Engineering With Nature® (EWN®)

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WEDA Webinar
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US Army Corps of Engineers®

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Creating Value through Alignment…

- What opportunities are there for achieving better alignment of natural and engineered systems?
  - Can improved alignment reduce risks to life, property and ecosystems?
  - What range of services can be produced through such alignment?
  - What are the science and engineering needs in order to achieve better alignment?

Sustainable Solutions Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

A "Sustainability Ledger" for Sediment Management

Efficiency

- Reducing sedimentation in channels & reservoirs
- Reducing transport distances for dredged material
- Reducing dredging time
- Expanding operational flexibility
- Linking multiple projects

Value Creation

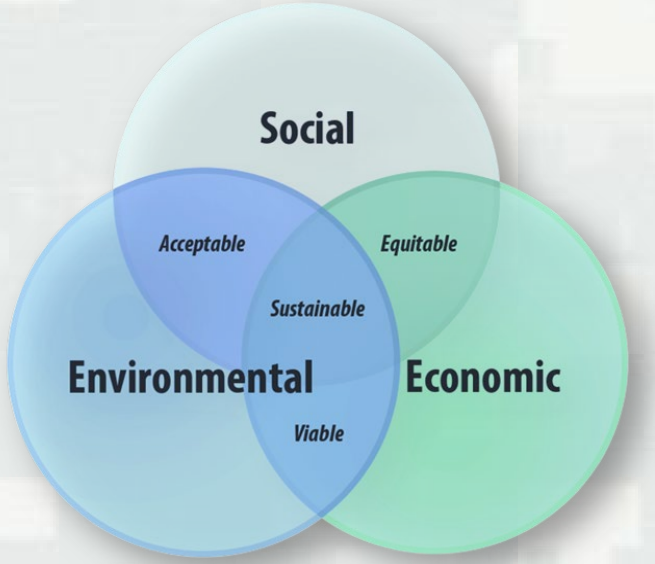
- Restoring natural sediment processes to sustain landscapes
- New nature-based features that reduce flood risks
- New habitat for fish and wildlife
- New features that provide recreational and other social value
- Budget space for additional infrastructure work

Engineering With Nature®

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaboration.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners



www.engineeringwithnature.org

BUILDING STRONG®

Engineering With Nature® Overview

Engineering With Nature® began in 2010

- Guided by a strategic plan
- Engaging across sectors
  - >50 workshops, technical meetings, etc.
- Established through Proving Grounds
  - Galveston, Buffalo, Philadelphia
- Informed by focused R&D
- Demonstrated with field projects
- Advanced through partnering
- Shared by strategic communications
- Marking progress
  - 2013, Chief of Engineers Environmental Award in Natural Resources Conservation
  - 2014, 2020 USACE National Award-Green Innovation
  - 2015, 2017 WEDA Awards; 2017 DPC Award
  - 2019, Renewable Natural Resources Foundation Award
  - 2020, USACE Green Innovation Award

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EWN® Across USACE Mission Space

- **Navigation**
  - Strategic placement of dredged material supporting habitat development
  - Habitat integrated into structures
  - Enhanced Natural Recovery
- **Flood Risk Management**
  - Natural and Nature-Based Features to support flood risk management
  - Levee setbacks
- **Ecosystem Restoration**
  - Ecosystem services supporting engineering function
  - “Natural” development of designed features
- **Water Operations**
  - Shoreline stabilization using native plants
  - Environmental flows and connectivity

EWN® and NNBF

- **Natural and Nature-based Features** (NNBF)
- **Natural features:** created & evolved over time through physical, biological, geologic and chemical processes operating in nature over time
- **Nature-based features:** mimic characteristics of natural features but created by human design, engineering and construction to provide coastal risk reduction
- **Built components:** include nature-based features as well as “gray” infrastructure (i.e. levees, floodwalls, etc.)
- **Non-structural measures:** policies, building codes, land use zoning

A Call to Action: Beneficial Use of Dredged Sediment

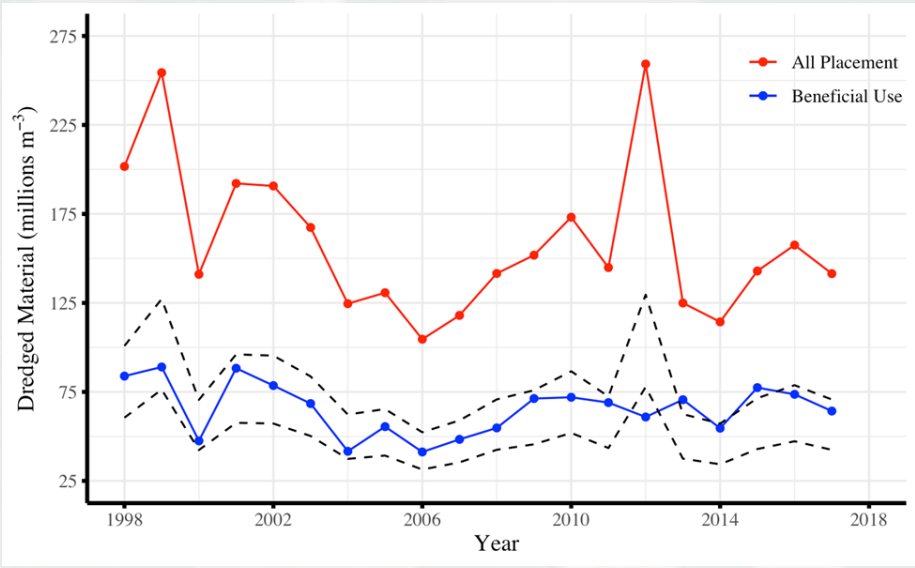
Beneficial use is using dredged sediment to achieve additional benefits beyond the purposes related to its removal, including other economic, environmental or social benefits.

21st Century Imperative:

Getting to 100% Beneficial Use!*

USACE Beneficial Use History:

- >1.5 billion cubic yards used in beach construction over the past 100 years
- 100's millions of cubic yards of BU since 1970
  - 25,000 acres of wetlands created in south Louisiana
- ~30% of dredged material beneficially used in the past 20 years



From: Bell et al. (In review) WEDA Journal of Dredging
Source: USACE RSM BU database

*Dr. Todd Bridges, Senior Research Scientist, Environmental Science

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Applying the Full Range of Beneficial Use

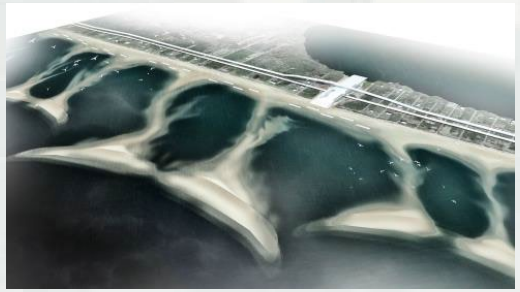
Sediment “Recharge” via Dredging

Direct Wetland “Nourishment”

Wetland Creation

Island Enhancement or Restoration

Engineering / Operational Effort



Strategic Placement

Thin Layer Placement for Bottom Contouring

Beach and Dune Construction

New Island Construction

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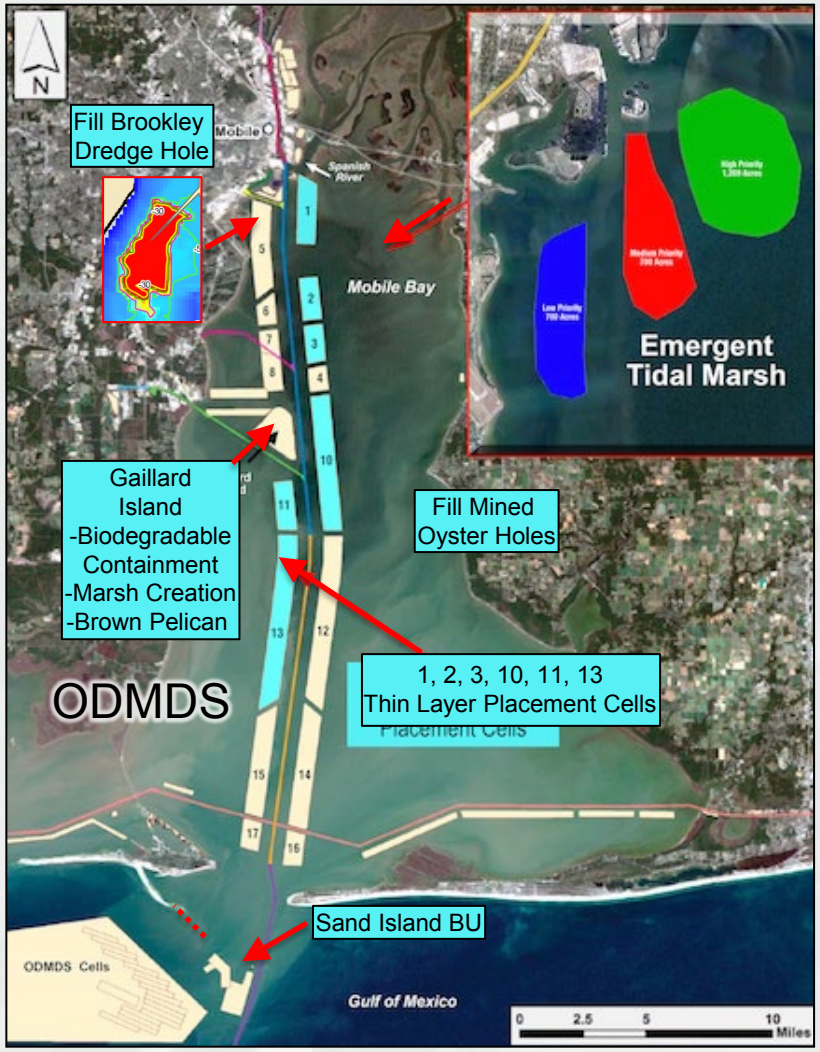
Sediment Beneficial Use Examples

- Mobile Bay
- New Jersey Back Bays
- Barrier Islands, Mississippi
- Drake Wilson Island, Apalachicola Bay, Florida
- Horseshoe Bend Island, lower Atchafalaya River, Louisiana
- Swan Island, Chesapeake Bay, Maryland

Mobile Bay: Applying Regional Sediment Management & EWN

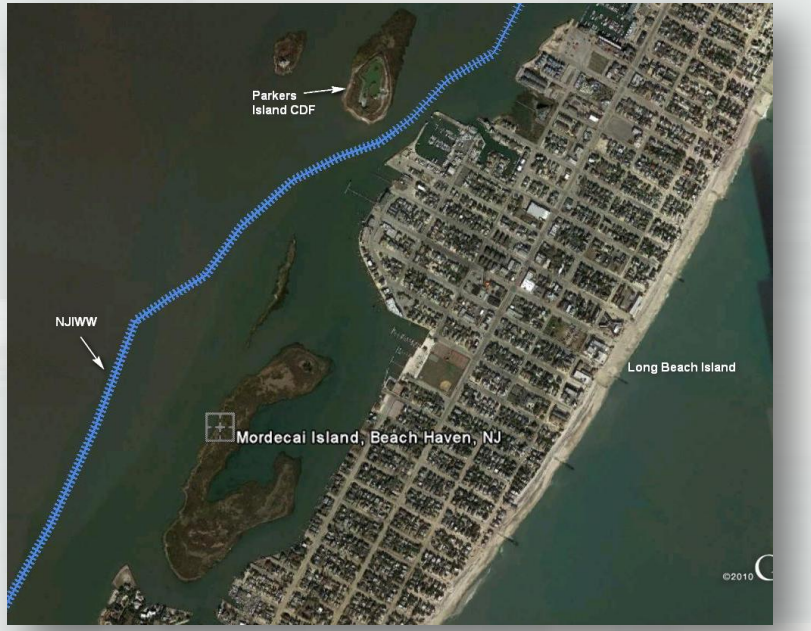


WRDA86 Codified:

- Place <u>all</u> dredged sediments in ODMDS
  - 4.0 mcy/yr, Hopper Dredge, 20 mi
  - Tripled maintenance costs
  - Starved Mobile Bay of sediment
  - Shoreline erosion; recession of wetlands and SAV
- 2014 decision reversed:
  - EWN approaches and techniques
  - RSM Interagency Work Group
- **$12M annual value**
  - Thin Layer Placement
  - Sand Island Beneficial Use Area
    - Downdrift benefits to Dauphin Island
  - Fill dredge & oyster holes
  - Gaillard Island
  - Biodegradable containment structures
    - Marsh Creation for Brown Pelican
  - Future in-bay placement:
    - TLP for 1,000 ac emergent marsh

EWN in Back Bay New Jersey

- Federal navigation channel and coastal marsh habitat damaged by Hurricane Sandy
- Restore the New Jersey Intracoastal Waterway and local marshes
- Shoal dredged as part of the 188 km long Intracoastal Waterway dredging project
- Improve coastal navigation in New Jersey
- Stone Harbor Black Skimmer habitat restored via thin-layer placement with dredged sediment from adjacent navigation channel
- Collaboration between USACE, State of New Jersey, The Nature Conservancy



Large, conventional disposal islands unsightly and unsustainable

EWN in New Jersey Back Bays

Mordecai Island

Avalon

Power of Co-Development and Demonstration

Seven Mile Island Innovation Laboratory (SMIIL)

- Collaboration and partnership building innovative NBS projects in coastal New Jersey
  - Began the conversation
  - Accelerated by a storm (H. Sandy)
  - Progressed through pilot projects
  - Now full–scale implementation

Stone Harbor

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Barrier Island: Deer Island, Biloxi, MS

- Biloxi Harbor Navigation Project – 3.65 m (12 ft) deep navigation channel
- Sediment beneficial use to restore marsh, create terrestrial and aquatic habitat, provide a more resilient shoreline for future storm events, create long term disposal capacity
- Hurricanes over time destroyed forests, significantly eroded shoreline, and left elevations too low to support marsh vegetation
- Filled breach in west end of the island
- 1.5 mcm dredged material to restore southern shoreline using 4 km long wave barrier
- Strategic vegetation plantings (625,000+ plants)
- Construction of a 0.76 mcm lagoon for BU dredged material from navigation channels
- Providing significant environmental, coastal storm, and recreational benefits

Historical Island Beneficial Use: Drake Wilson Island

- 5 ha marsh originally constructed in 1976
- Provided valuable habitat and prevented erosion into adjacent navigation channel subject to long wind fetches and strong currents
- Previously an unmanaged, low habitat value, dredged material placement site composed of sandy dredged material deposits, the island has since become a thriving marsh habitat for native wildlife
- Marsh constructed in two phases; by 1982, native plantings placed during construction completely covered the island
- Natural events breached the dike providing intertidal flow

Photos: Nathan Beane, USACE ERDC

Historical Island Beneficial Use: Drake Wilson Island

- Observations in 2019 documented several diverse habitats: natural sand deposits, pine woodlands, and high quality marsh habitat
- Provides forage and nesting sites for a variety of shorebirds, song birds, and raptors
- Successful historic beneficial use project

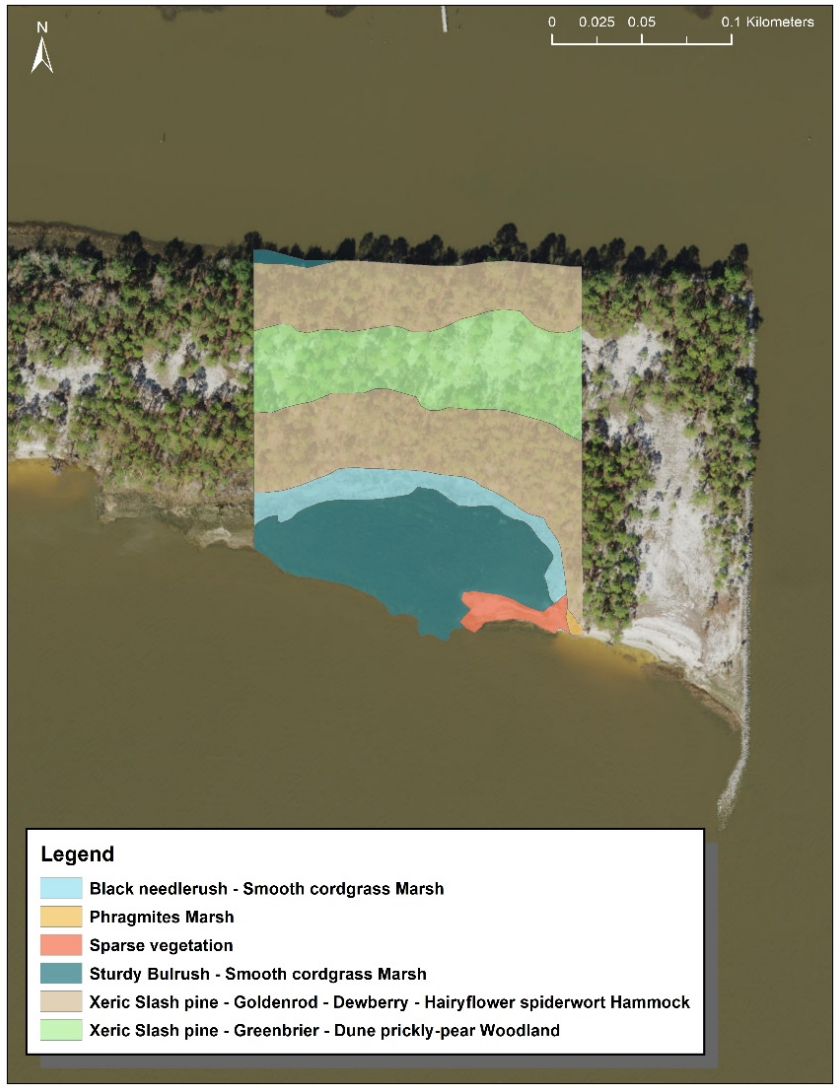


Photo: Nathan Beane, USACE ERDC

Horseshoe Bend Island

Problem

Capacity of Bankline Disposal Areas Exhausted

Preferred Alternative

Mid-River Mounding of Dredged Material

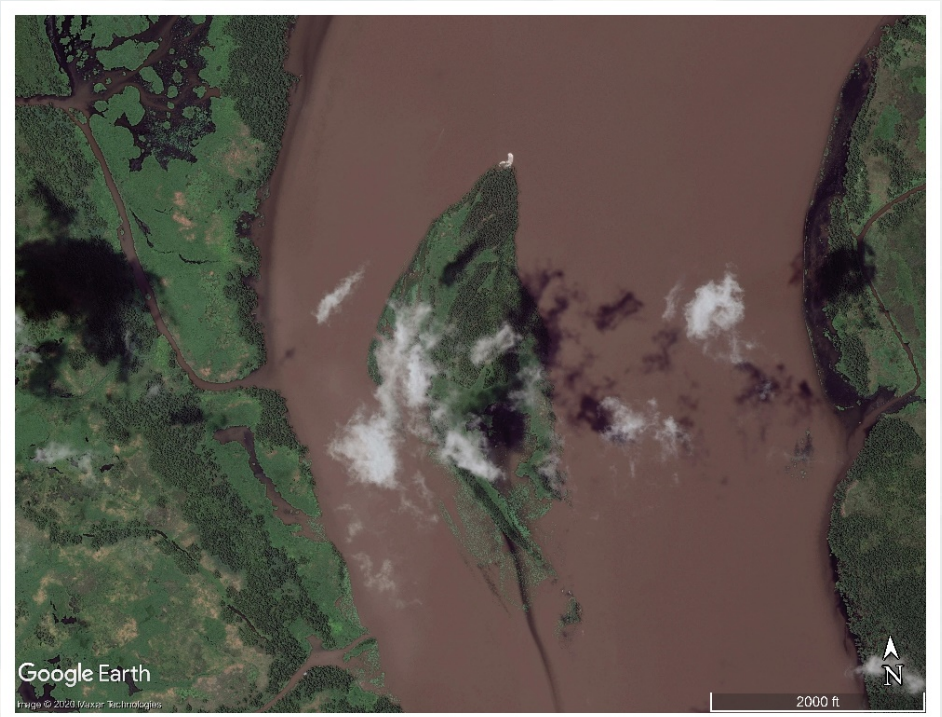
~~Conversion of Wetland Disposal Areas into Upland~~

~~Open Water Disposal in Atchafalaya Bay~~

Year	Total (ha)
2008	26.7
2009	24.4
2010	22.6
2011	28.8
2012	28.4
2013	31.2
2014	35.5

Navigation and Climate Benefits

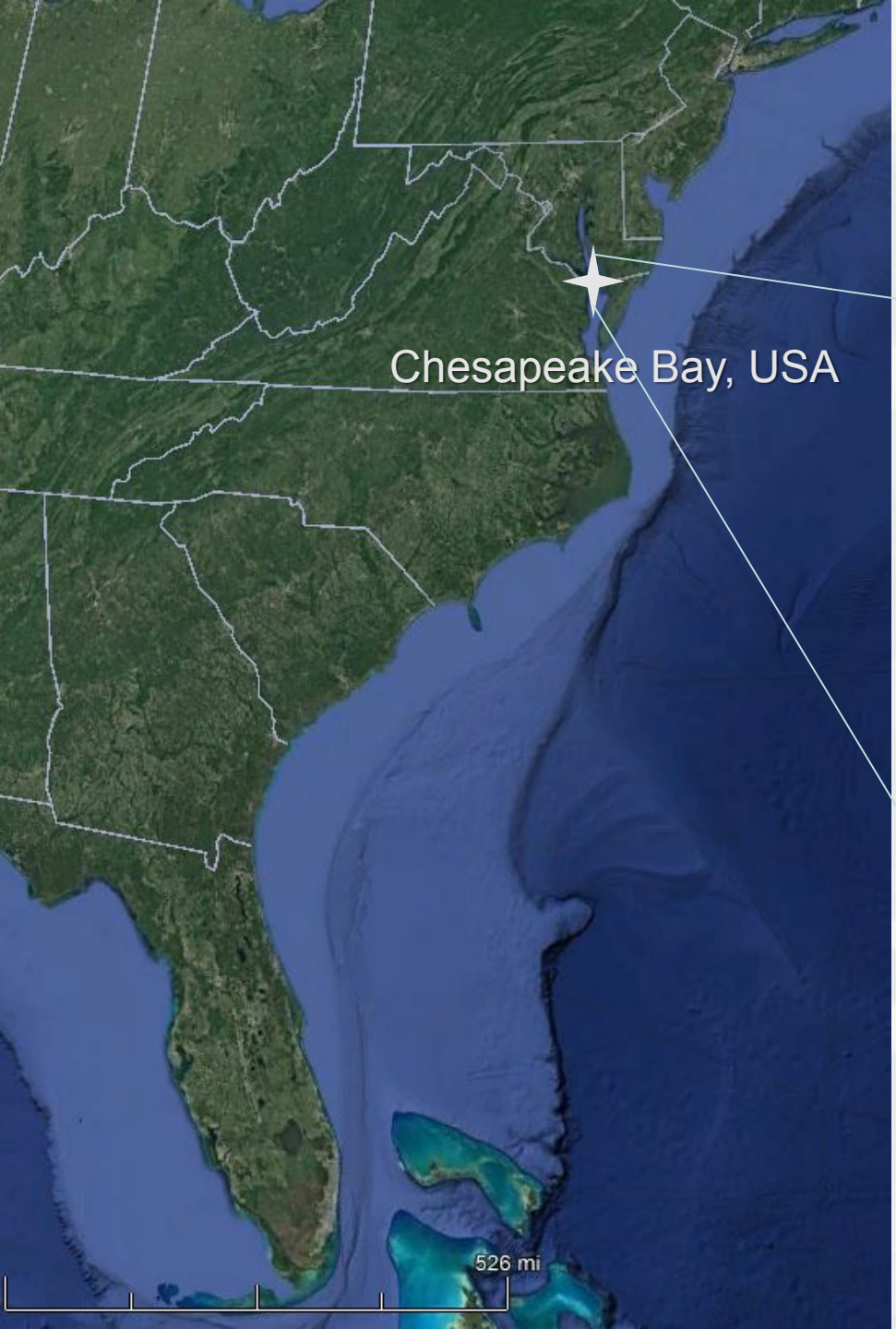
Last dredged: 2014
915,000 cy Apr-May 2019
Photo: June 2019



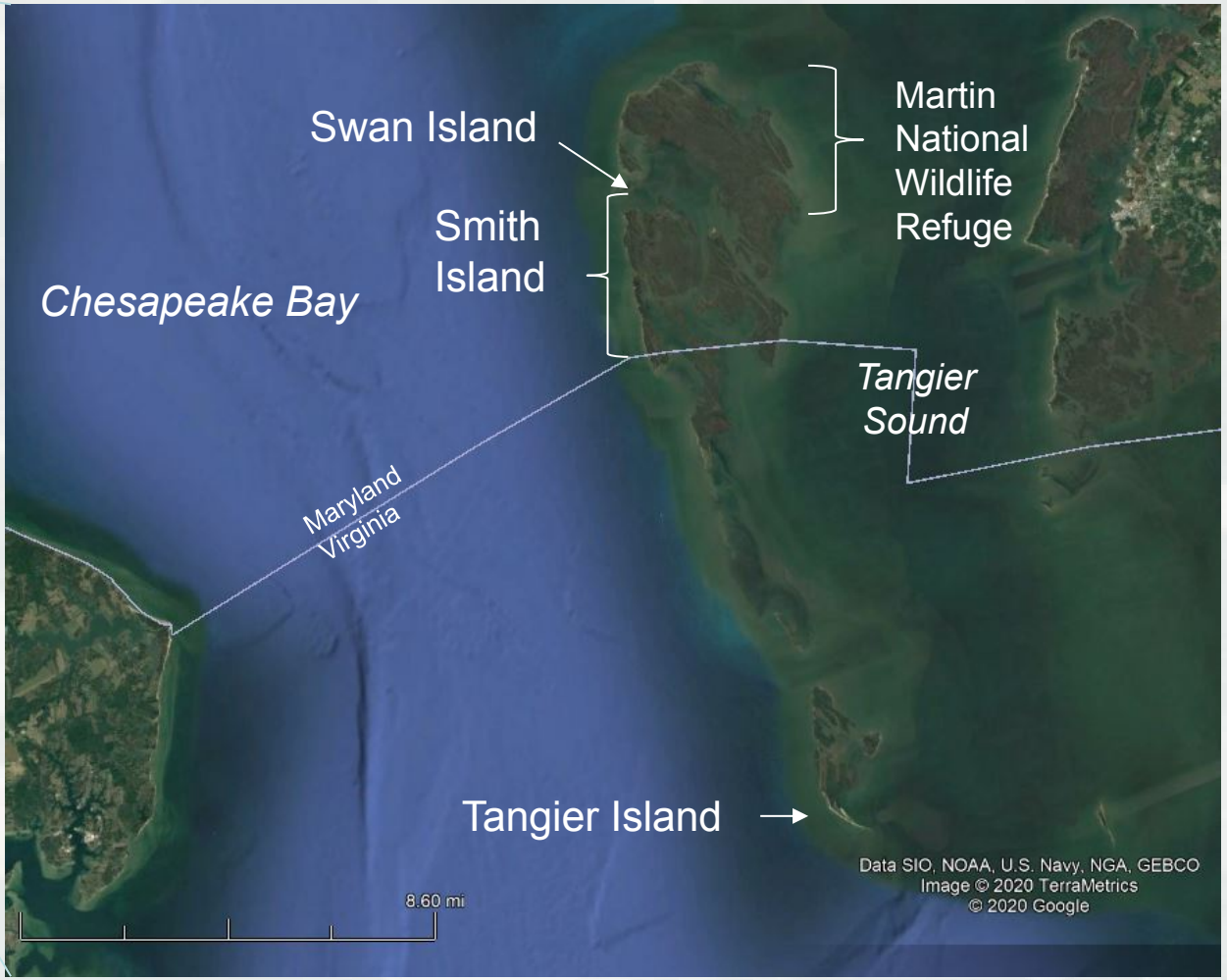
500,000 cy 10-21 Jan 2020
Photo: 30 Jan 2020

- Island formation reduced dredging requirements
- Natural channel formed east of the island due to self-scouring
- US Coast Guard realigned channel
  - channel length reduced
  - sharp bends eliminated
  - improved navigation safety
- Reduction in long-term dredging requirements
- Resultant carbon savings and reduced air pollution

Swan Island

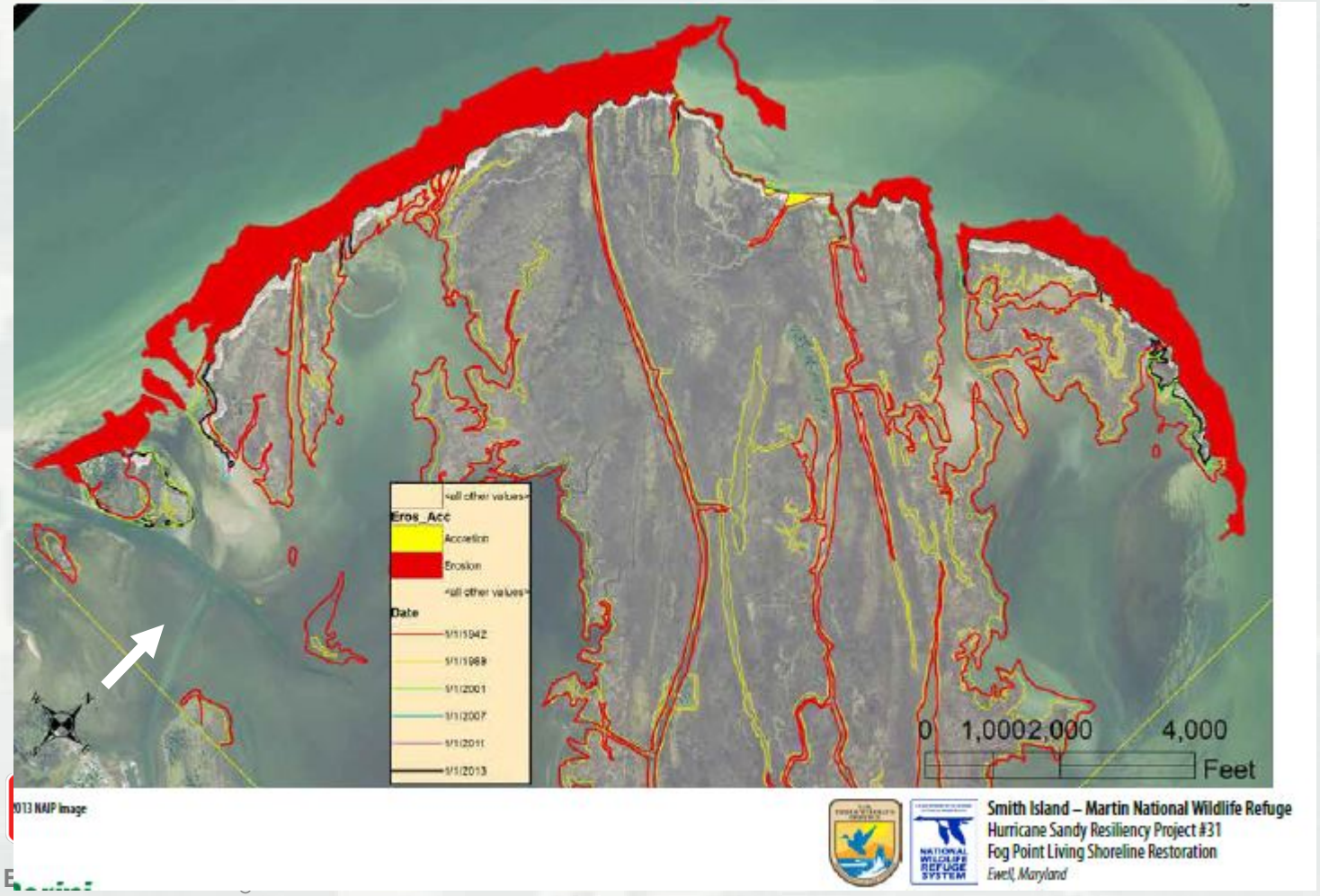


Swan Island - Chesapeake Bay, USA



Swan Island Challenges

- Erosion 2-3 meters per year for Swan Island & Martin National Wildlife Refuge since 1942
- Island fragmented, low marsh at sub-optimal elevations
- Natural wave break for Town of Ewell.



Swan Island Restoration
Sediment Beneficial Use

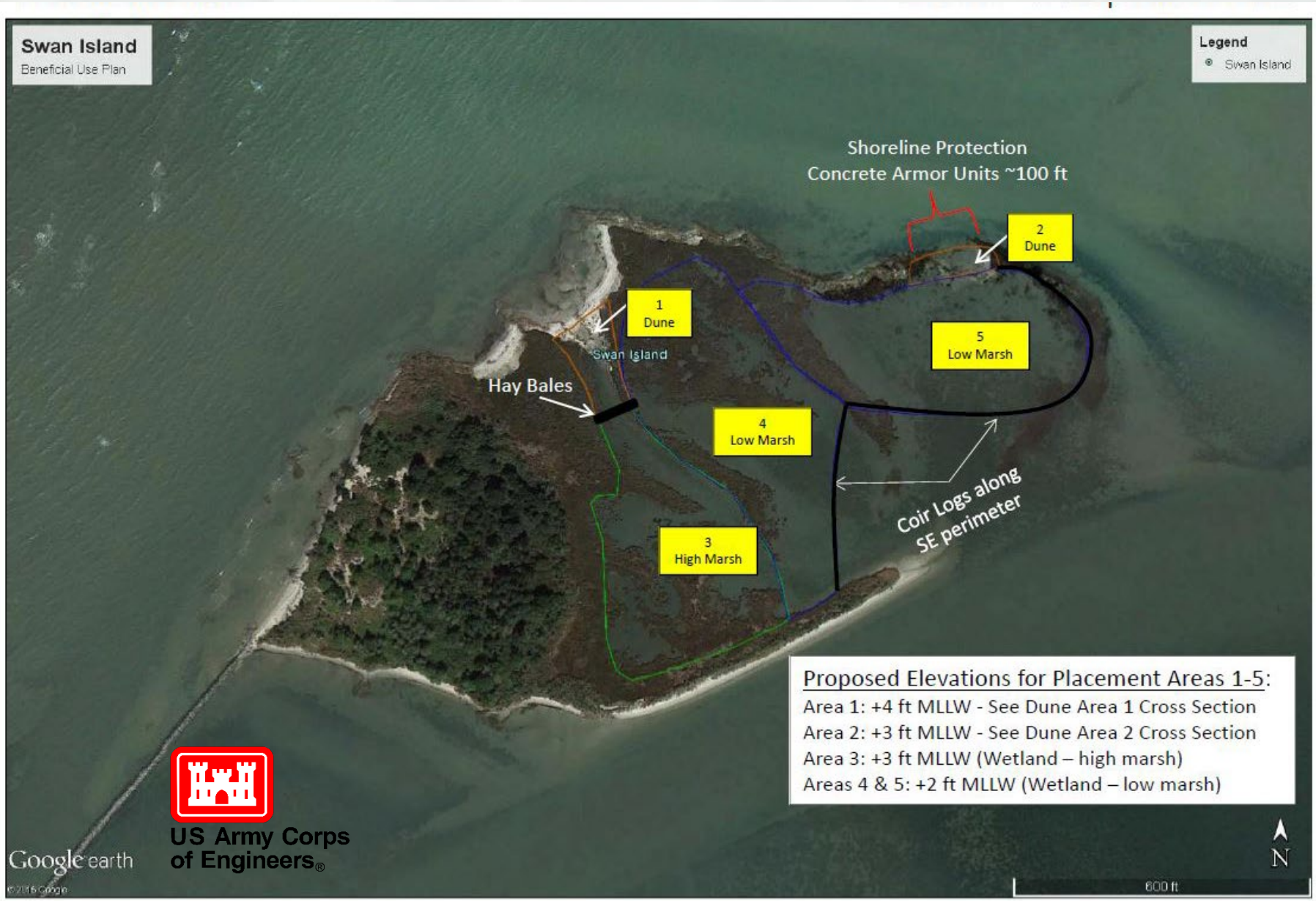
- Economic benefits from proximity to Federal navigation channel
- Social benefits to Smith Island communities
- USACE Baltimore District beneficially placed dredged sediment from Federal navigation channels (completed April 2019)
- ~ 60,000 CY, 65% silt, 35% fine grained sand

Swan Island Restoration Design

- Area 1 & 2 – Dune (+3 to +4 ft MLLW)
- Area 3 - High Marsh (+3 ft MLLW)
- Area 4 & 5 - Low Marsh (+2 ft MLLW)

- ~200,000 dune and marsh plants installed – completed July 2019

- Pre (Sept 2018) and Post-placement Monitoring (August 2019, Sept 2020)



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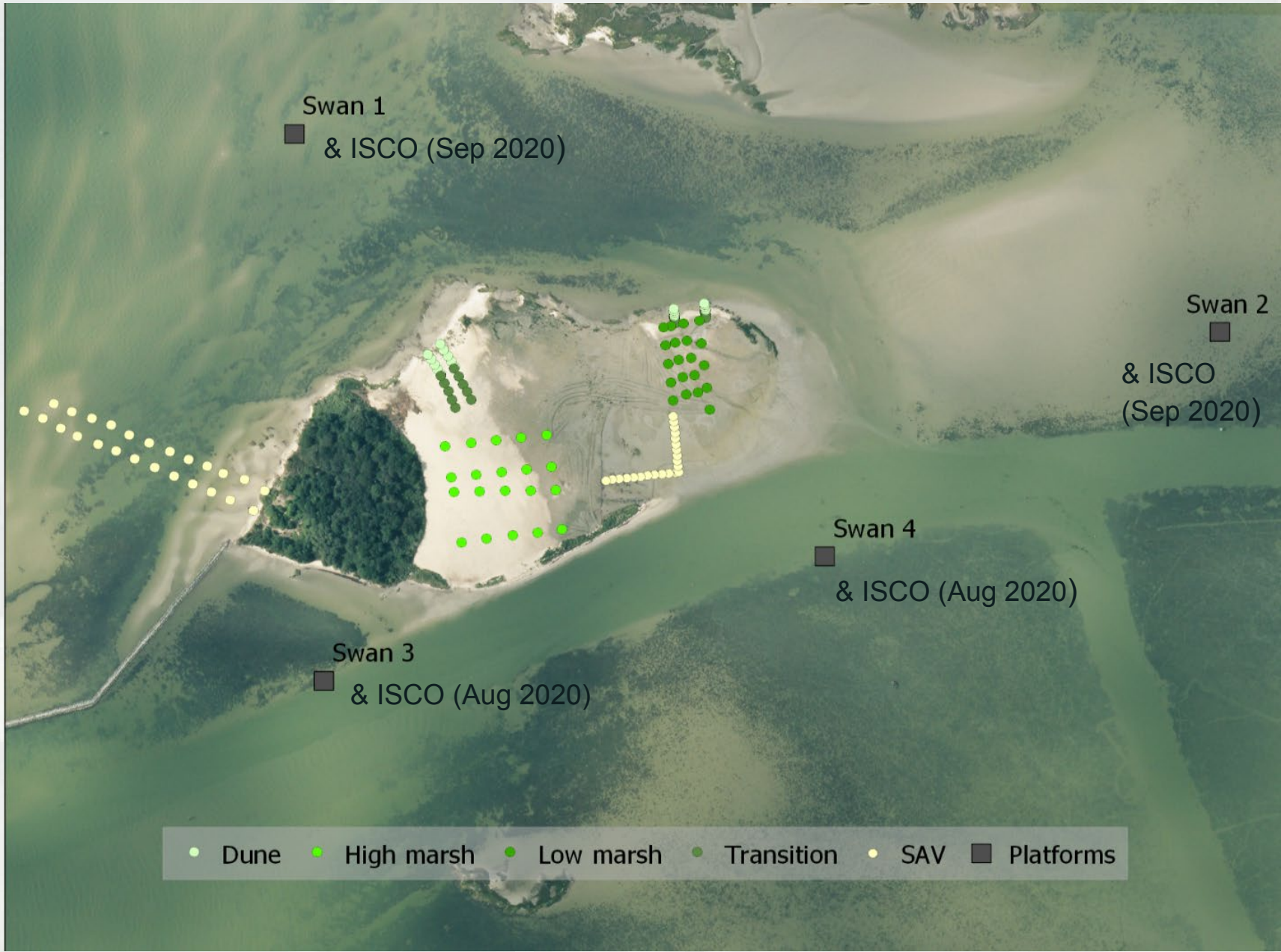
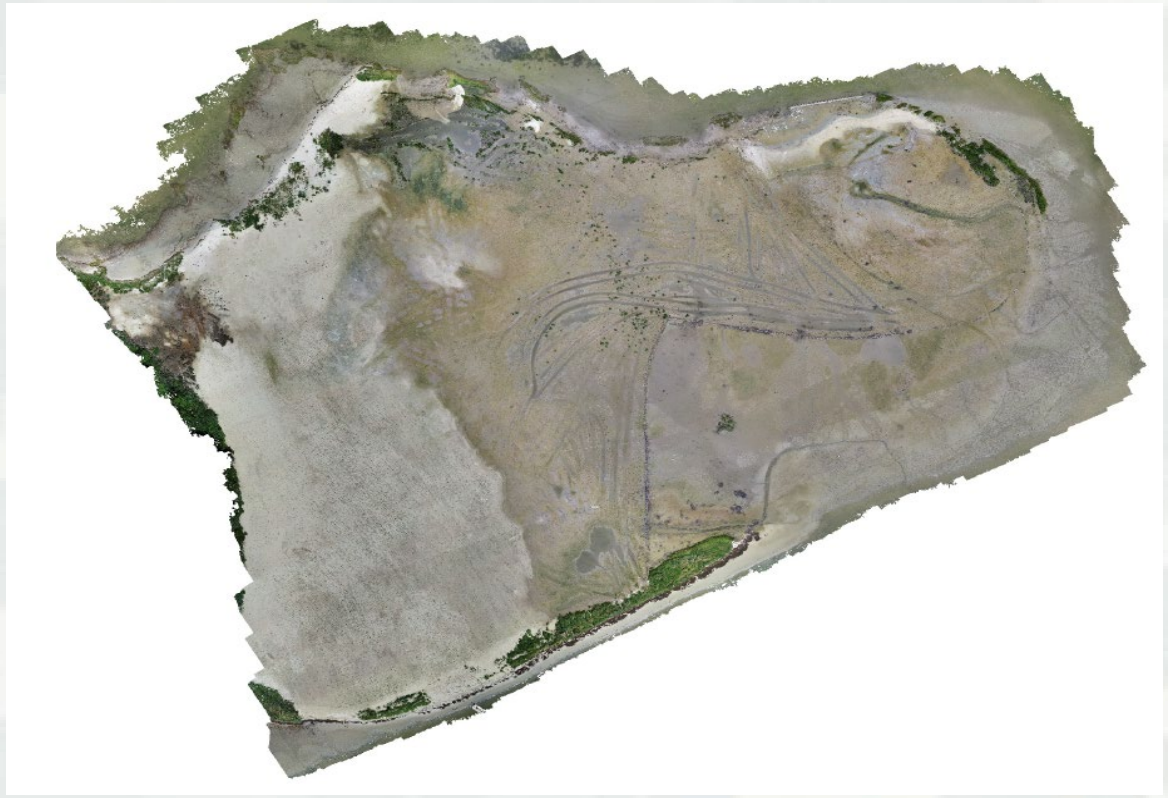
Hydrodynamic, Topographic and Ecological Parameters

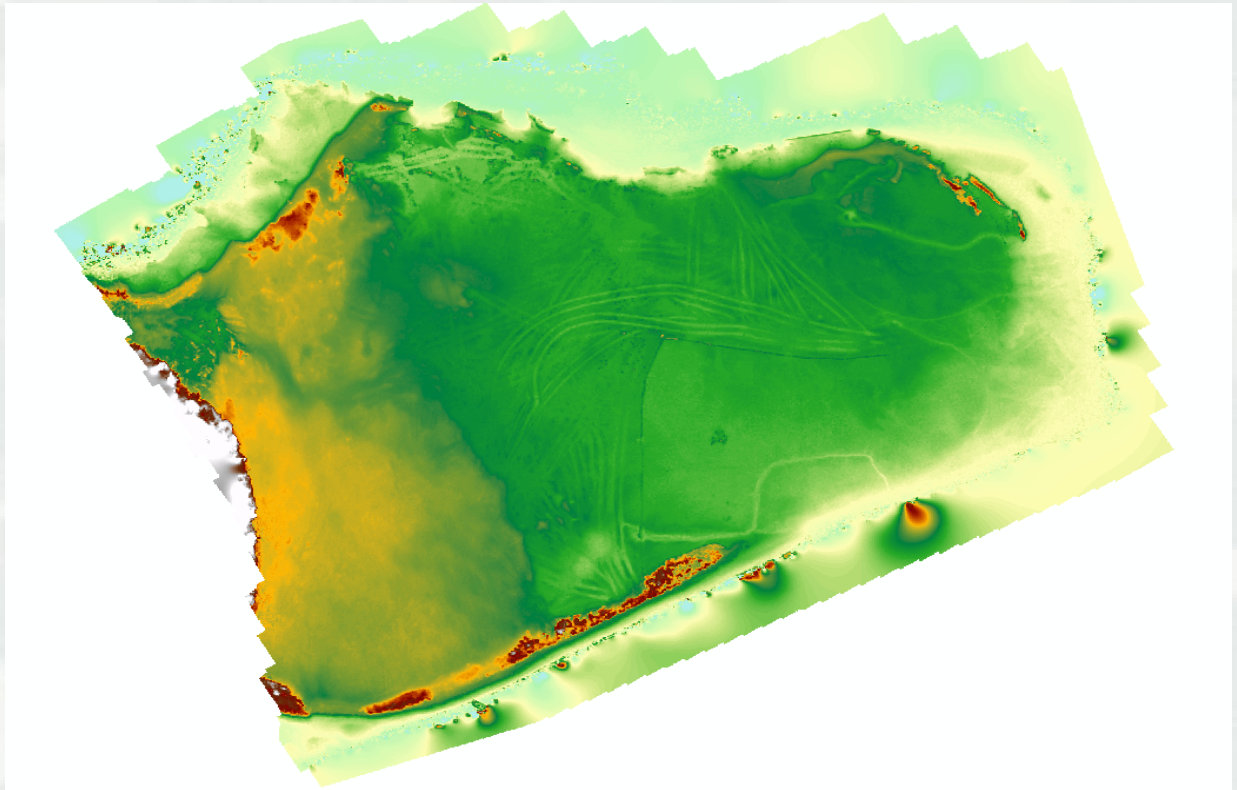
- Hydrodynamic & Water Quality – waves, currents, water level, TSS etc. (ADV and CTD, ISCO)
- Ecological – Dune, Transition, Intertidal and subtidal vegetation, sediment characteristics
- Topographic – Island elevations (using UAS), shoreline position, and elevations at all sample plots



Topographic and Ecological Parameters from UAS



Georectified composite images allow for direct comparison to future image sets (e.g., Habitat Classifications/change over time)



Digital Elevation Models (2 cm x/y, 3 cm z accuracy) (e.g., ‘cut and fill’ analysis to measure change in elevation)

Successful Collaboration

National Oceanic & Atmospheric Admin. NCCOS

Paula Whitfield, Jenny Davis

US Fish & Wildlife Service

Matt Whitbeck

Maryland Dept. Natural Resources

Becky Golden

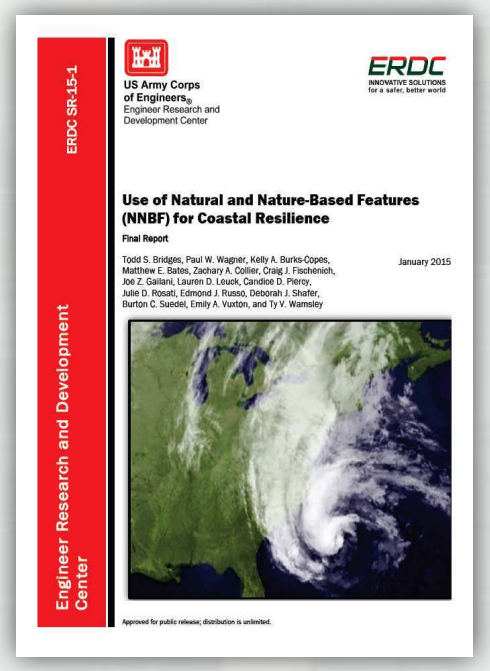
USACE Baltimore District

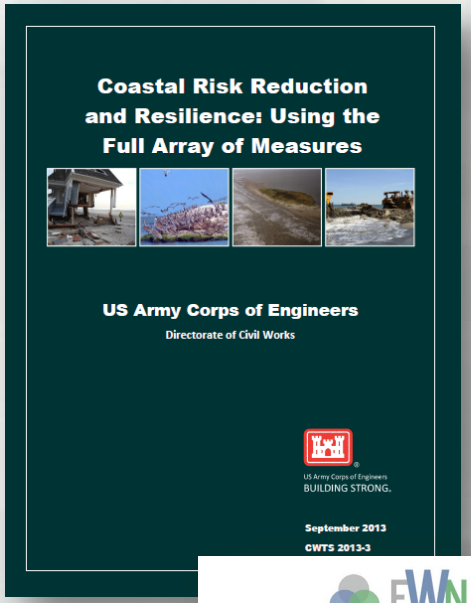
Danielle Szimanski

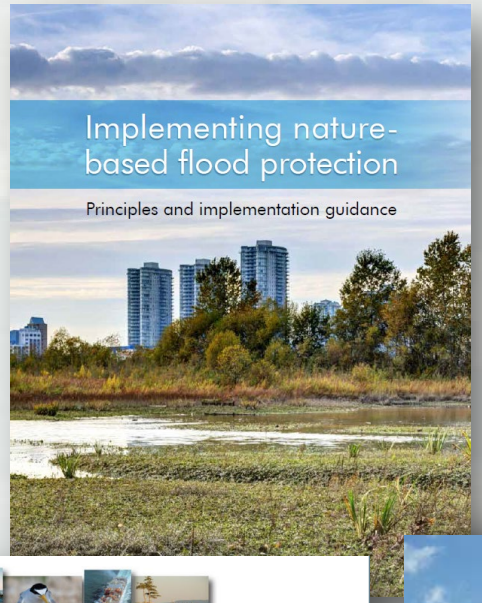
USACE Engineer Res. & Development Center

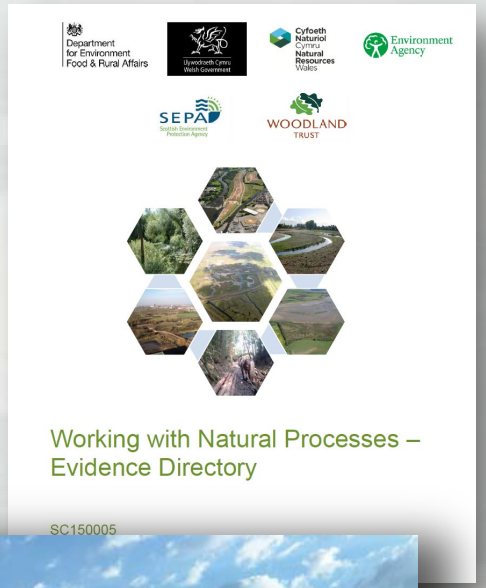
Jeff King, Brook Herman, Amanda Tritinger, Joe Gailani, Todd Swannack

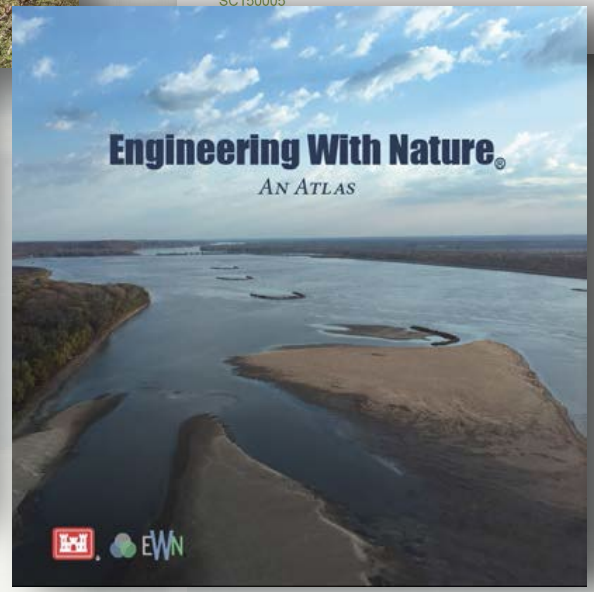
Nature-Based Guidance, Standards, Evidence to Foster Innovation











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International Guidelines on the Use of Natural and Nature-Based Features for Flood Risk Management

Goal: Draw together collection international expertise, across sectors, to develop guidelines for using NNBF for flood risk management while expanding and diversifying project value through economic, environmental and social benefits.

- Publish NNBF technical guidelines spring 2021:
  - Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - Addressing the full project life cycle
  - Guidelines in 4 Parts
    - Overarching Topics
    - Coastal Applications
    - Fluvial Applications
    - Conclusions

Engineering With Nature® Atlases

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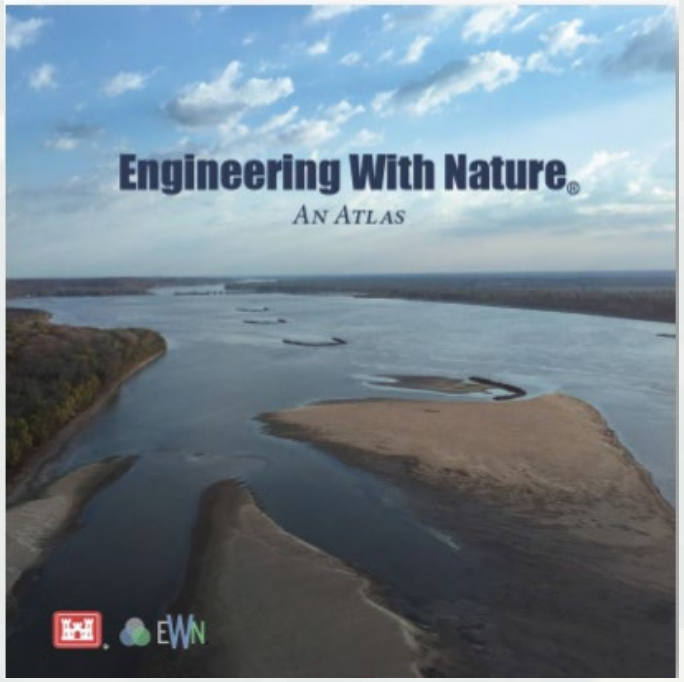

Volume 1
56 Projects
27 USACE

Volume 2
62 Projects
23 USACE

"The mission of US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation's security, energize the economy and reduce risks from disasters. Engineering With Nature supports this mission which is why it will always be an important initiative for the Corps."
LTG Scott A. Spellman, 55th Chief of Engineers, Commanding General, USACE

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The Network for Engineering With Nature (N-EWN)

- Large scale network is needed for innovation / knowledge acceleration
- Driven primarily by research community
- Aligning research with the needs of practice
- Grounding research in real projects
- EWN education: curricula and training
- Experiential learning for students – systems thinking, cross-disciplinary training
- Types of partners
  - Research – academic, private
  - Industry practitioners
  - Users and project owners
- Freely flowing communication and knowledge sharing
- Shorten road to implementation

Institute for Resilient Infrastructure Systems
UNIVERSITY OF GEORGIA

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

https://ewn.el.erdc.dren.mil/n-ewn.html

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Take Home Message

- Many opportunities to apply EWN principles through sediment beneficial use
- Focus energy to motivate and facilitate innovation in both technical and business processes
- Accelerate progress through co-development of solutions
- Elevate communication about advancing practice to enhance project value
- Promote beneficial use by documenting and demonstrating how past projects were implemented and successfully stood test of time

Thank You!

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