ENGINEERING WITH NATURE TO CREATE SUSTAINABLE VALUE

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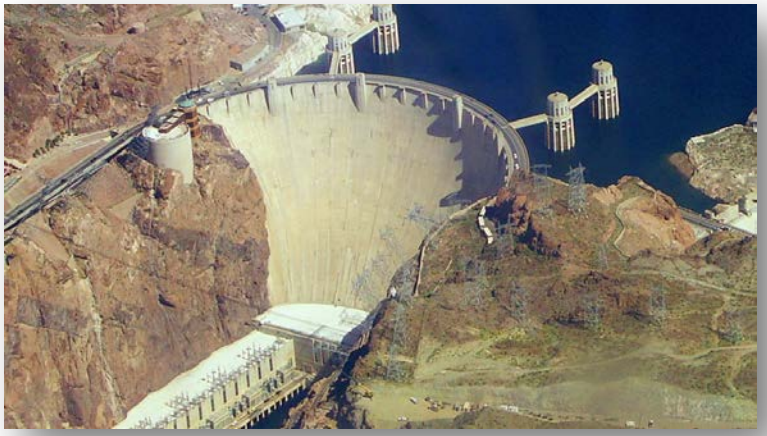
US Army Corps of Engineers

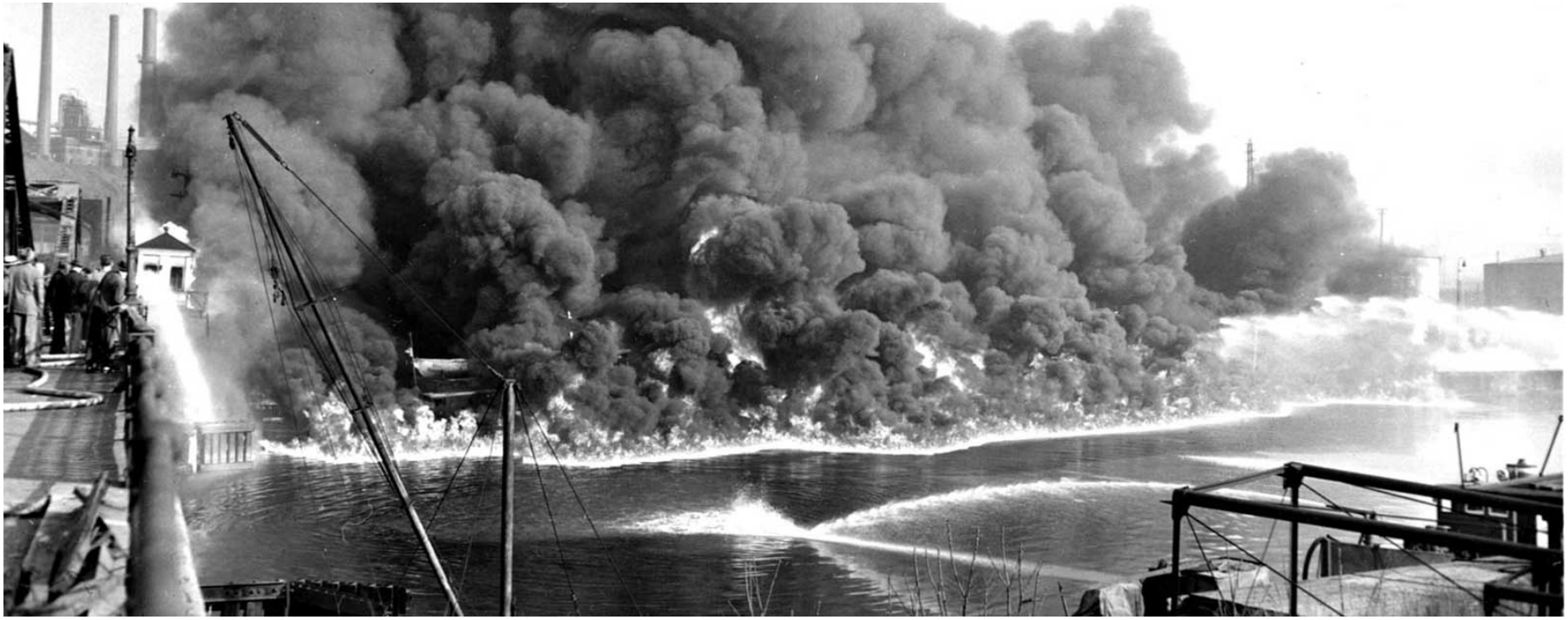
ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

1900-2000: THE CENTURY OF INFRASTRUCTURE (US)

- 4,071,000 miles of roadway
  - 47,182 miles in the Interstate system
- 149,136 miles of mainline rail
- 640,000 miles of high-voltage transmission lines
- 614,387 bridges
- 90,580 dams
- 155,000 public drinking water systems
- 4,500 military installations
- 926 ports



Cuyahoga River; Cleveland, OH

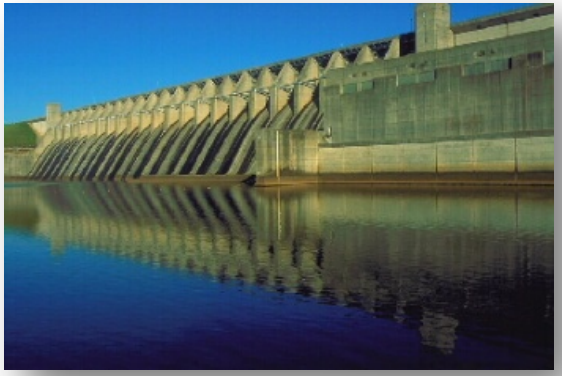


THE 1970's: THE DECADE OF ENVIRONMENTAL LAW AND REGULATION

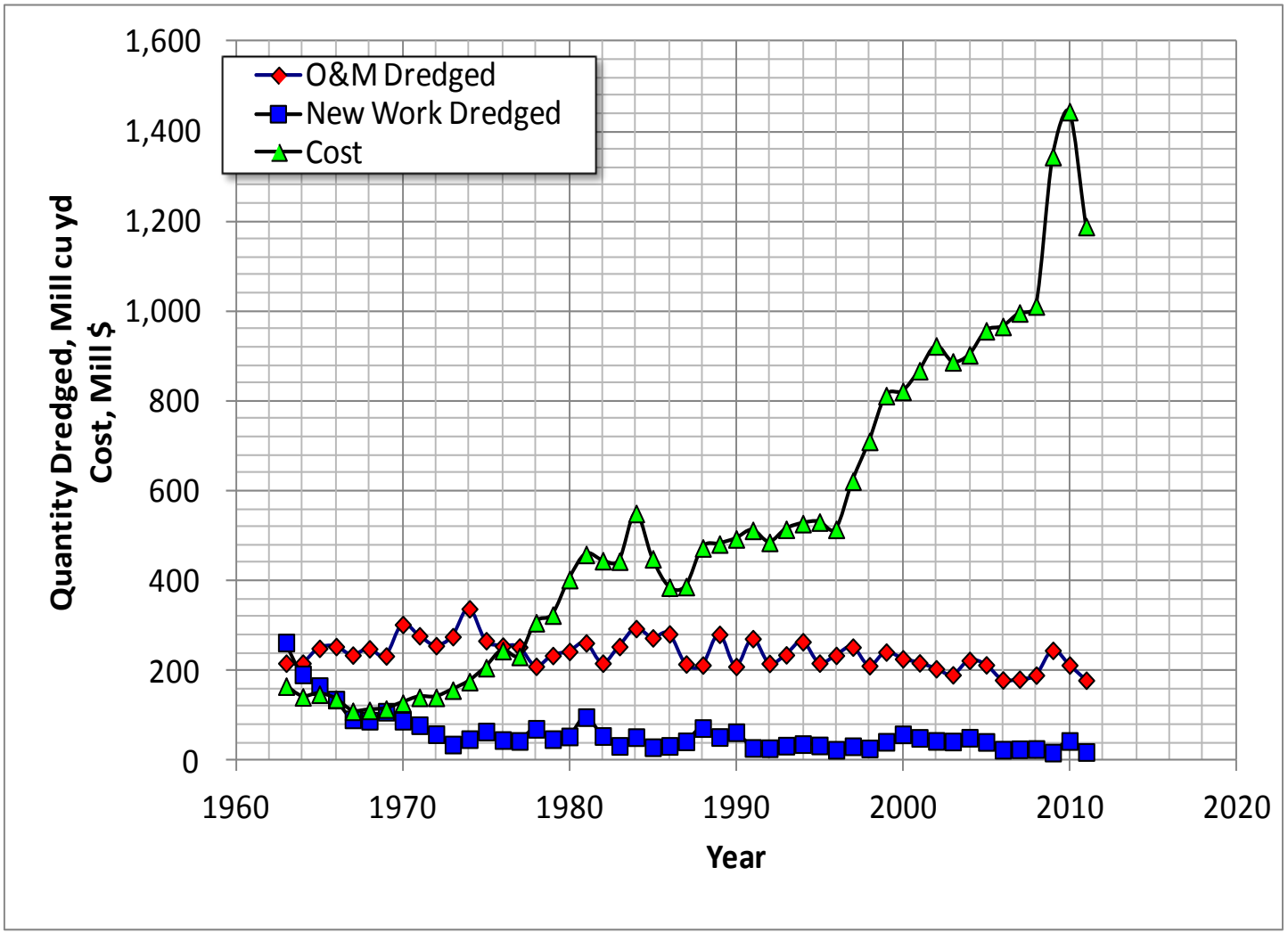
- National Environmental Policy Act of 1969
- Clean Water Act 1972
- Marine Protection, Research, and Sanctuaries Act of 1972
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- Resource Conservation and Recovery Act of 1976
- Comprehensive Environmental Response, Compensation and Liability Act of 1980

USACE INFRASTRUCTURE

- 25,000 miles of navigation channel
  - Supporting 926 ports
- 707 dams
  - 75 hydroelectric power facilities
  - 55,390 miles of shoreline
- 14,500 miles of flood levee
- 236 lock chambers at 192 lock sites
- 929 navigation structures
- 844 bridges
- 12 million acres of public land and water



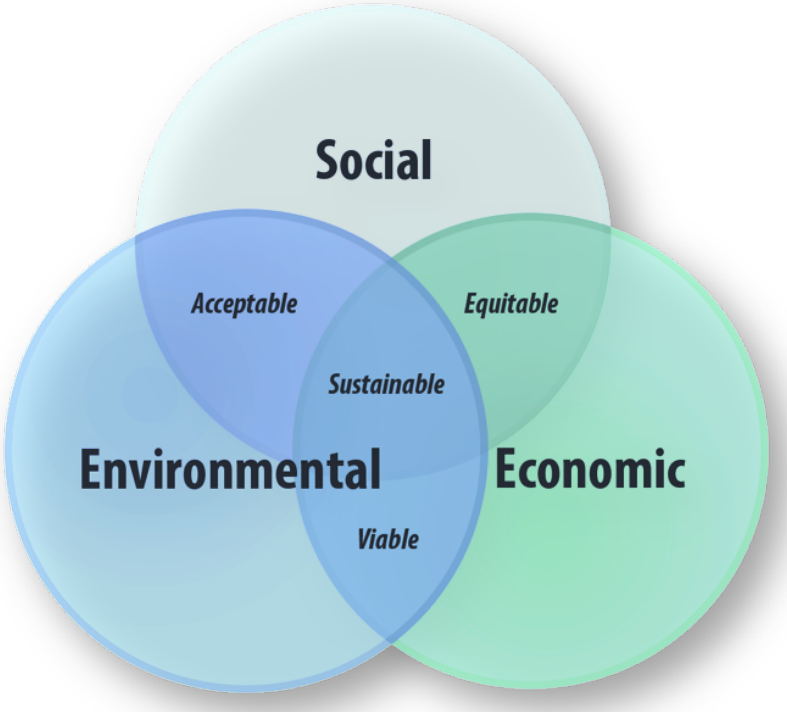
THE ESCALATING COSTS OF DREDGING




SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

SUSTAINABILITY

Sustainability is achieved by efficiently investing resources to create present and future value



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

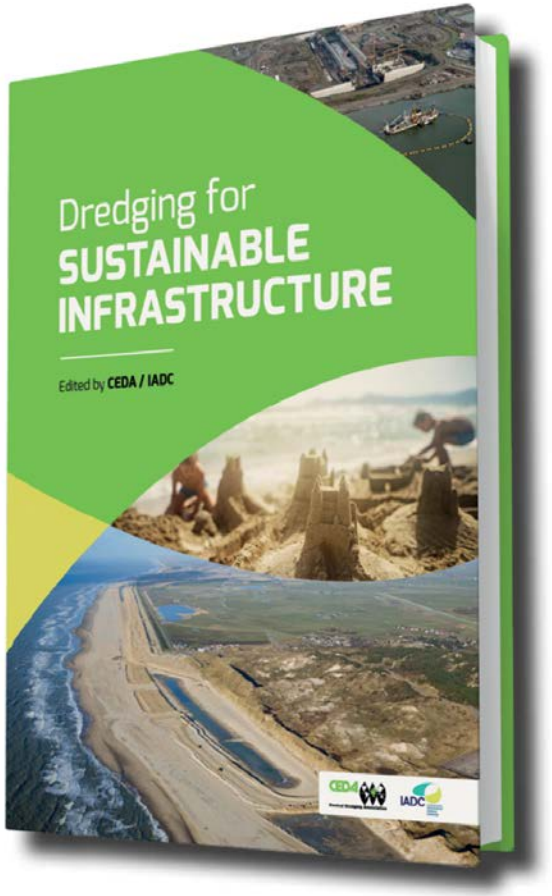
Dredging for Sustainable Infrastructure

Integrating Dredging with Sustainable Development

By Todd Bridges and Tiedo Velinga

Guiding Principles

1. *Comprehensive consideration and analysis of the social, environmental and economic costs and benefits of a project is used to guide the development of sustainable infrastructure.*
2. *Commitments to process improvement and innovation are used to conserve resources, maximize efficiency, increase productivity, and extend the useful lifespan of assets and infrastruc-ture.*
3. *Comprehensive stakeholder engagement and partnering are used to enhance project value.*

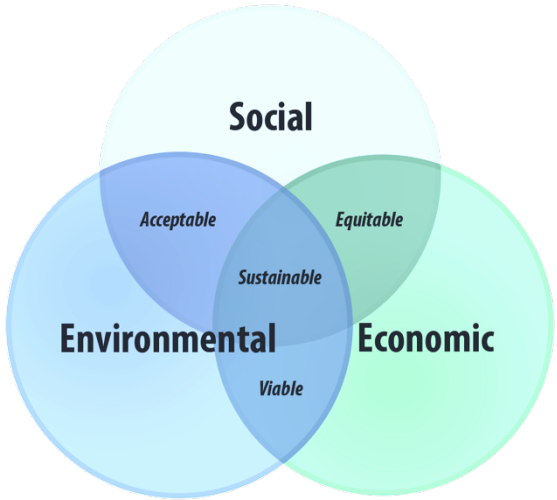


Engineering With Nature®

…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



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EWN® OVERVIEW

Engineering With Nature® initiative started within the USACE Civil Works program in 2010

- Engaging across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
  - Workshops (>20), dialogue sessions, project development teams, etc.
- Guided by a strategic plan
- 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 USACE National Award-Green Innovation
  - 2015, 2017 WEDA Awards; 2017 DPC Award

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EWN® STRATEGIC PLAN

Wave I: Broaden and Deepen Partnerships

- Build the organization and internal capacity to support, grow, and sustain EWN
- Expand by engaging districts and early adopters throughout USACE
- Expand by engaging agency partners and key external stakeholders
- Establish/expand collaboration through agreements with key international partners
- Advance EWN through effective governance

Wave II: Expand Capabilities

- Continue to develop science and technical alliances
- Leverage social science to better engage agency partners and stakeholders, and build capacity
- Expand and focus the EWN research agenda to strengthen capabilities

Wave III: Expand Applications and Communication

- Support and document multi-scale demonstrations of EWN practices
- Support and reinforce EWN progress through ongoing engagement and communication
- Enable EWN application through development of policies and guidance

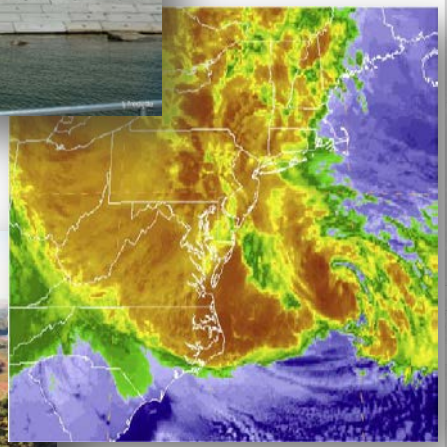
EWN® ACROSS USACE MISSION SPACE

Navigation
- Strategic placement of dredged material supporting habitat development
- Habitat integrated into structures
- Enhanced Natural Recovery

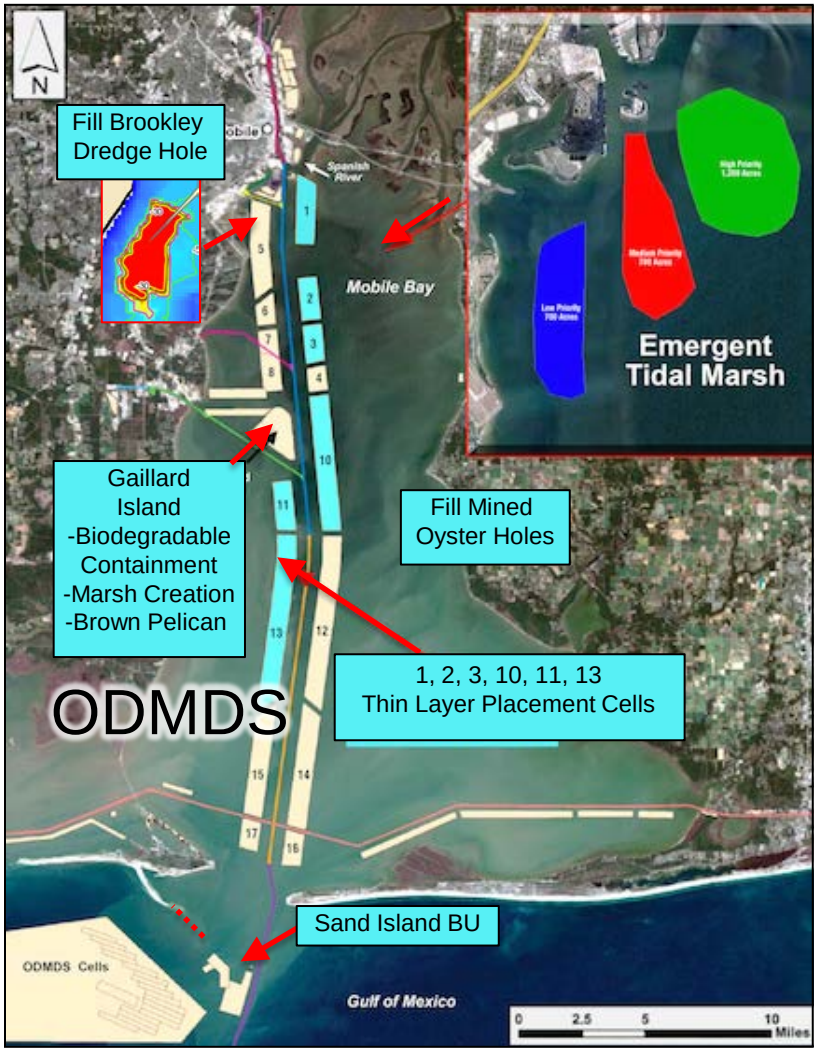
Flood Risk Management
- Natural and Nature-Based Features to support FRM
- Levee setbacks

Ecosystem Restoration
- Ecosystem services supporting engineering function
- “Natural” development of designed features

Water Operations
- Shoreline stabilization using native plants
- Environmental flows and connectivity



MOBILE BAY: APPLYING RSM AND EWN



WRDA86:

Place all dredged sediments in ODMDS

- 4.0 Mcy/yr, Hopper Dredge, 20-Miles
- Tripled maintenance costs

2014 decision reversed:

- EWN approaches and techniques
- RSM Interagency Work Group

$12M annual value

Thin Layer Placement in Mobile Bay

Sand Island Beneficial Use Area (SIBUA)

-Downdrift benefits to Dauphin Island

-Protect lighthouse

Fill dredge holes

-Brookley Hole, Oyster Holes

Gaillard Island

- Biodegradable Containment
- Marsh Creation
- Brown Pelican

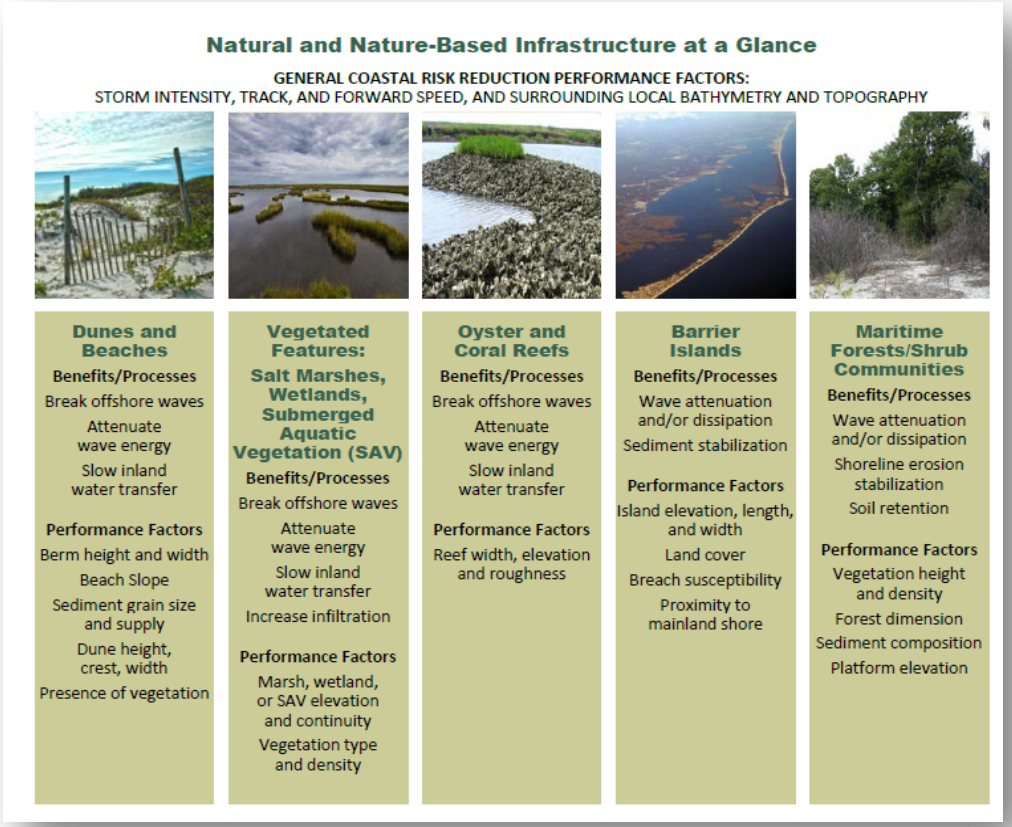
Future in-Bay placement:

Thin Layer Placement

-1000 acre emergent marsh

NATURAL AND NATURE-BASED FEATURES

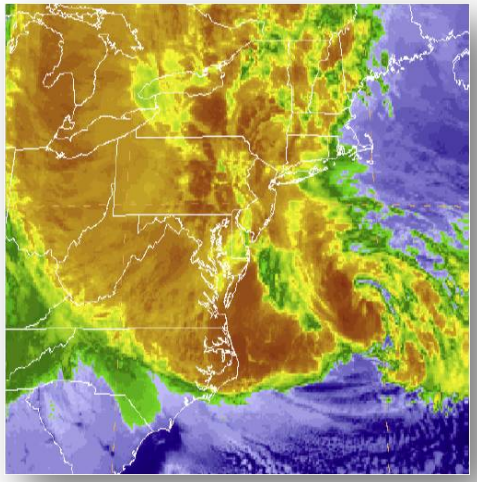
NNBF are landscape features that are developed to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.



LEVERAGING NATURE FOR ENGINEERING VALUE

Following Hurricane Sandy:

- Risk industry-based tools used to quantify the economic benefits of coastal wetlands
  - Temperate coastal wetlands saved more than $625 million in flood damages.
  - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.



COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

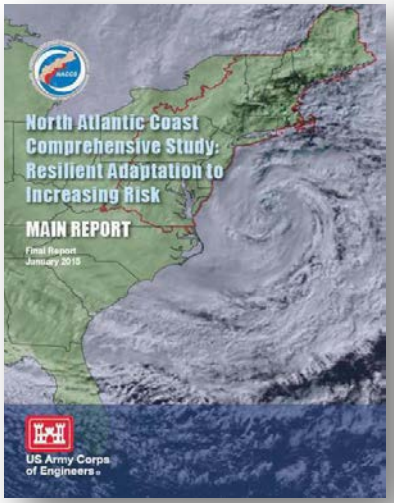
Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

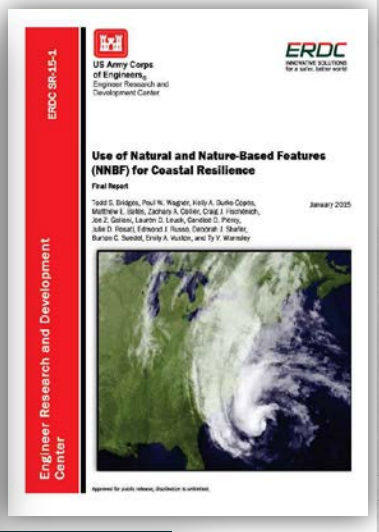
October 2016

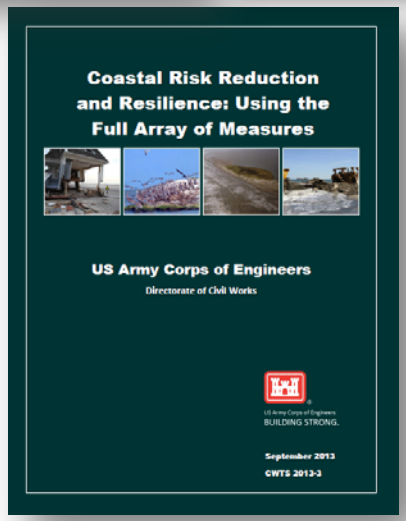
UNIVERSITY OF CALIFORNIA SANTA CRUZ · The Nature Conservancy · Wildlife Conservation Society · LLOYD'S TERCENTENARY RESEARCH FOUNDATION

RESILIENCE THROUGH INTEGRATED SOLUTIONS

"The USACE planning approach supports an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience through a combination of the full array of measures: natural, nature-based, nonstructural, and structural. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short and long term. It also considers the full range of environmental and social benefits produced by the component features."

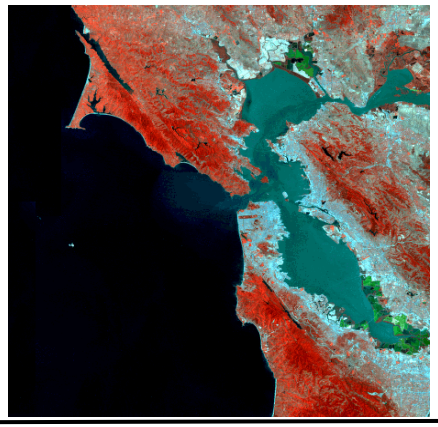






Coastal Risk Reduction and Resilience. Todd Bridges, Roselle Henn, Shawn Komlos, Debby Scerno, Ty Wamsley, and Kate White. CWTS 2013-3. Washington, DC: Directorate of Civil Works, US Army Corps of Engineers.

HAMILTON AND SEARS POINT WETLANDS SAN PABLO BAY, CA



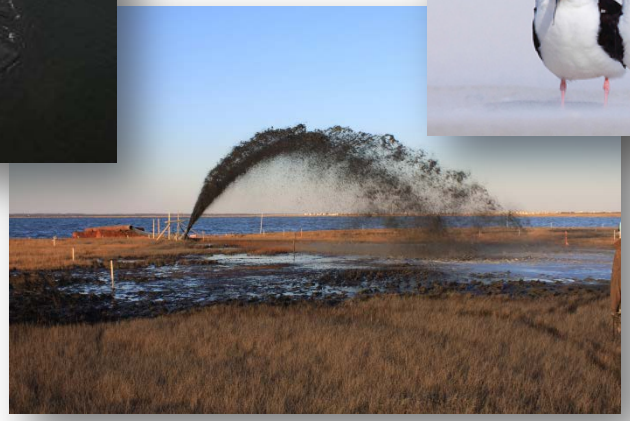
CAT ISLAND ON GREEN BAY, WISCONSIN

ONEHUNGA BAY FORESHORE RESTORATION AUCKLAND, NEW ZEALAND

USACE PHILADELPHIA DISTRICT: EWN IN BACK BAY NEW JERSEY

Mordecai Island

Stone Harbor



Avalon

HUMBER ESTUARY; ALKBOROUGH, UK (INCREASED FLOOD STORAGE CAPACITY)

FORT PIERCE CITY MARINA, FLORIDA

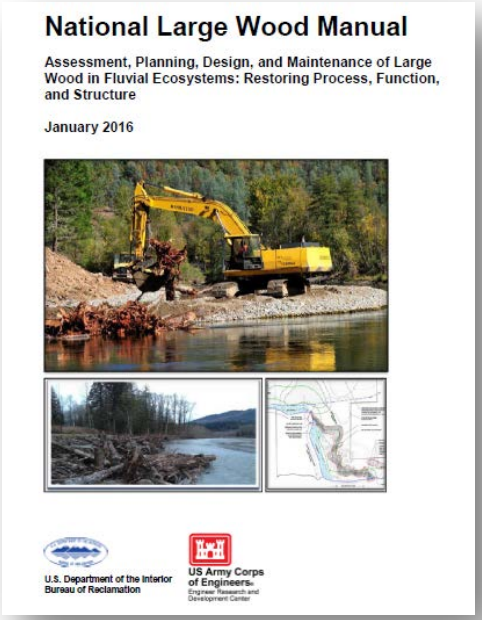
HORSESHOE BEND ISLAND, ATCHAFALAYA RIVER

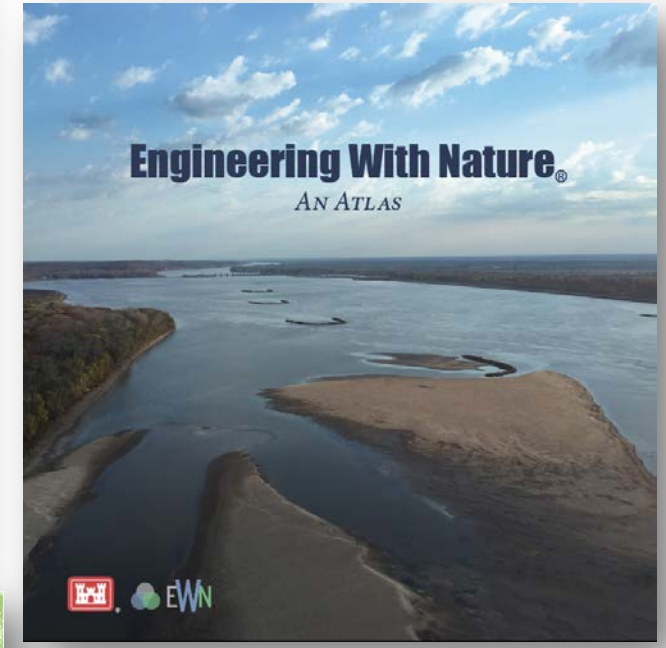
- Options for managing DM via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project Awards:
  - 2015 WEDA Award for Environmental Excellence
  - 2017 WEDA Award for CC Adaption
  - 2017 DPC Award for Working, Building, and Engineering with Nature

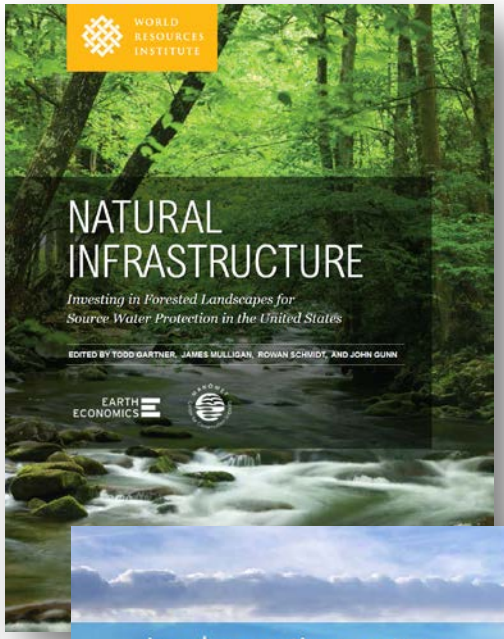
STRATEGIC SEDIMENT PLACEMENT

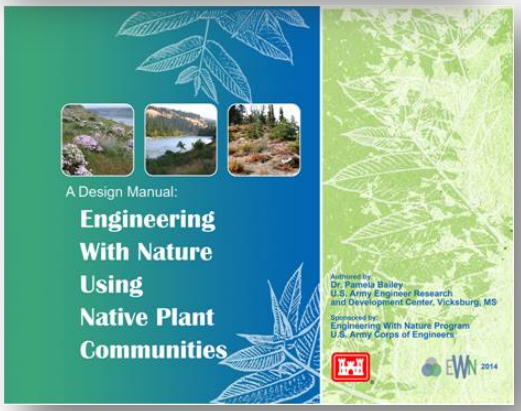
- A BIG opportunity!
- “The placement of dredged sediments in a manner that facilitates their transport by natural forces to locations of interest where sediments are needed.”
  - Recognizes the importance of sediment process to natural systems and engineering function
  - Keeps sediments in the water, where sediments belong
  - Supports sustainability

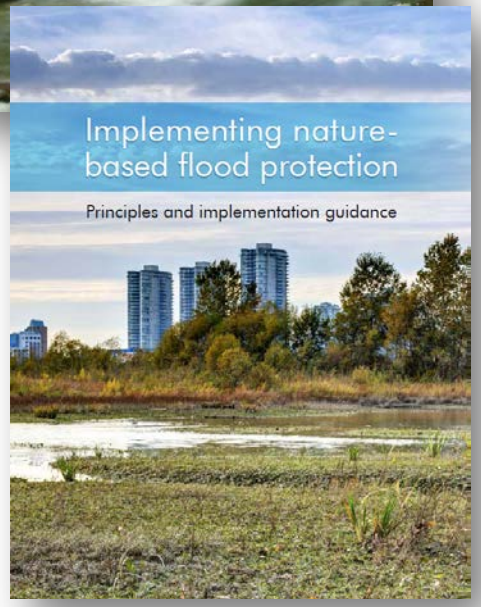
ROLE OF GUIDANCE AND STANDARDS IN *INNOVATION*











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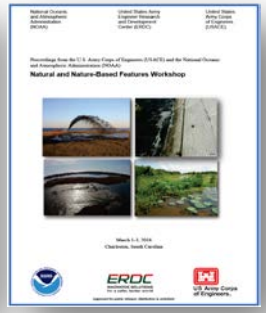
INTERNATIONAL GUIDELINES ON THE USE OF NATURAL AND NATURE-BASED FEATURES FOR SUSTAINABLE COASTAL AND FLUVIAL SYSTEMS

Purpose: Develop guidelines for using NNBF to provide engineering functions relevant to flood risk management while producing additional economic, environmental and social benefits.

- Publish NNBF technical guidelines by 2020:
  - Multi-author: government, academia, NGOs, engineering firms, construction companies, etc.
  - Addressing the full project life cycle
  - Guidelines in 4 Parts
    - Overarching
    - Coastal Applications
    - Fluvial Applications
    - Conclusions

COLLABORATION ACROSS GOVERNMENT

USACE/NOAA Collaboration Workshop: Natural and Nature-based Features, Charleston, SC; 1-3 March 2016



USACE/NOAA-NMFS Collaboration Workshop Engineering With Nature, Gloucester, MA; October 5-6, 2016

www.engineeringwithnature.org (NNBF)

COLLABORATION WITH THE PRIVATE SECTOR

- Caterpillar Inc.
  - Restoring Natural Infrastructure Summit; November 4th, 2015; New York City
  - Natural Infrastructure Initiative – USACE Collaboration Work Streams
    1. NI Opportunity Evaluation Tool. Capitalizing on enterprise-level capability: CE Dredge DST
    2. Evaluation and Decision Making
    3. Field Application and Demonstration
- Western Dredging Association (WEDA)
  - Collaborative technical workshop on engineering and construction techniques for Engineering With Nature

http://www.caterpillar.com/en/company/sustainability/natural-infrastructure.html

COLLABORATION WITH ACADEMIA

- Texas A&M University
  - Partnering through the Coastal Science and Engineering Collaborative (CSEC)
  - Joint research on NNBF
  - EWN Seminar spring 2018
  - Developing graduate curriculum to support EWN

- University of Georgia
  - Institute for Resilient Infrastructure Systems (IRIS)
  - CRADA and Educational Partnering Agreement
  - Multiple levels of collaboration on EWN and NNBF
  - EWN curriculum development

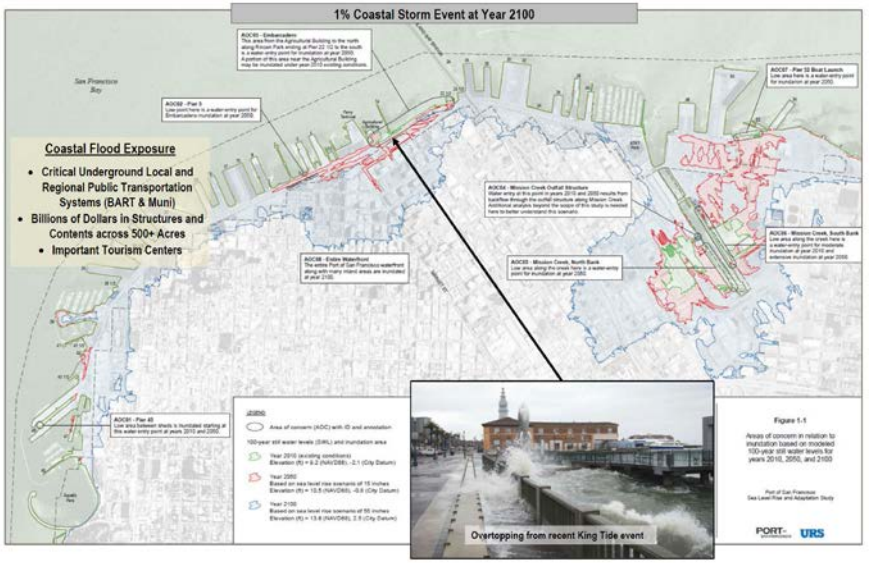
Institute for Resilient Infrastructure Systems
UNIVERSITY OF GEORGIA

PARTNERING TO GET THINGS DONE

- Integrate mandates and authorities across agencies
  - Federal, state, local
- Create vehicles to attract and integrate private investment
  - Dow-TNC and Emerson Collective workshop on “Natural Currency” at Cavallo Point on 11 September 2018
- P4s- Public-public-private partnerships

San Francisco Bay Restoration Authority

San Francisco Waterfront Storm Risk Management Study



THE MEANS

Engineering With Nature

- Commit to innovation
- Expand the “vision” to diversify project benefits
- Scale up the size of projects to fully address the needs and opportunities
- Keep the projects “real”
  - Beware of over-design, -constraint, -requirement
  - Affordability is key
- Document the produced benefits and values created
- Coordinate communication across partnering organizations for maximum impact

1906 SAN FRANCISCO EARTHQUAKE

Agnews State Hospital, 1906