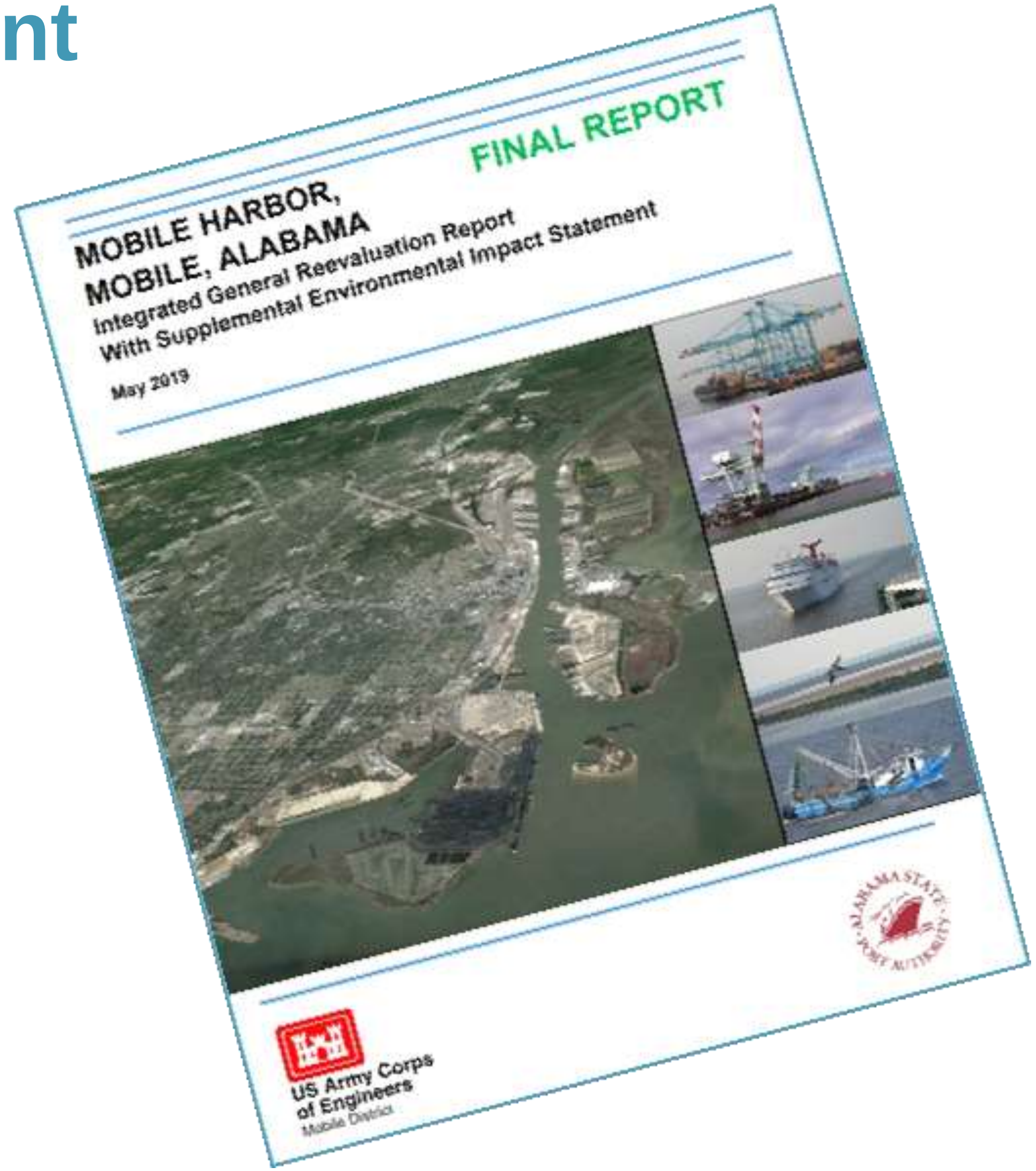
PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) reviews the development of a Regional Sediment Management (RSM) implementation strategy for Mobile Bay, AL.

BACKGROUND: Mobile Bay is the terminal repository of sediments transported downstream from several riverine systems.

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
  - Bend easing at the double bends of the bar channel
  - Widening of the bay channel from 400 feet to 500 feet from the mouth of Mobile Bay northward for three miles
  - 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

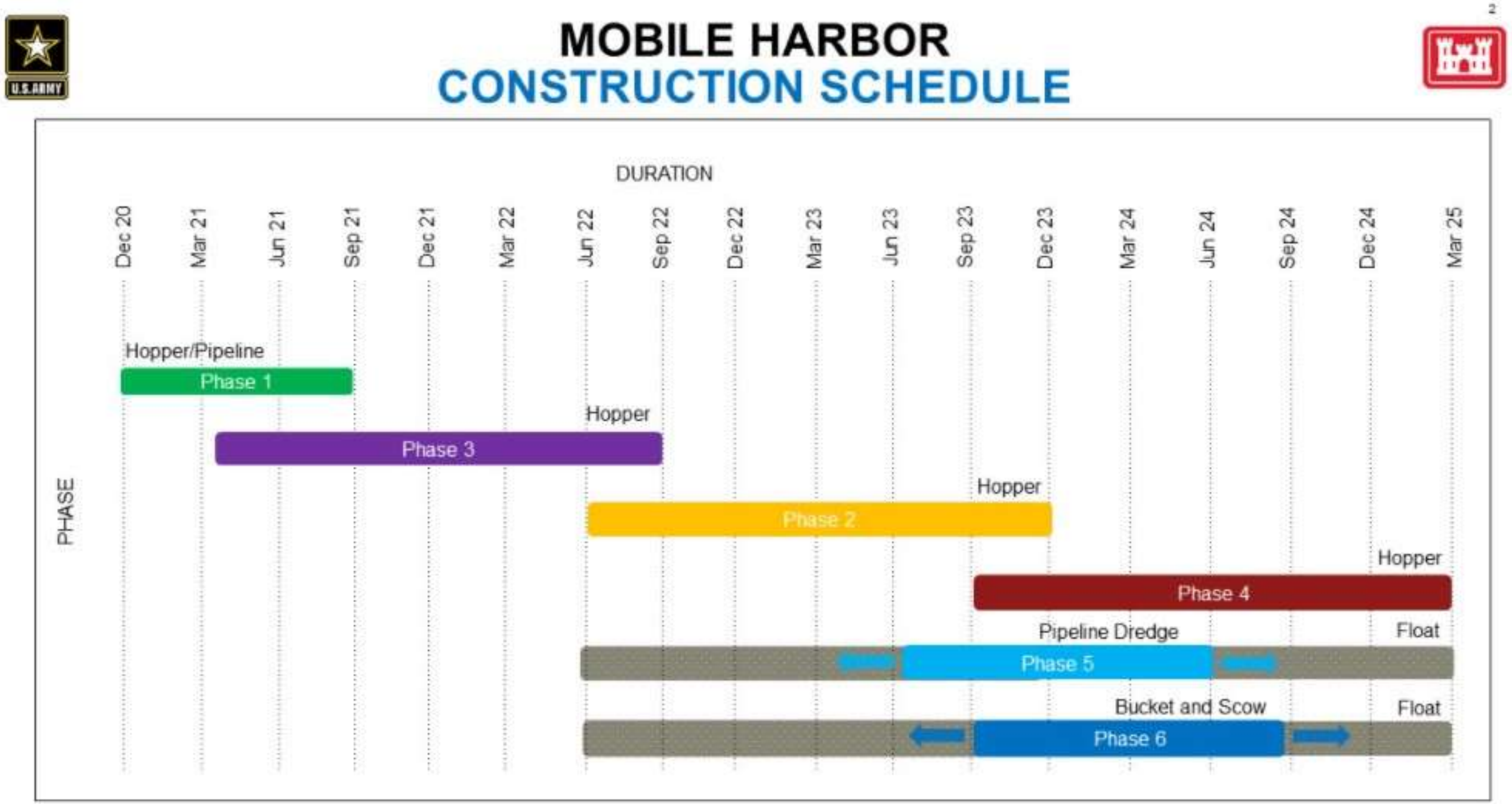
MOBILE HARBOR
APPROVED PLAN

- 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



Dredging Efficiencies Investigation

Port Tampa Bay (PTB)

PORT TAMPA BAY

Tampa Bay's Federal Waterways

USACE District:

All

USACE Channel:

All

Channel ID:

All

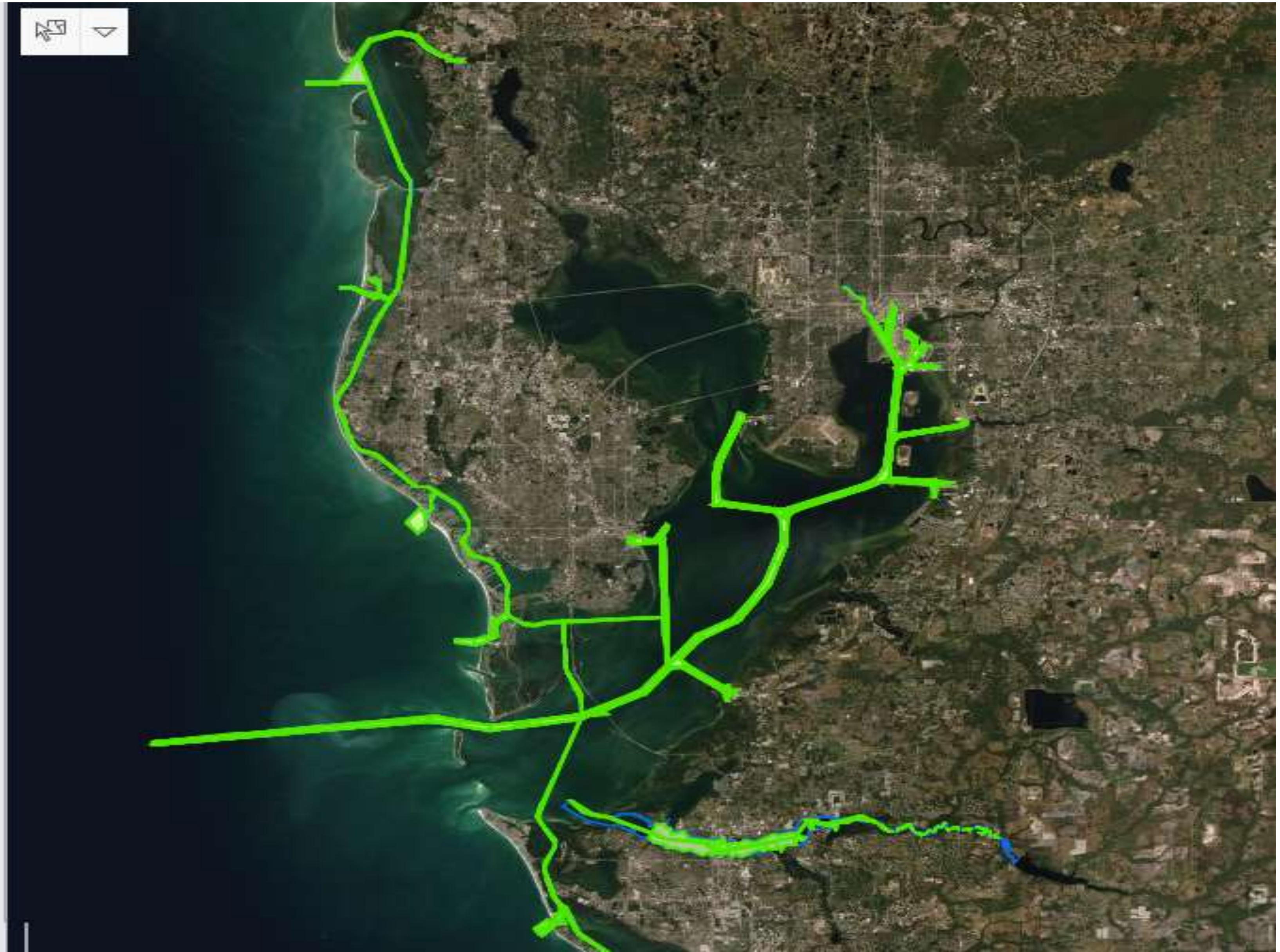
Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

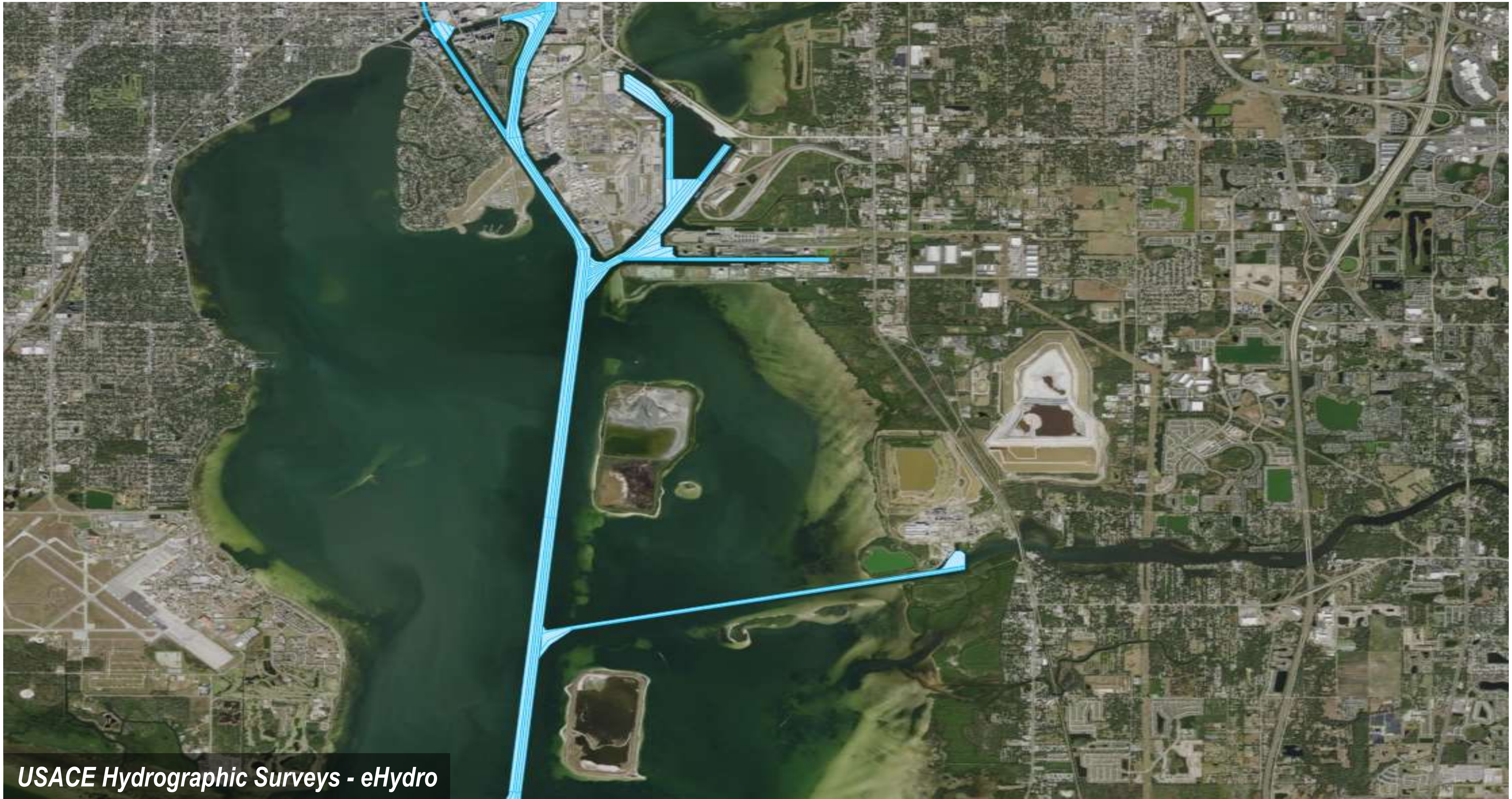
Custom Date Range

USACE Hydrographic Surveys – eHydro

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



Tampa Harbor



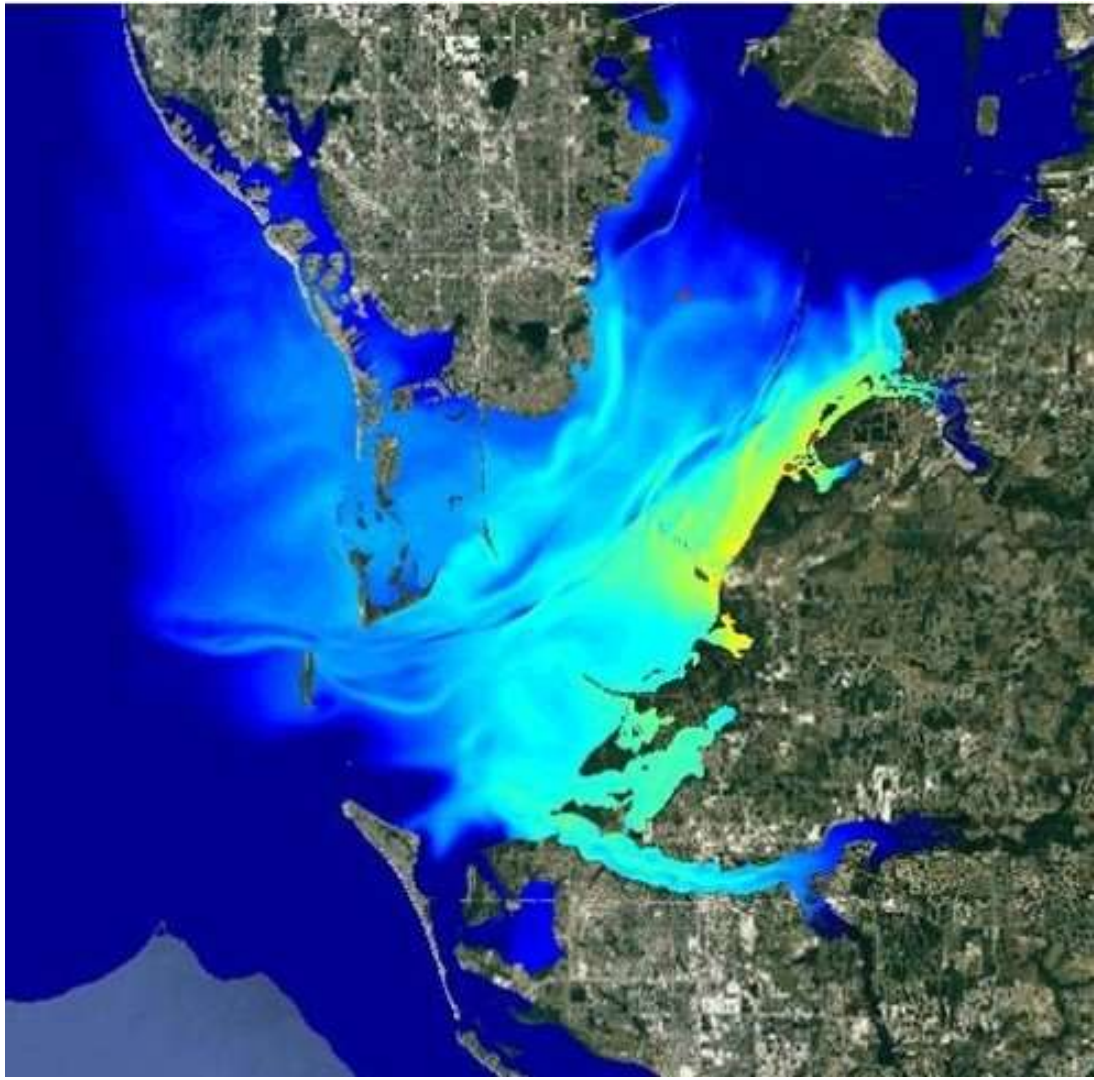
USACE Hydrographic Surveys - eHydro

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:
  - 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

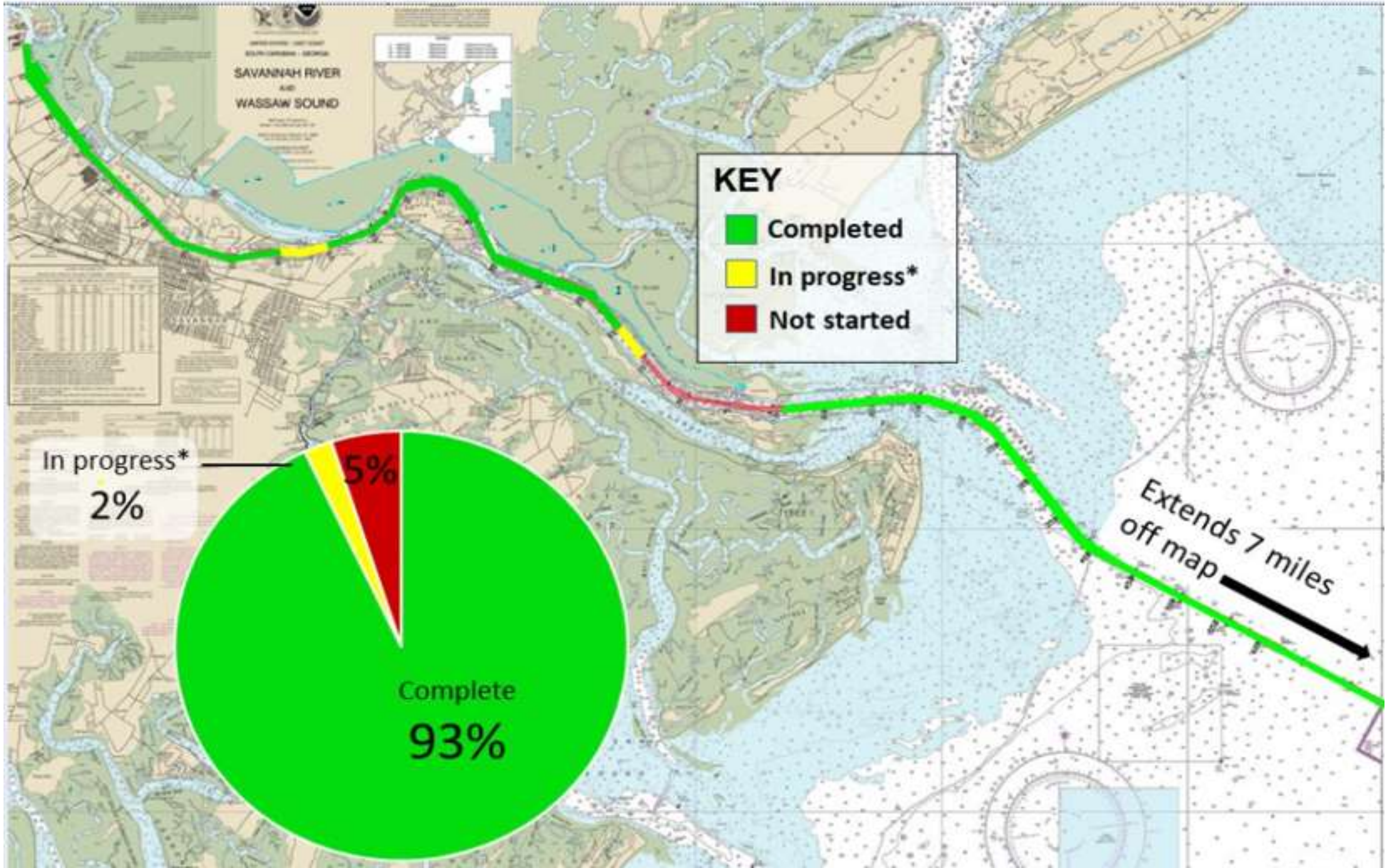


Water Injection Dredge (WID)

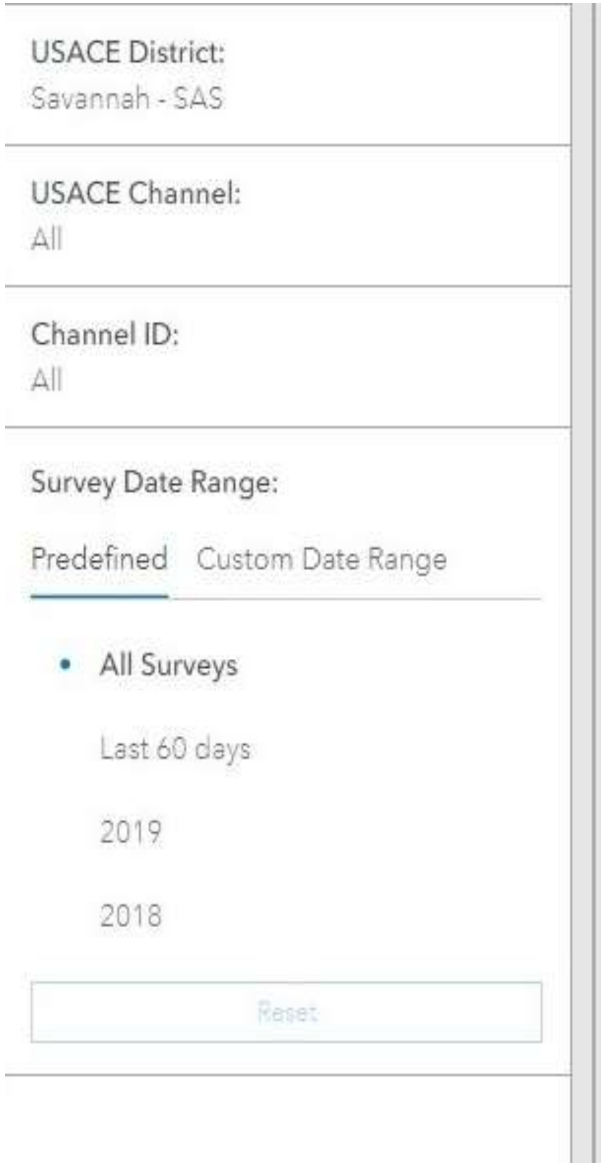
Georgia Ports Authority (GPA)

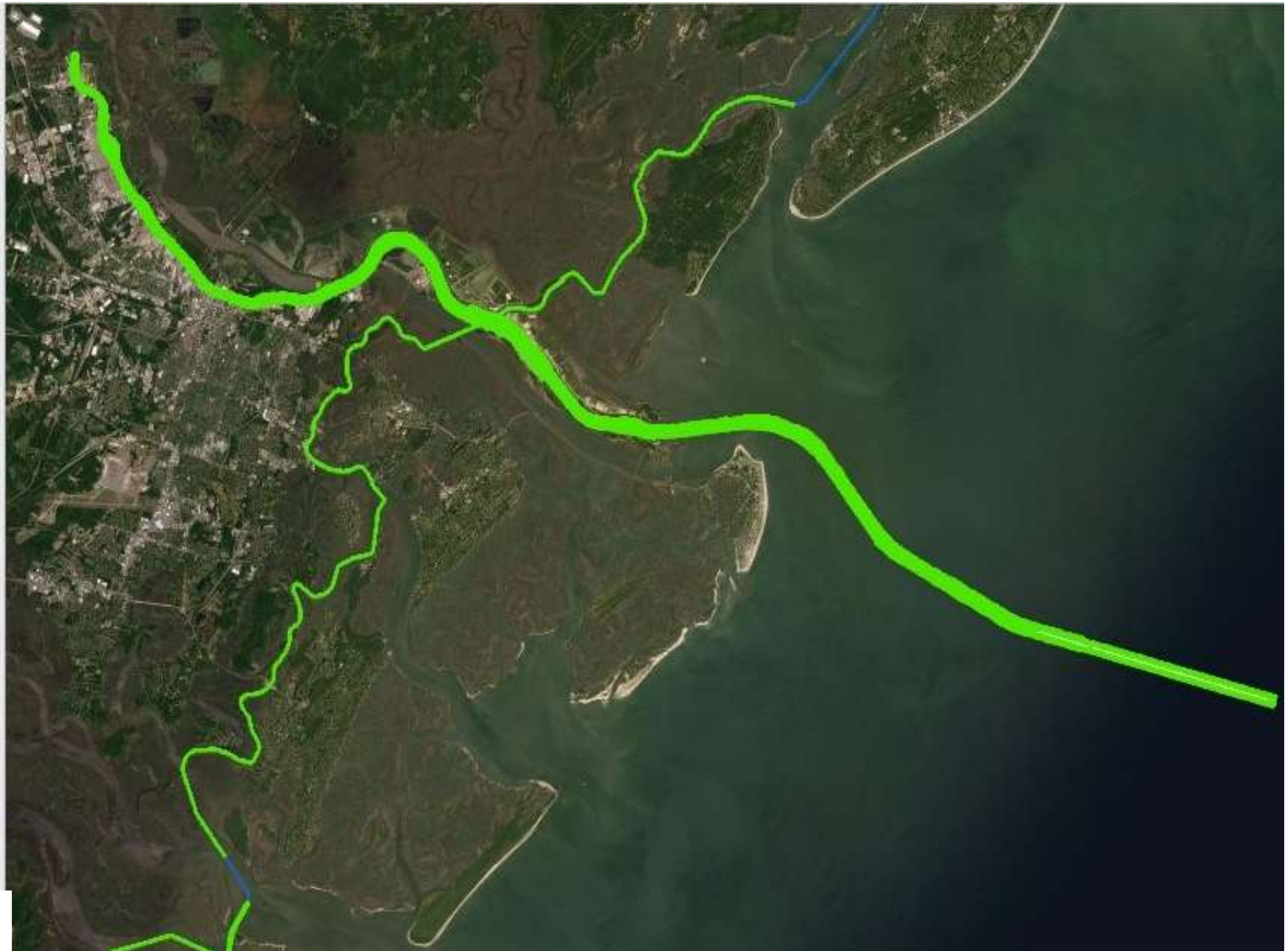
Georgia Ports Authority

Savannah Harbor Expansion Project (SHEP)



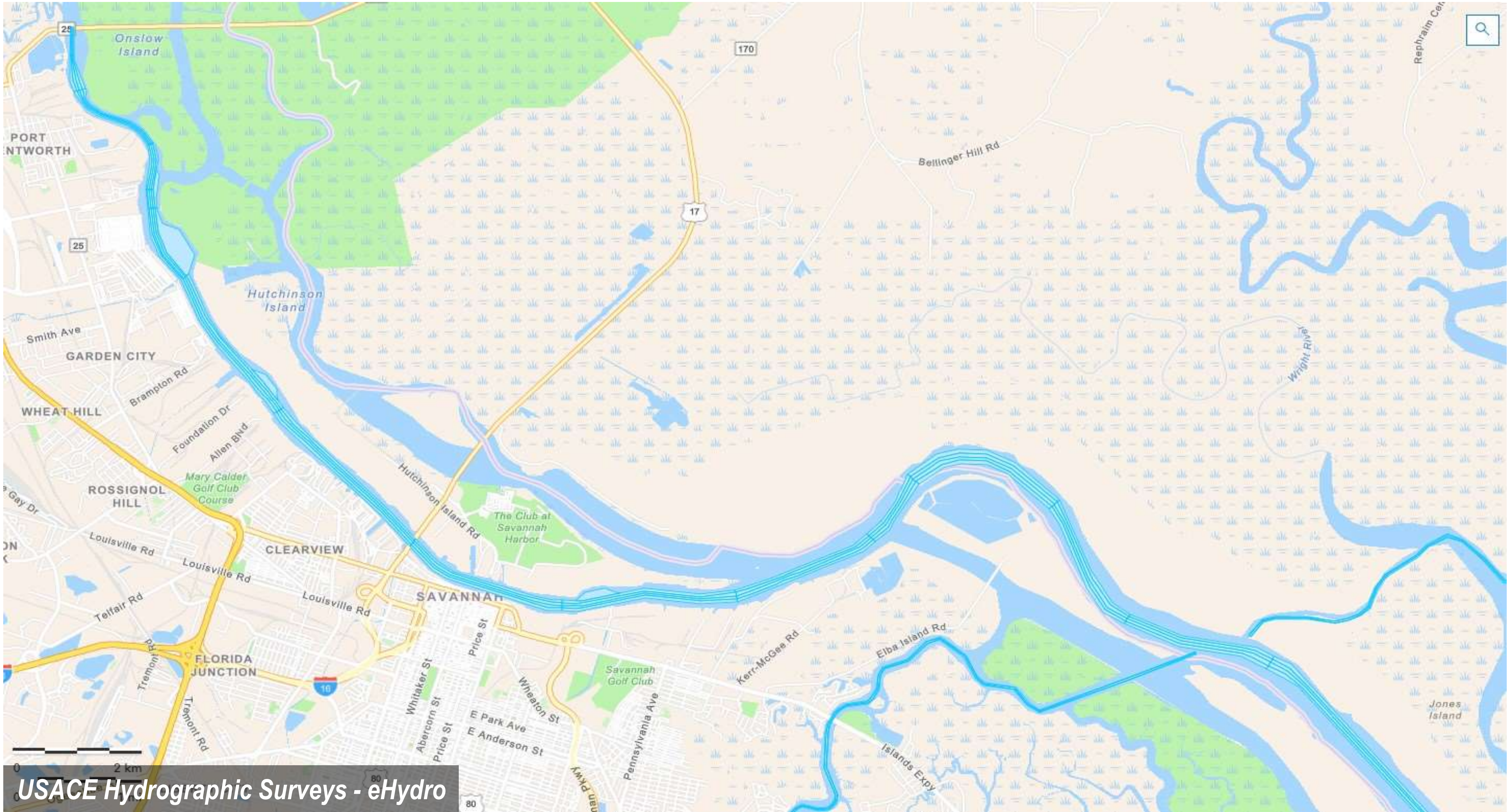
GPA Waterways – Savannah Harbor



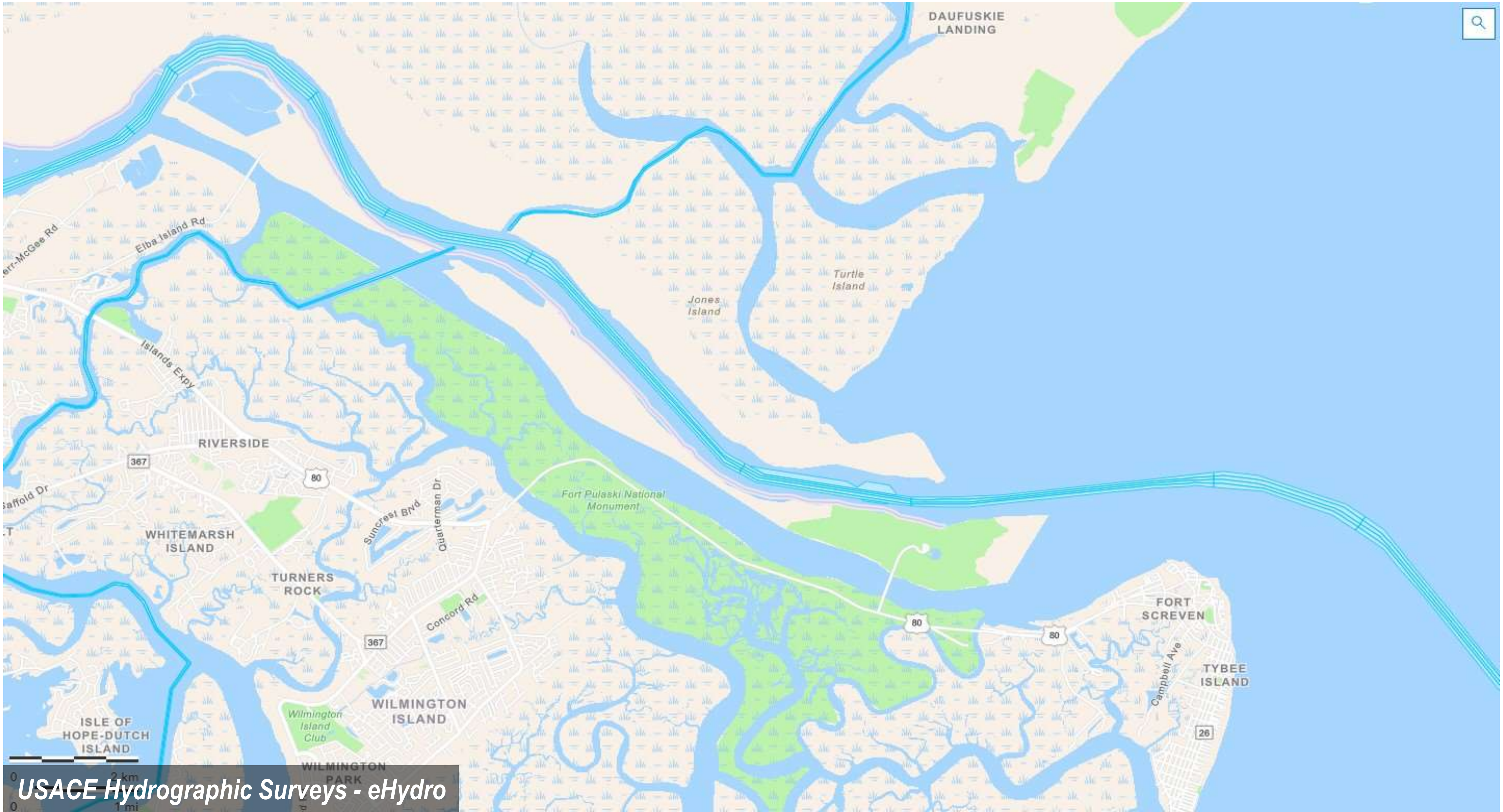


USACE Hydrographic Surveys – eHydro
www.navigation.usace.army.mil/Survey/Hydro

Savannah Harbor (West)

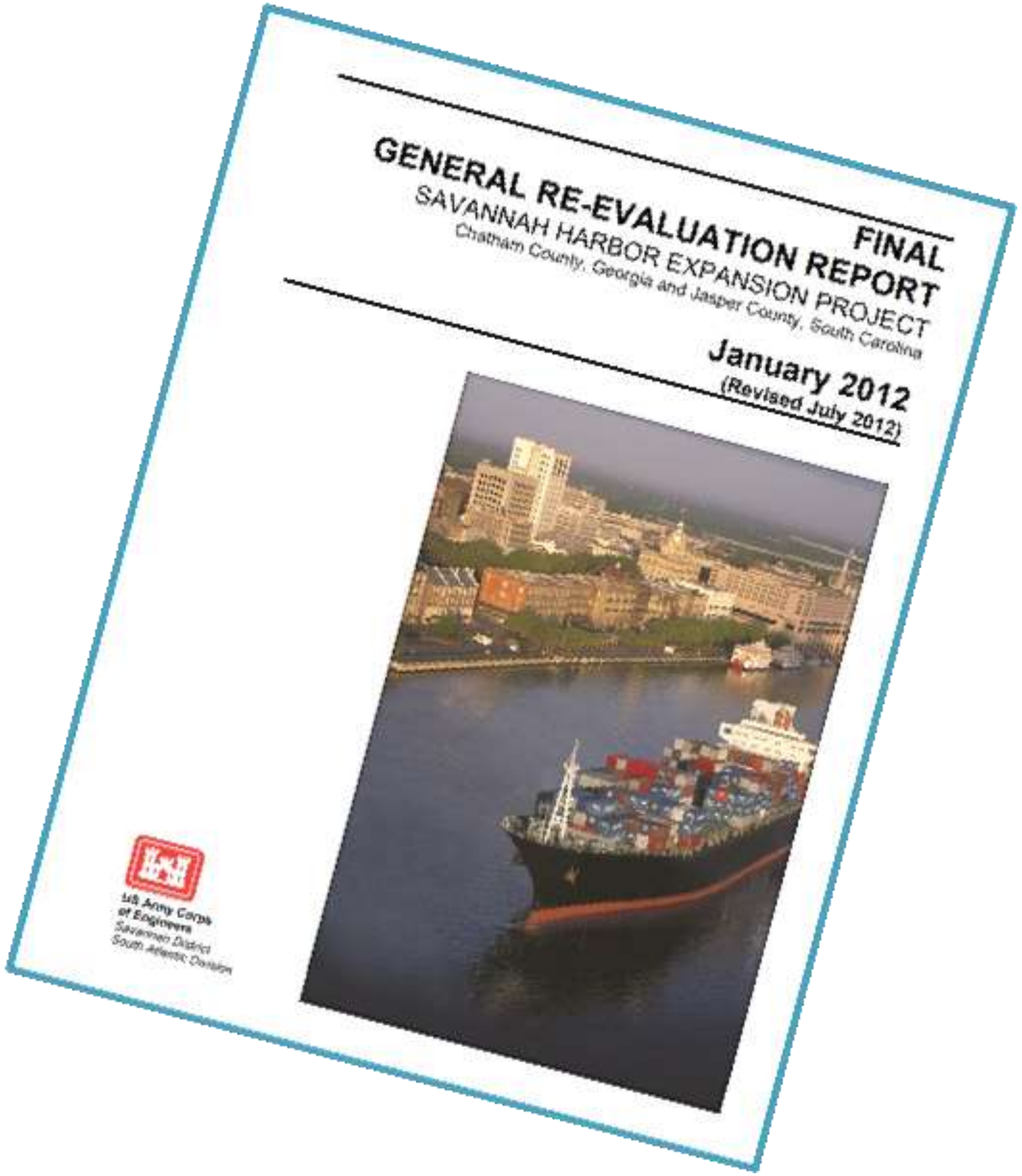


Savannah Harbor (East)

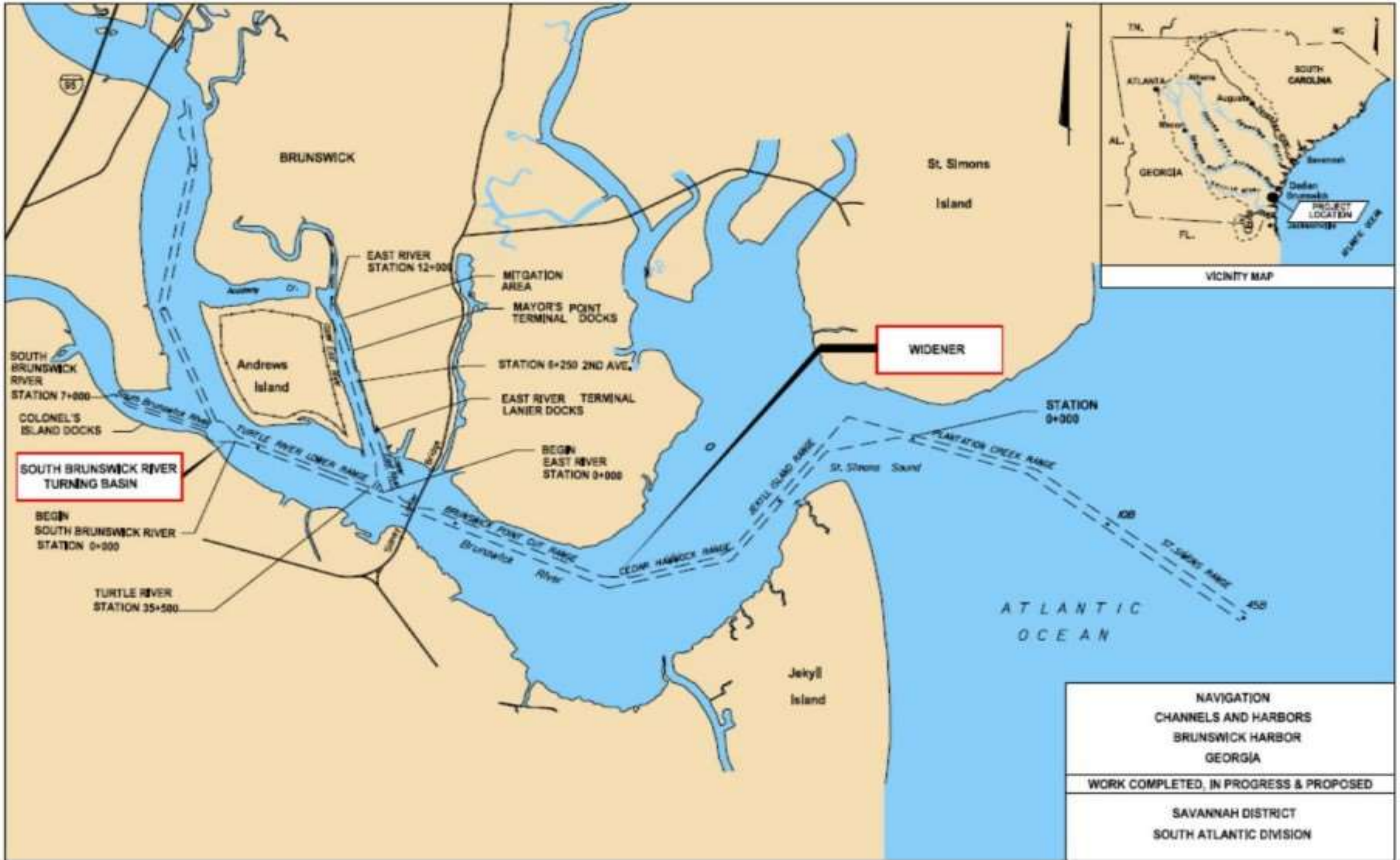


Savannah Harbor Expansion Project (SHEP) General Re-evaluation Report (GRR)

- 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

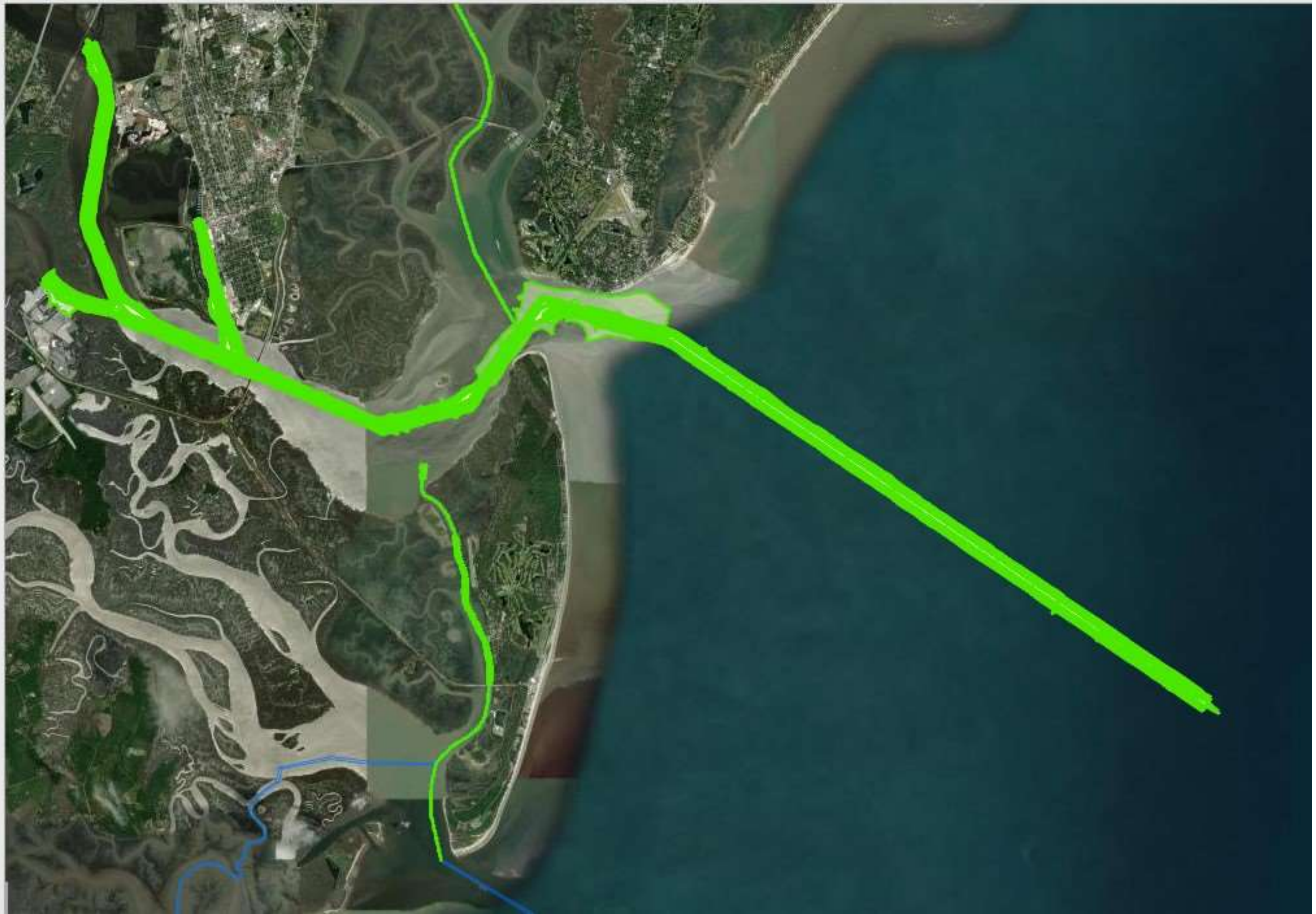
Last 60 days

2019

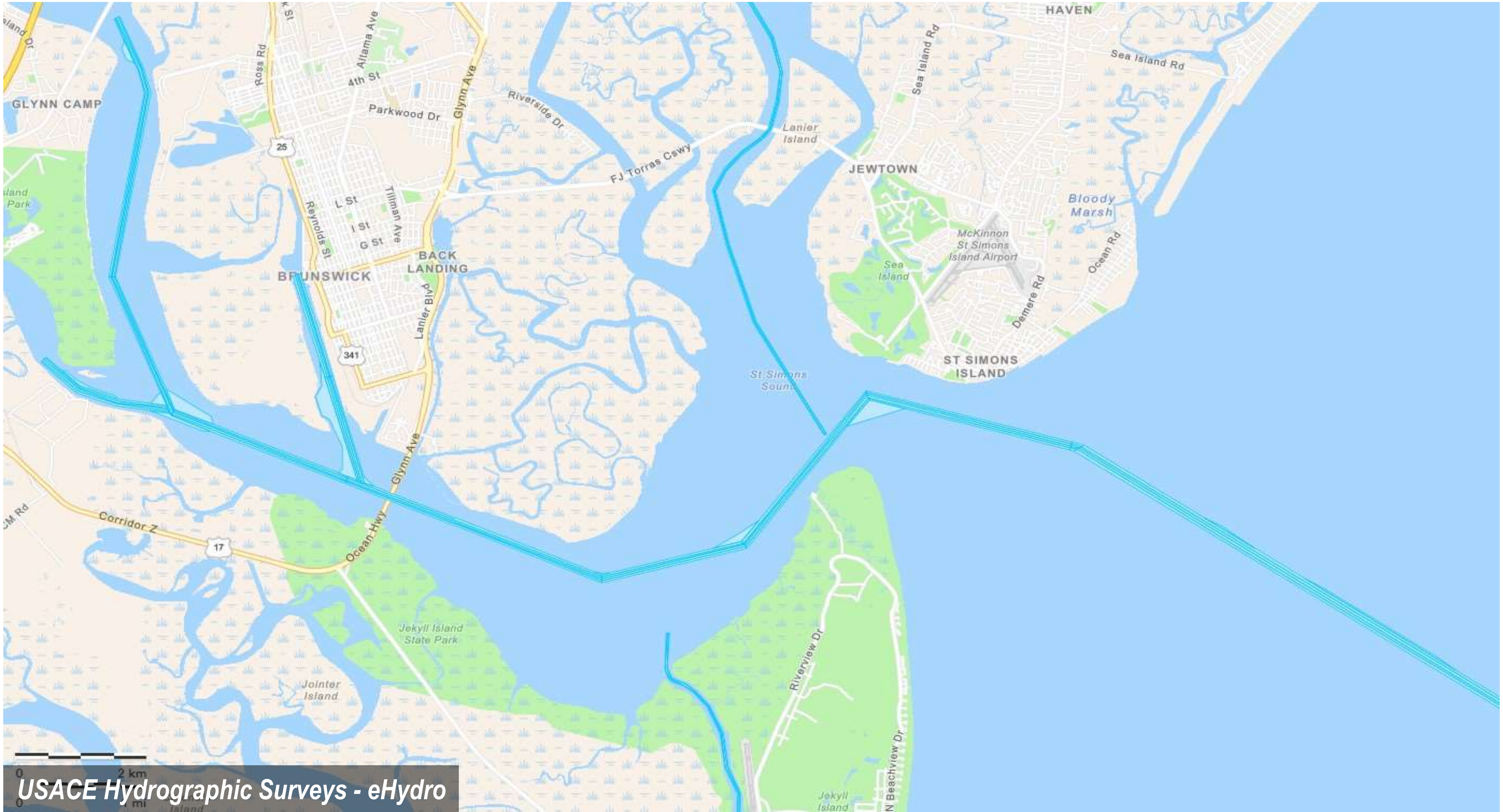
2018

Reset

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



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


Brunswick Harbor Modifications Study, Glynn County, Georgia

DRAFT Integrated Feasibility Report and Environmental Assessment and Draft FONSI

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
100 WEST OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401

June 2021

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

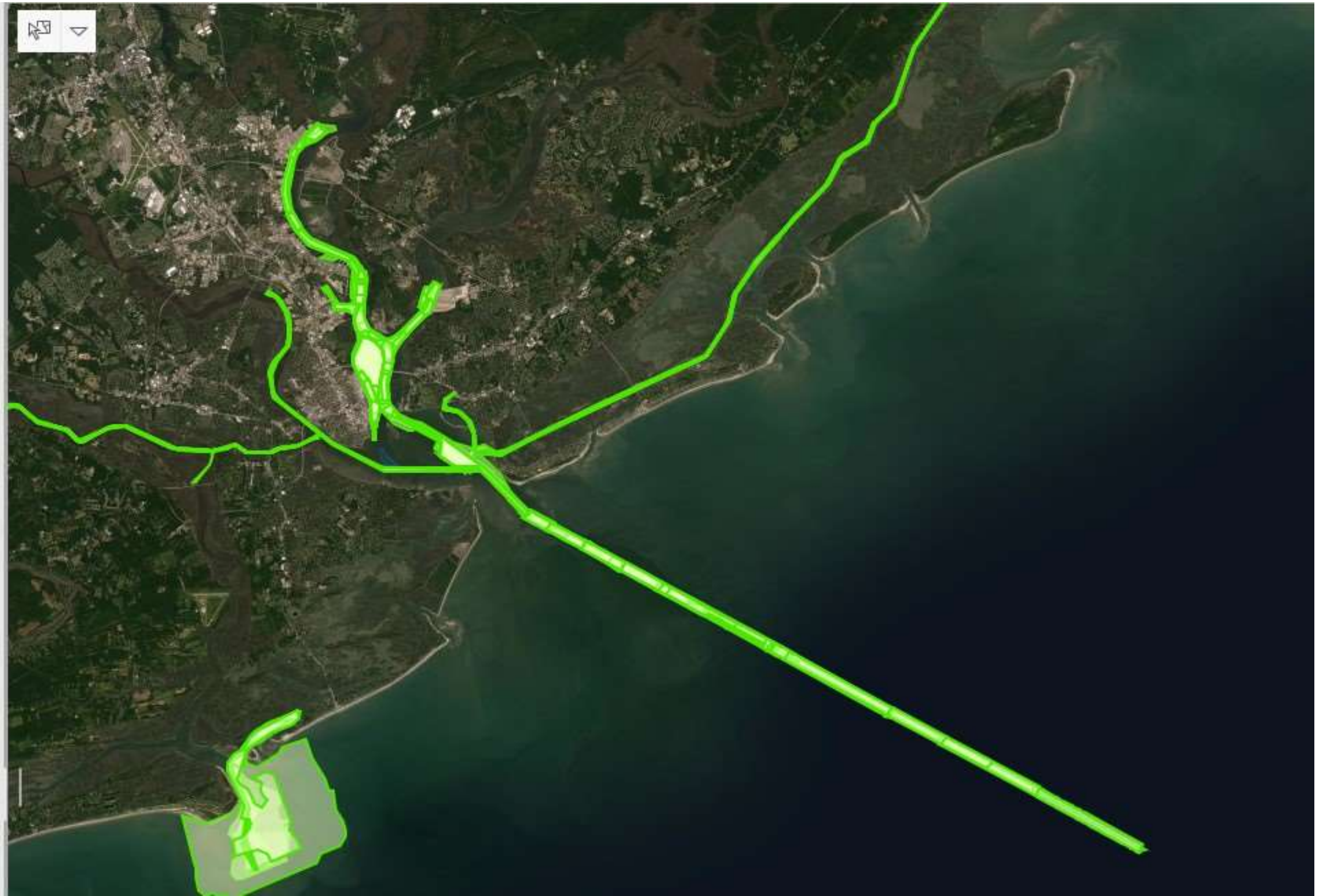
Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

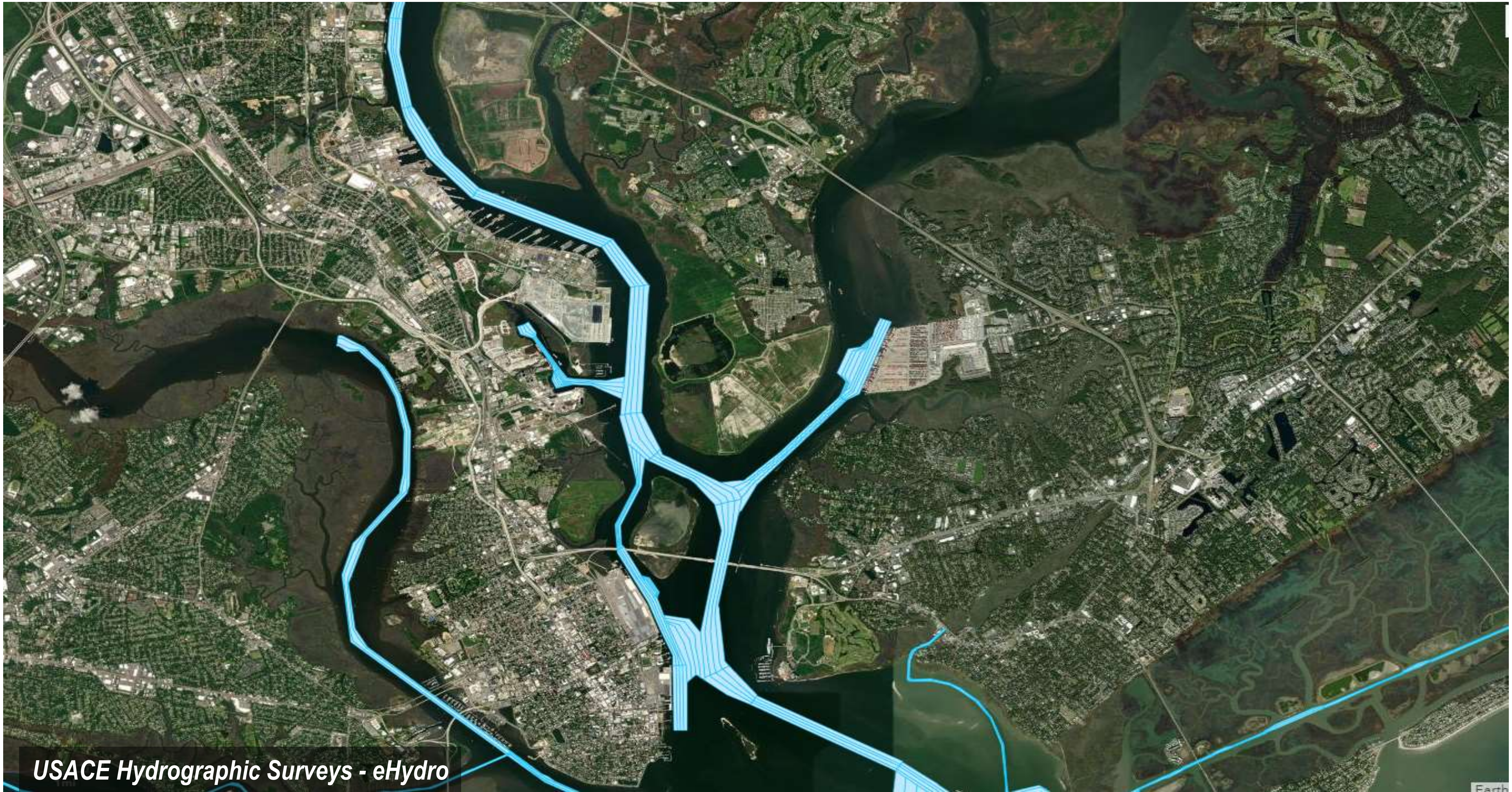
Custom Date Range

USACE Hydrographic Surveys – eHydro

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



Cooper River & HLT



USACE Hydrographic Surveys - eHydro

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)

MDOT
MARYLAND DEPARTMENT OF TRANSPORTATION

MARYLAND ENVIRONMENTAL SERVICE

PORT OF BALTIMORE 1706 Helen Delich Bentley

MPA Waterways (Northern)

USACE District:

All

USACE Channel:

All

Channel ID:

All

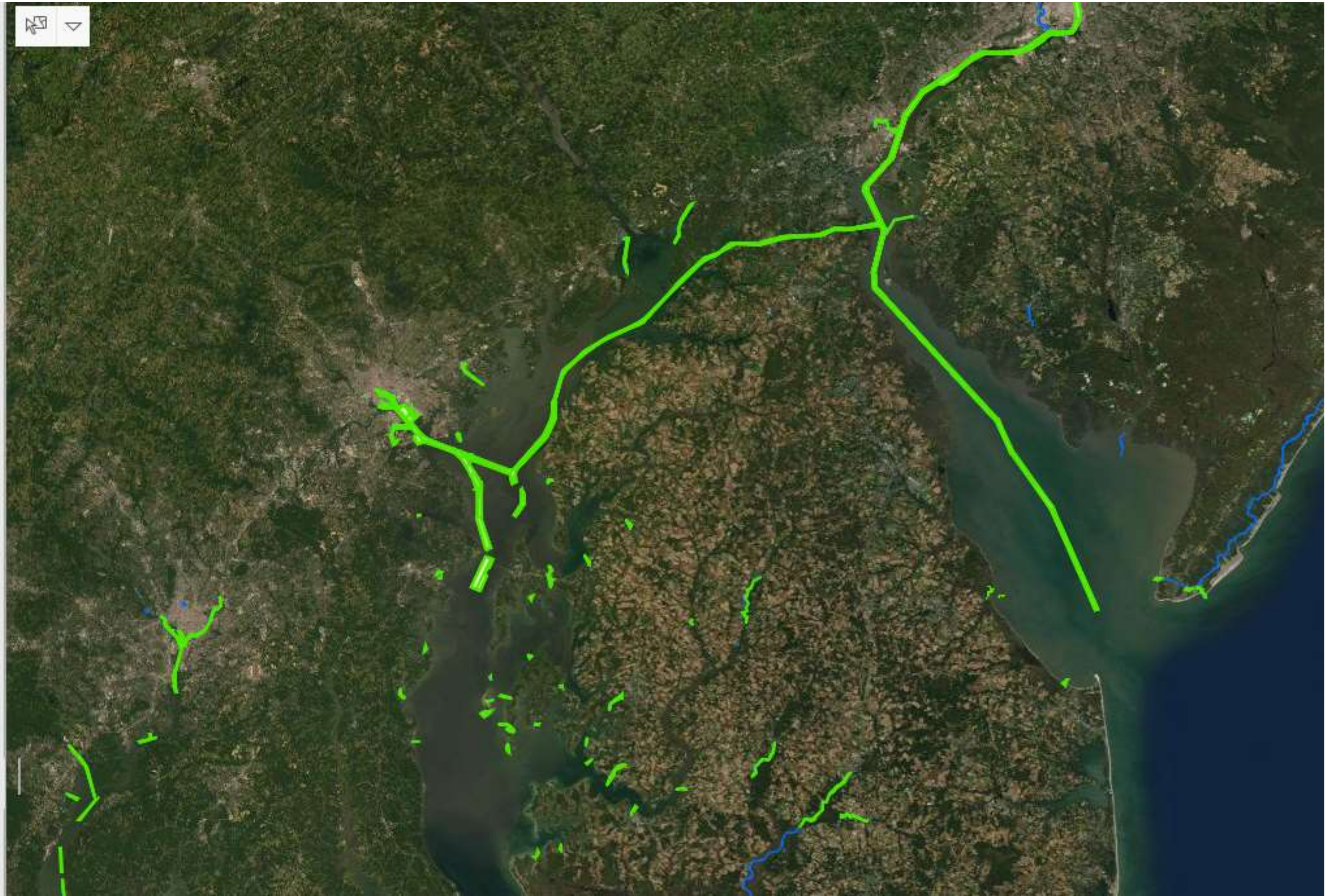
Survey Date Range:

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

MPA Waterways (Southern)

USACE District:

All

USACE Channel:

All

Channel ID:

All

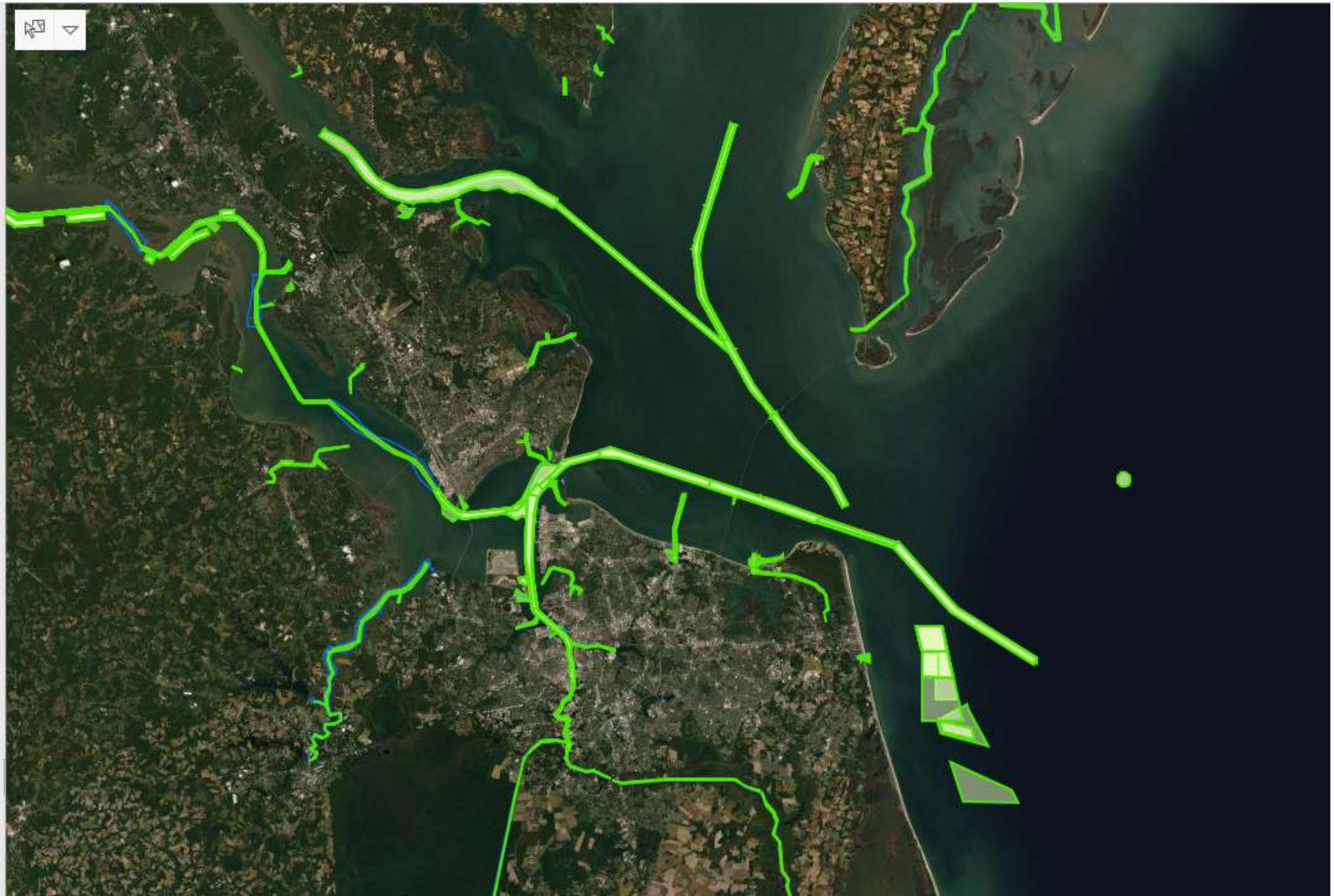
Survey Date Range:

All Surveys | Last 60 days | 2019 | 2018

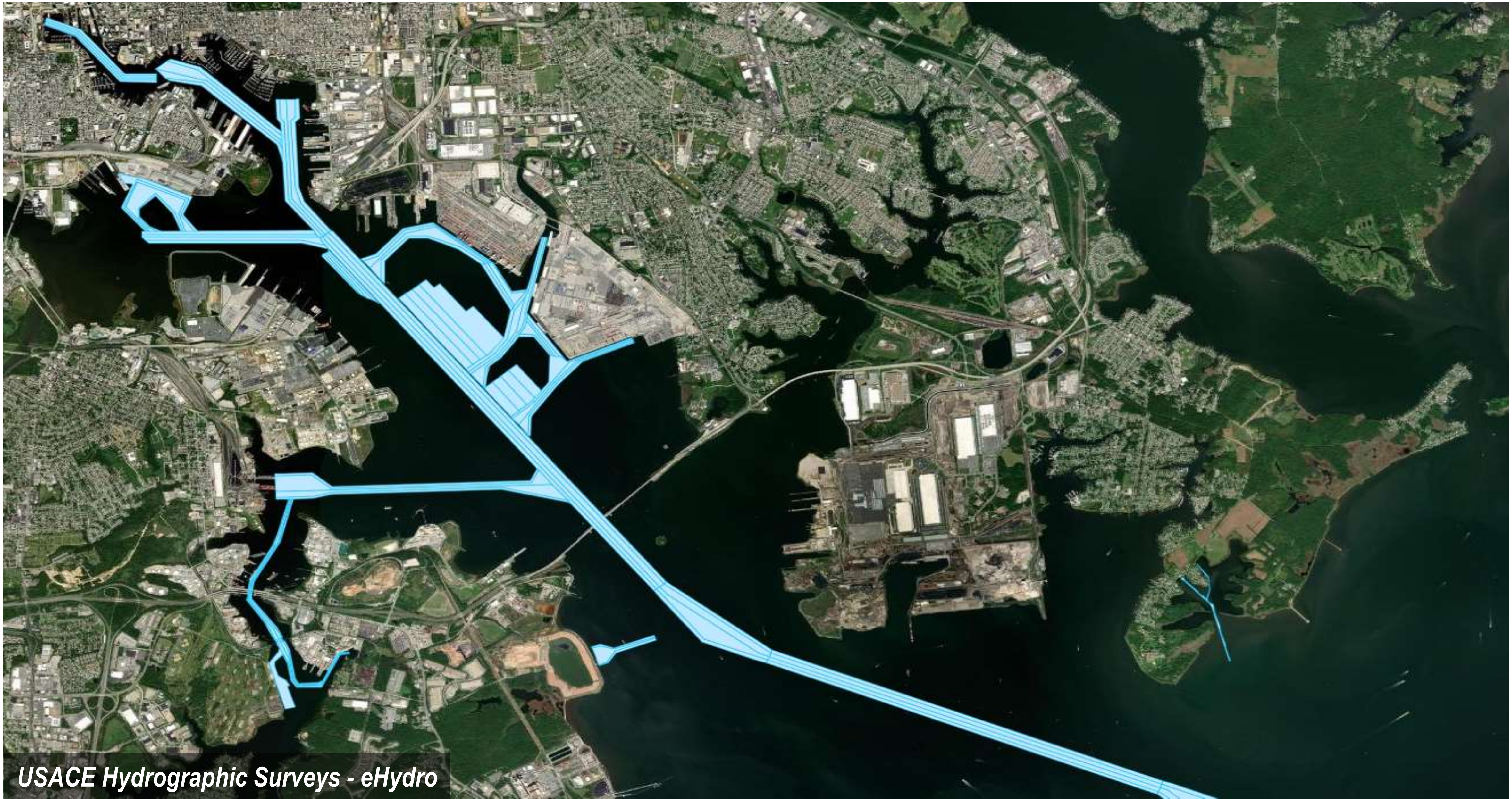
Custom Date Range

USACE Hydrographic Surveys – eHydro

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

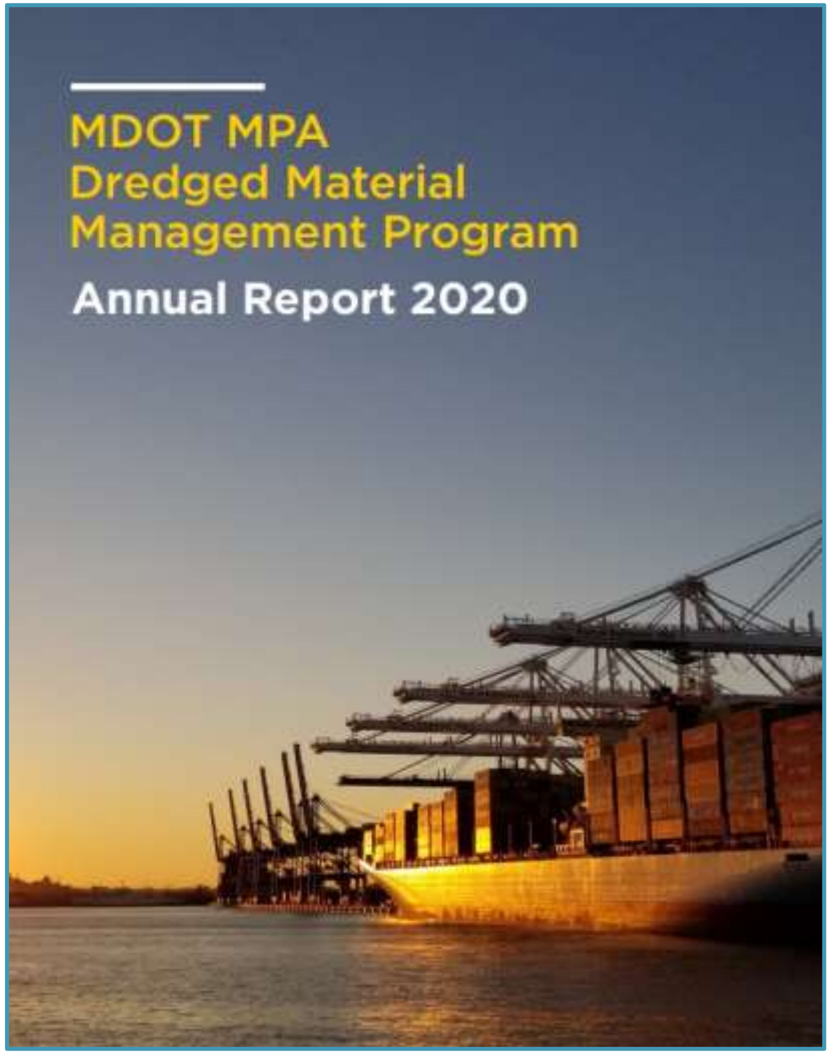


Port of Baltimore



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?

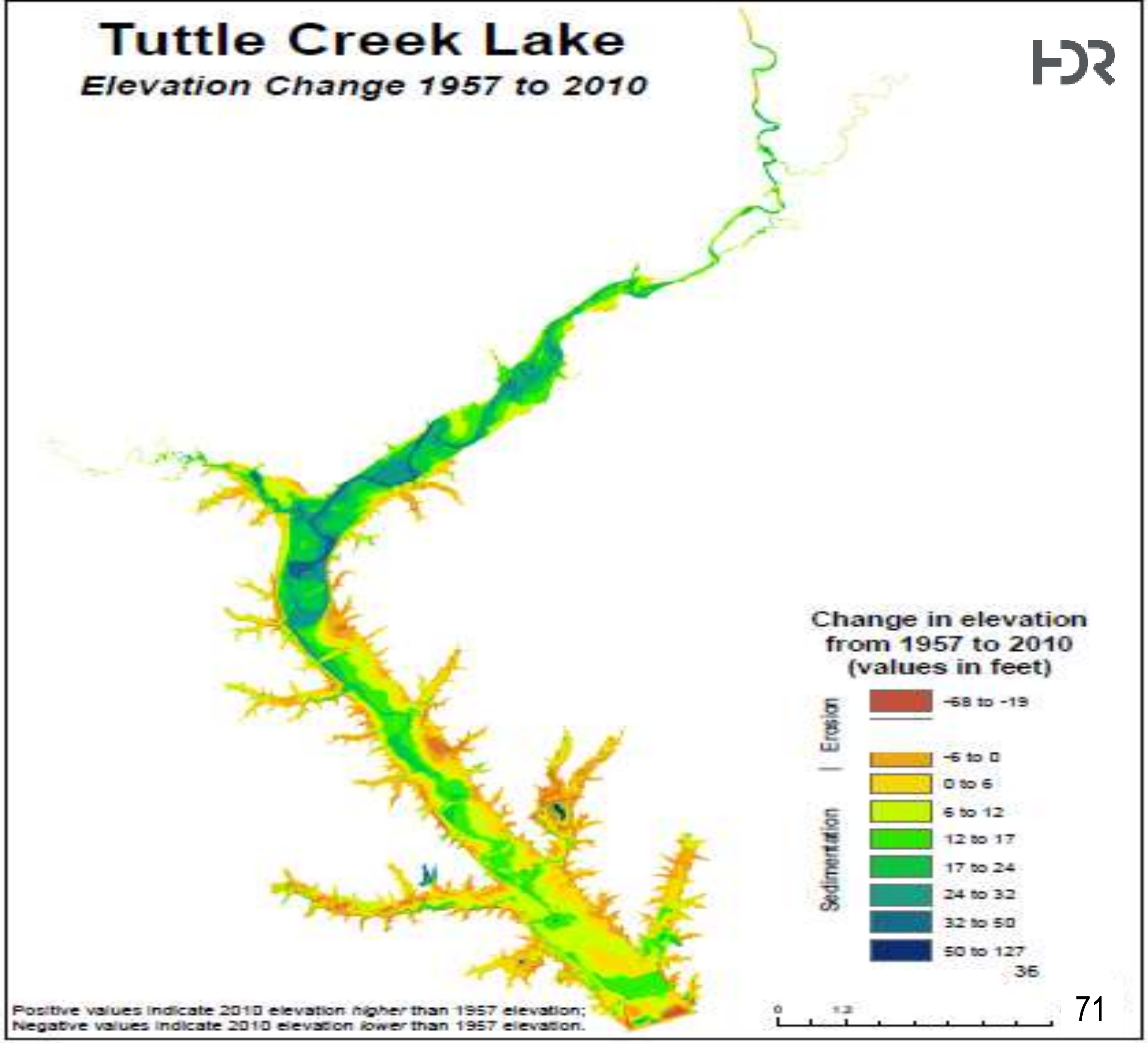


MDOT MPA DMMP 2020
www.maryland-dmmp.com

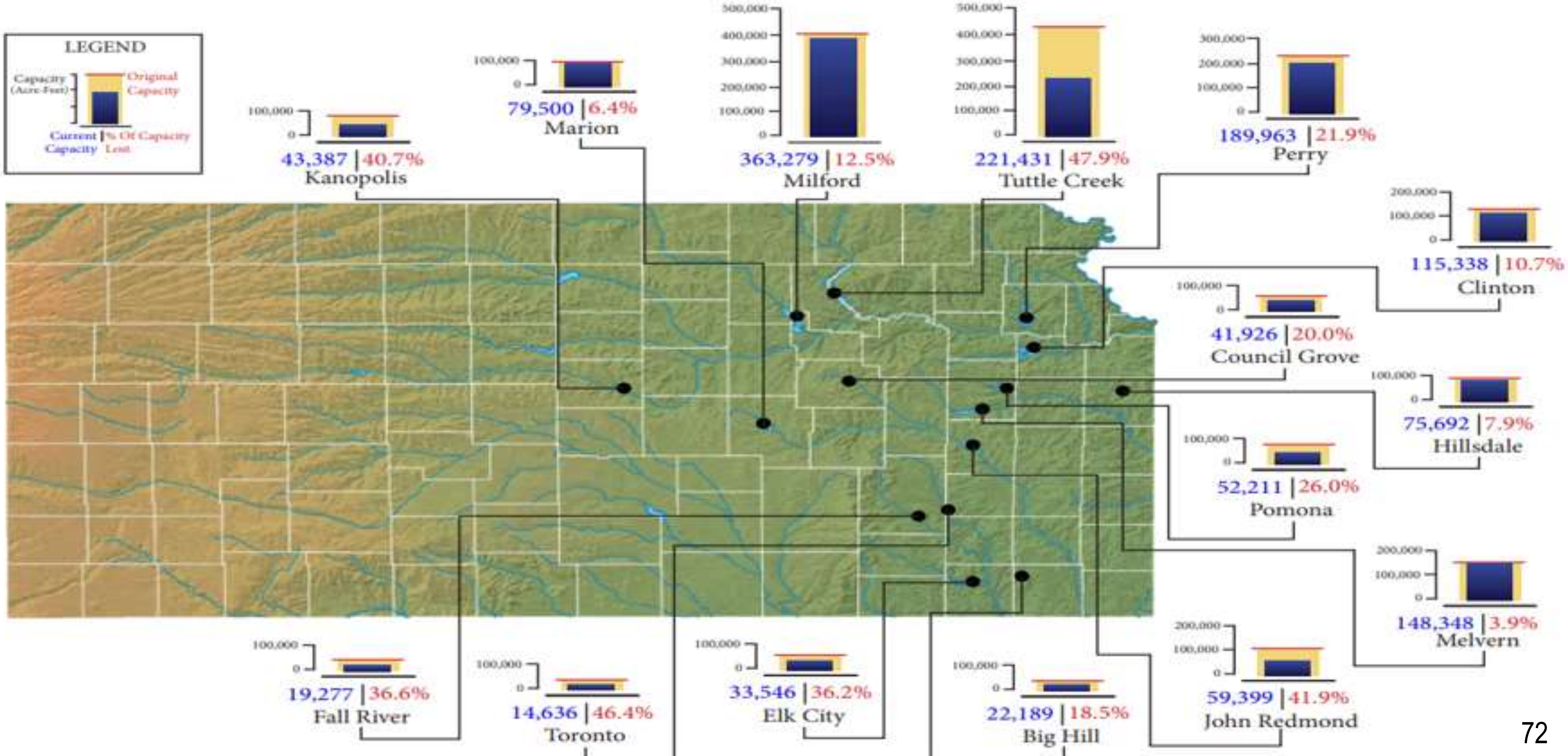
Water Injection Dredge (WID) in Reservoirs

Kansas Water Office (KWO)

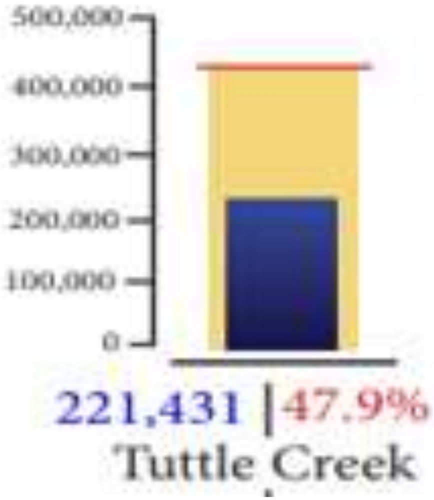
Tuttle Creek Lake

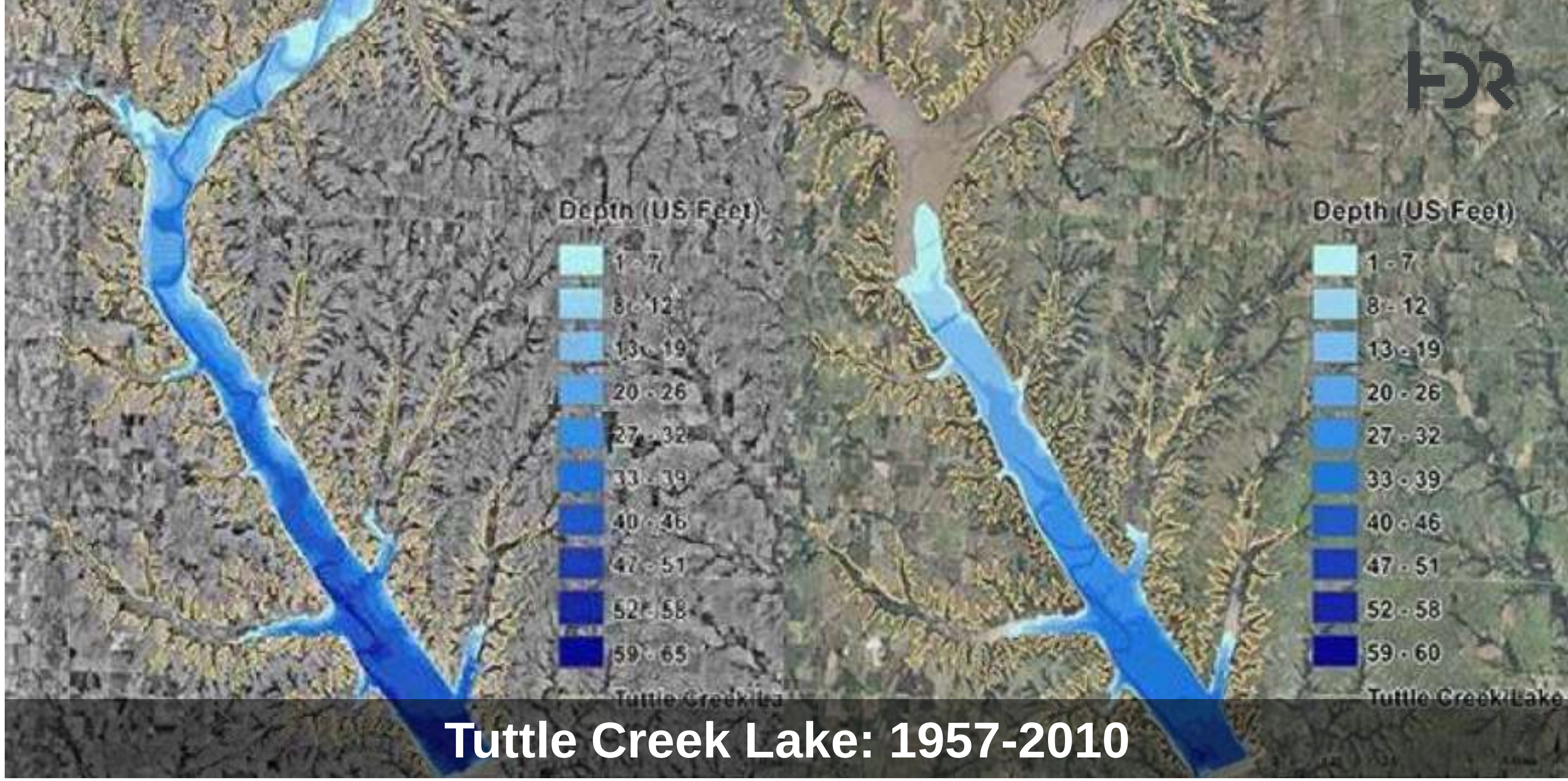


WID Kansas Water Office (KWO) Tuttle Creek Lake

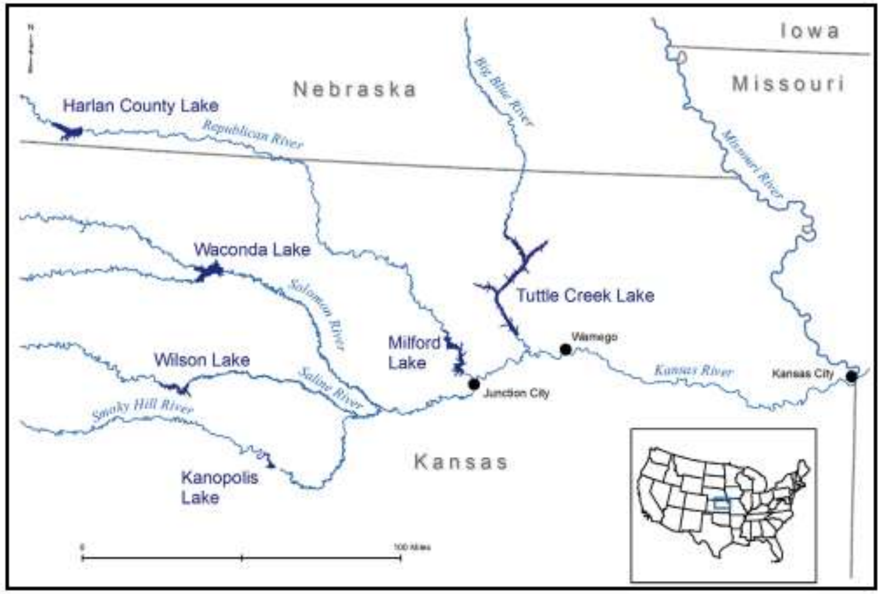


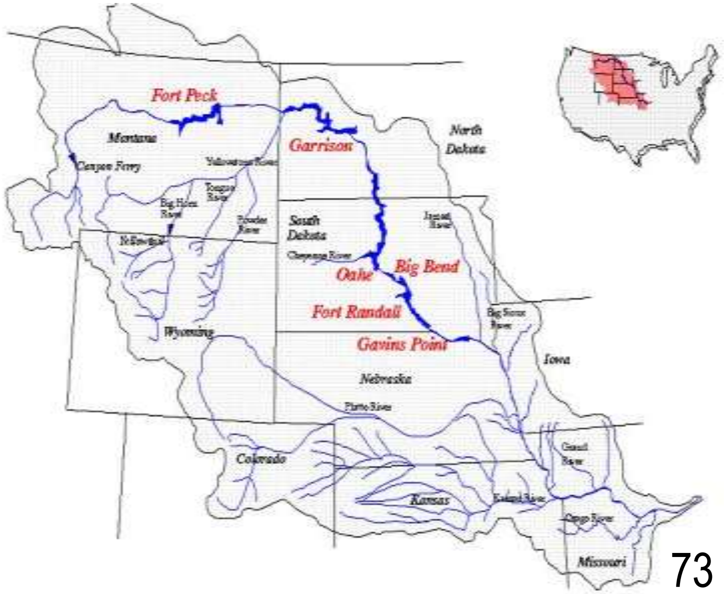
WID KWO – Tuttle Creek Lake (Cont.)



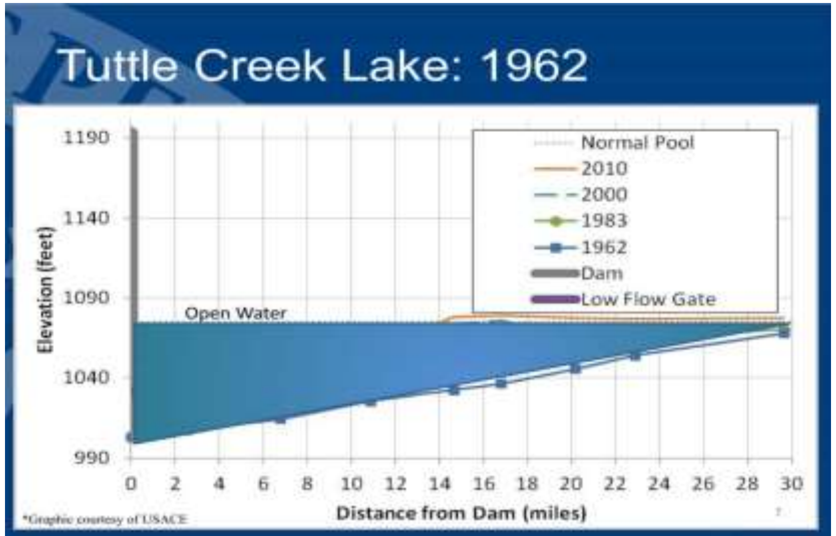


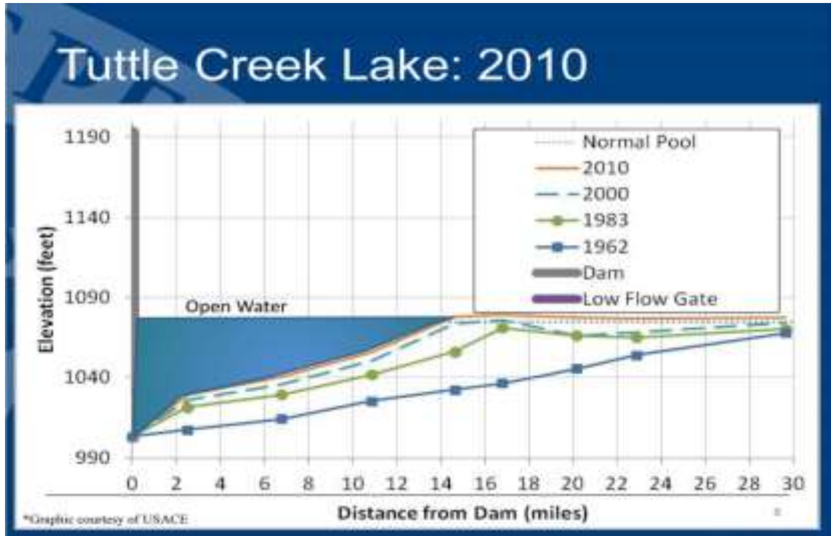
Tuttle Creek Lake: 1957-2010





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

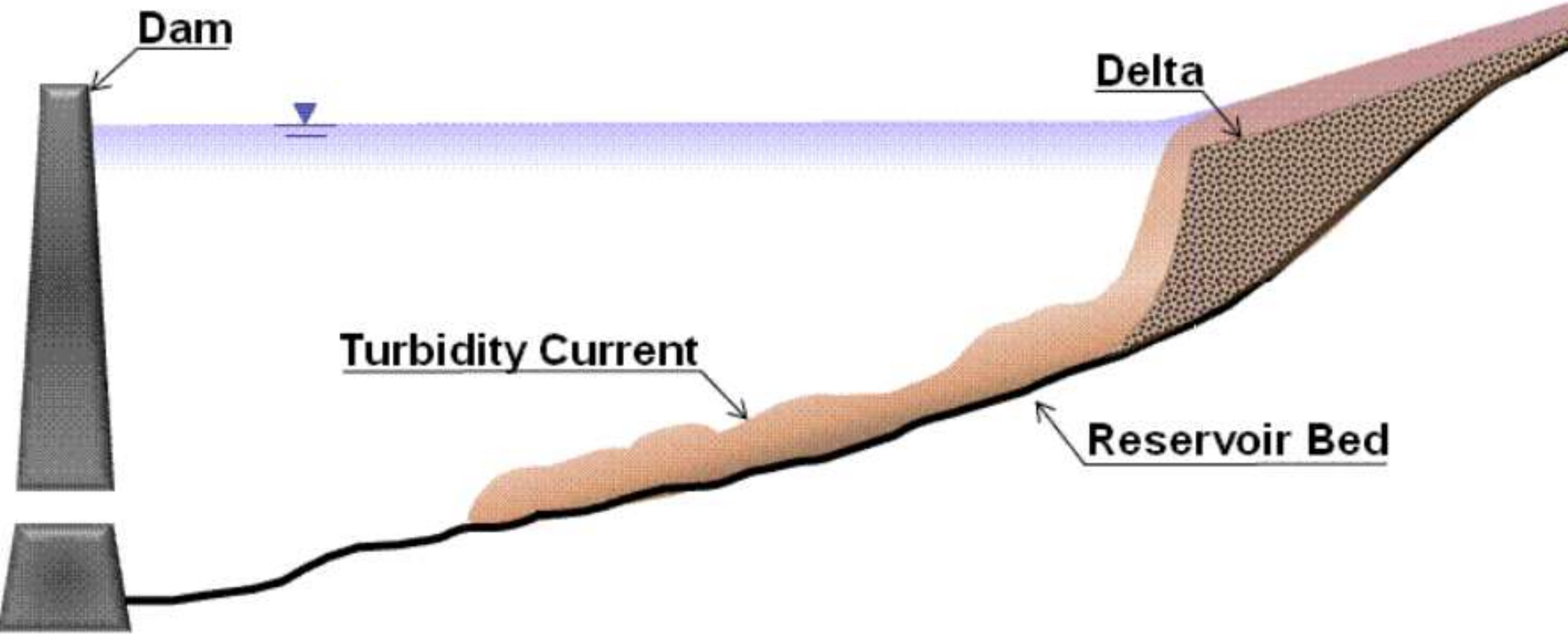
Water Injection Dredging

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.)



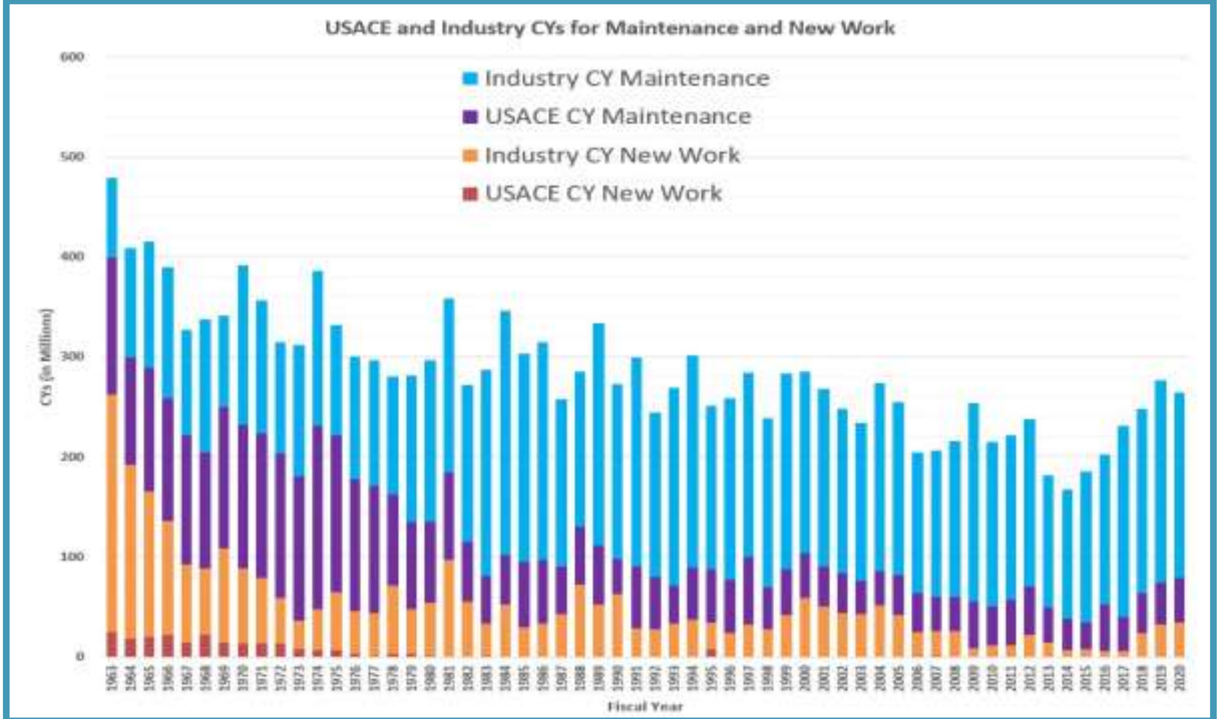
USACE NDC Dredging Costs (1963-2020)

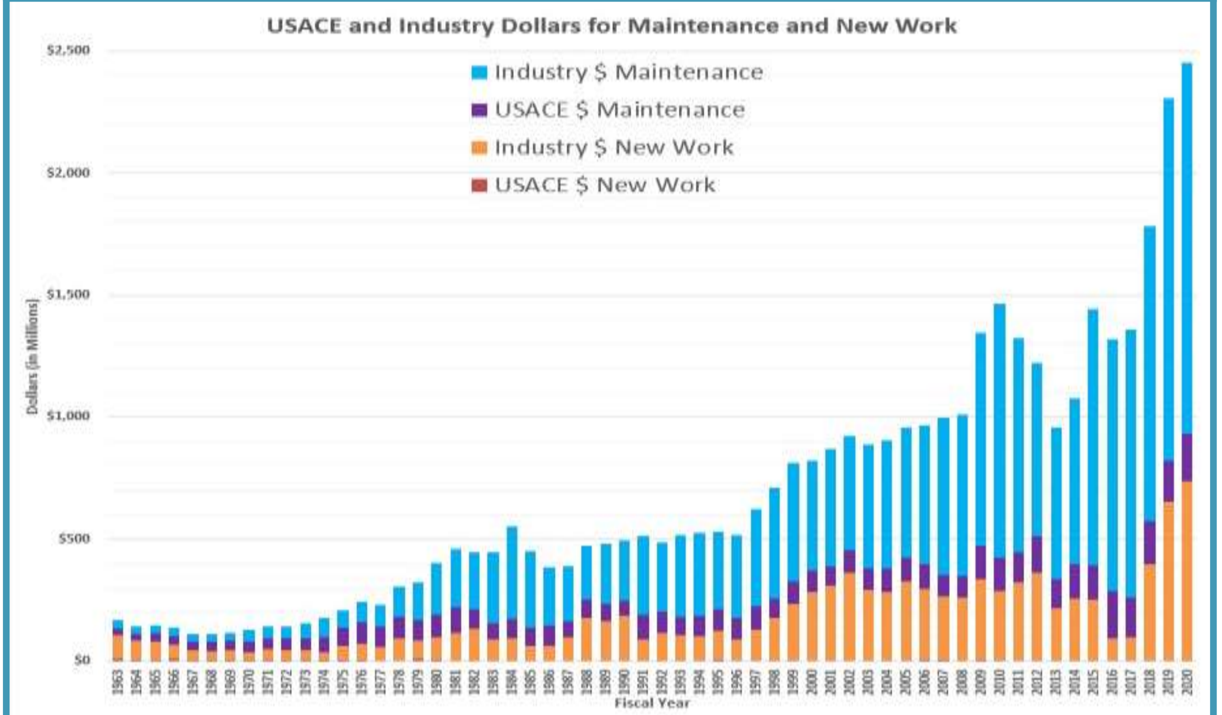
https://publibrary.planusace.us/#/series/Dredging%20Information

	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%

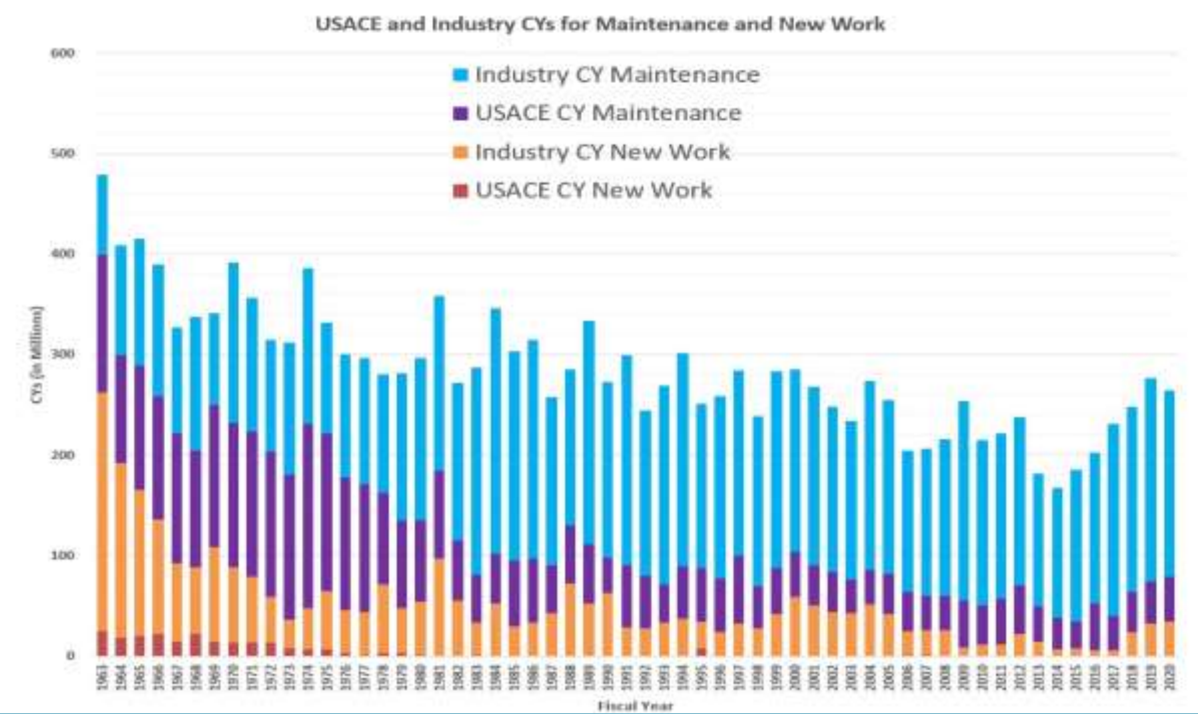
	USACE & INDUSTRY								
	DOLLARS			CUBIC YARDS			2020 $$/CY		
	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	TOTAL	MAINT	NEW WORK	WEIGHTED AVG.
First Ten Years	$74	$60	$134	249	127	377	$2.26	$3.56	$2.70
Last Ten Years	$1,185	$339	$1,524	205	16	222	$5.77	$20.55	$6.87
				121%	773%	170%	256%	578%	255%

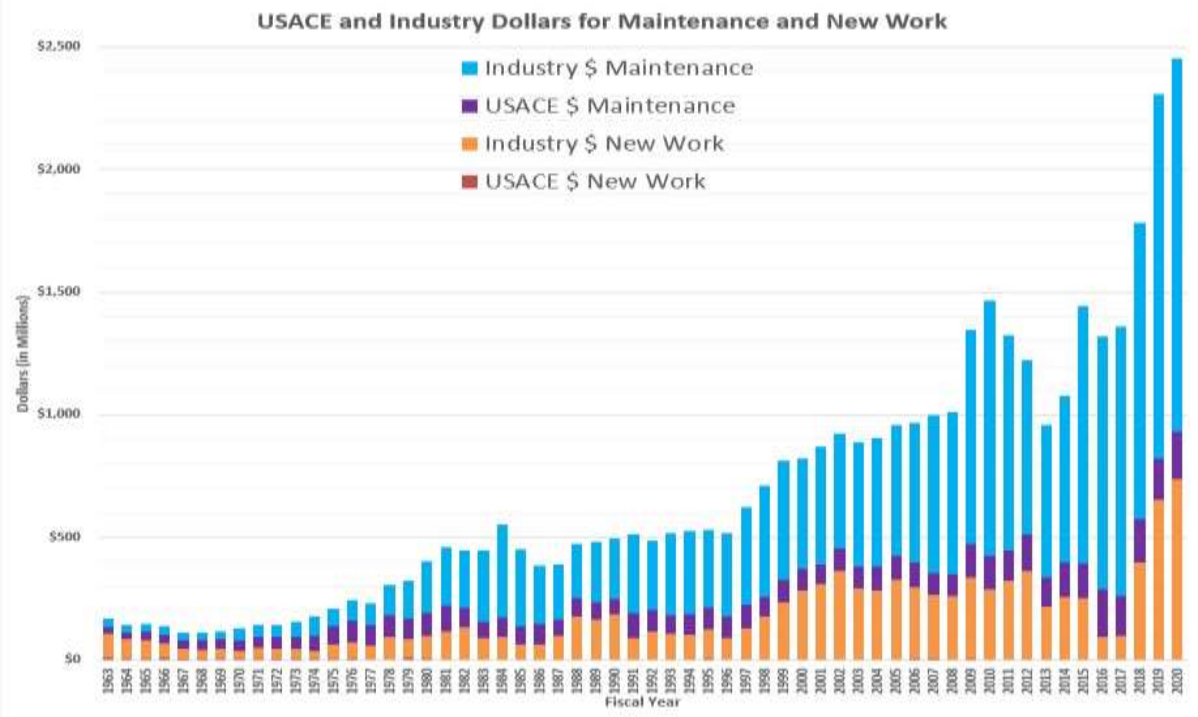




USACE NDC Dredging Costs (1963-2020)

- 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





USACE NDC Dredging Costs (1963-2020)

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

Project Approach

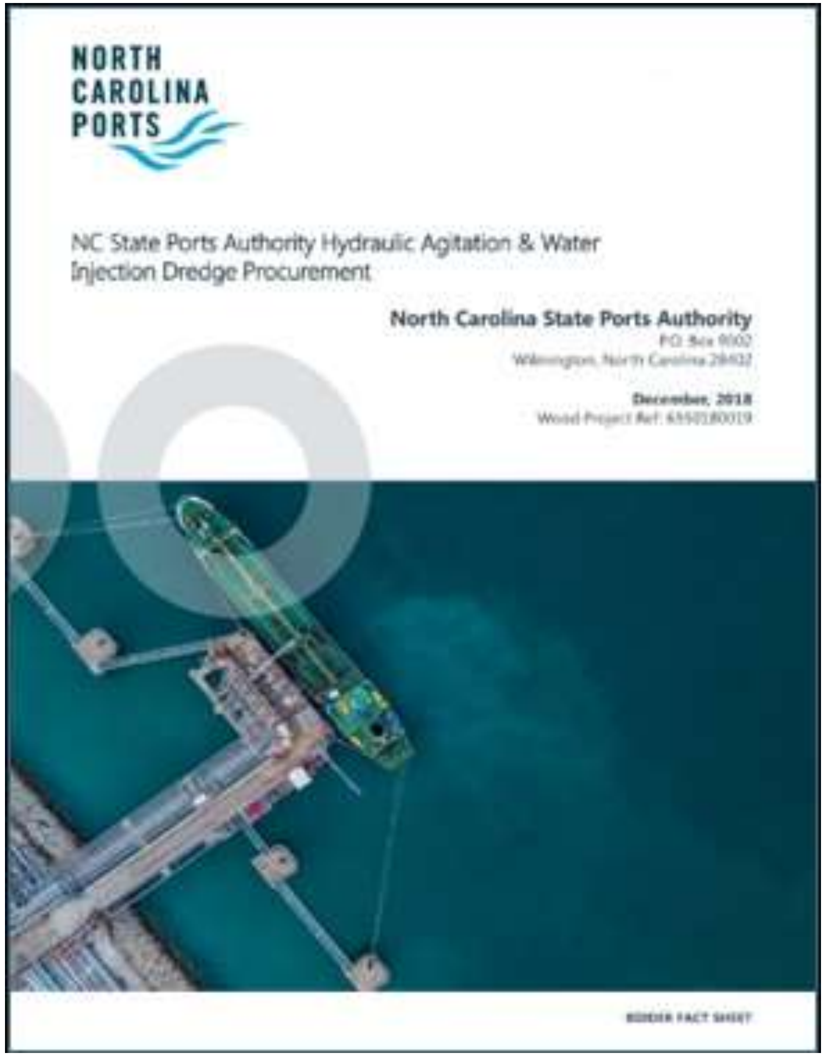
- NCSPA authorized research into acquiring a WID, hiring a WID contractor, or some other variant (Spring 2018)
- Contacted over ***70 organizations***, including dredge manufacturers & other possible sources of relevant information)
    - ***Dredging related electronic newsletters***
    - ***Trade publications***
    - ***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