Sustainable Dredging

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US Army Corps of Engineers
BUILDING STRONG®

The USACE Navigation Mission

To provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation

Navigation Dredging

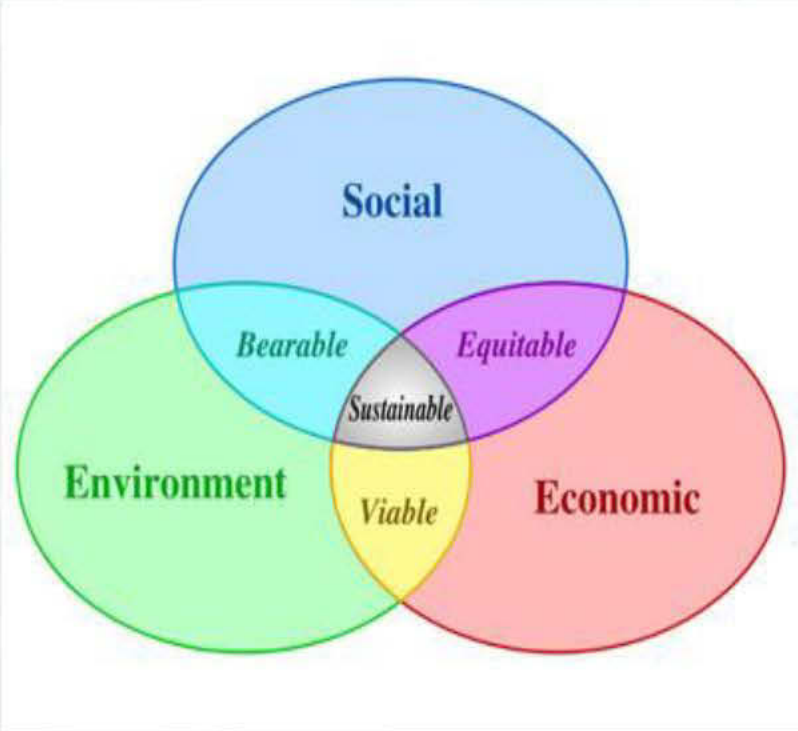
- The Problem
  - Cost and time pressures on dredging operations
  - Constraints generated from environmental issues and conflicts
- The Opportunity
  - Develop broad-based support for the navigation program
  - Change the paradigm that pits navigation interests against environmental interests

Sustainability: Past and Present

- Current paradigm: economic development occurs at the cost of environmental damage
  - The basis of relevant environmental laws and regulations
    - National Environmental Policy Act
    - Clean Water Act
    - Marine Protection, Research, and Sanctuaries Act
    - Endangered Species Act
    - Etc.
  - Federal Standard: least costly environmentally acceptable alternative

Sustainability: The Future

- Past: maximize economic benefits while minimizing environmental damage
- Future: expand and optimize the distribution of benefits within the system, i.e., across all three sustainability domains



Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Brundtland Commission

Sustainability: Looking Forward

- Applying the principles of sustainability to navigation dredging
  - For example:
    - Extending the life of CDFs by applying DM to restore aquatic habitat
      - provides environmental, social, and economic benefits (e.g., conserved CDF capacity)
    - Constructing features and/or habitat to enhance navigation channel performance
    - Reducing energy usage and the carbon footprint associated with operations

Sustainability: Programmatic Benefits

- Reduced costs and delays
  - Environmental agencies retain considerable flexibility and latitude in pursuing their mandates
    - Sustainability model (expanding benefits) will incentive cooperative behavior
  - Beneficial alignment of physical processes serving navigation
    - E.g., extracting benefit from the work of natural processes
- Expanded benefits will lead to broader support
  - E.g., navigation recognized as supporting a broader array of benefits and services
- Win-win-win solutions provide the basis for maximizing returns on investment over the long-term

Sustainability and PIANC's "Working with Nature"

- Developed as a position paper by PIANC's Environmental Commission in 2007-2008
- Endorsed by PIANC Executive Committee
- Broad support within the international dredging community
- Aims to provide a practical framework for sustainable navigation infrastructure development

Sustainability and WwN

PIANC Position Paper

'Working with Nature'

October 2008

What do we mean by 'Working with Nature'?

Maximising opportunities; reducing frustrations. **Working with Nature** is an integrated process which involves working to identify and exploit win-win solutions which respect nature and are acceptable to both project proponents and environmental stakeholders. It is an approach which needs to be applied early in a project[1] when flexibility is still possible. By adopting a determined and proactive approach from conception through to project completion, opportunities can be maximised and - importantly - frustrations, delays and associated extra costs can be reduced.

*The World Association for Waterborne Transport Infrastructure, formerly the Permanent International Association of Navigation Congresses

Sustainability and WwN
Builds on USACE Goals

US Army Corps of Engineers®

ENVIRONMENTAL OPERATING PRINCIPLES

One Corps Serving The Army and the Nation

Further information is available at: **http://www.usace.army.mil**

EOPs especially relevant to the concept

Environmental Sustainable Housing Fort Lee, VA

Wetlands at Melvin Price Lock and Dam

Endangered Whooping Crane Aransas National Wildlife Refuge, Texas

1. Strive to achieve Environmental Sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.

2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.

3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that

2009
US Army Corps of Engineers' Campaign Plan

Campaign Plan goals especially relevant to the concept

Goal 2: Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.

Objective 2a: Deliver integrated, sustainable, water resources solutions.

Objective 2b: Implement collaborative approaches to effectively solve water resource problems.

Objective 2c: Implement Streamlined and Transparent Regulatory Processes to Sustain Aquatic Resources.

Working with Nature: *The US Translation*

- Intentional expansion of benefits to achieve win-win-win outcomes
- Makes full use of purposeful coordination of natural and engineering processes to achieve more value (more benefits at lower costs)
- Starts with focus on achieving project objectives within an ecosystem context
  - Rather than assessing consequences of a pre-defined design and minimizing ecological harm

WwN is a Natural and Progressive Expansion of Beneficial Use and Regional Sediment Management

RSM is a systems approach for efficient and effective management of sediments in our Coastal, Estuarine, Riverine, and Watershed environments

- **Manage local projects and sediments within the regional context**
- **Consider sediments as a regional resource for beneficial uses**
- **Support sustainable solutions for navigation and dredging, flood and storm damage reduction, and ecosystem restoration**
- **Communicate and collaborate – USACE, Stakeholders, and Partners**

Beneficial Uses of Dredged Material

- WwN includes, but is more comprehensive than, “traditional” notions of BU
- In 2011, DOER initiated new project on “Managing Dredged Material For Beneficial Use”
  - Engineering for reducing the costs of BU (e.g., long distance conveyance, etc.)
  - Science for documenting the environmental benefits of BU
  - Economic benefits/costs of BU
  - Strategies and plans for resolving regulatory impediments to accelerate project schedules

Working with Nature Examples

- Habitat construction
- Open-water disposal of dredged material
- Inland systems
- Coastal systems

Familiar Examples

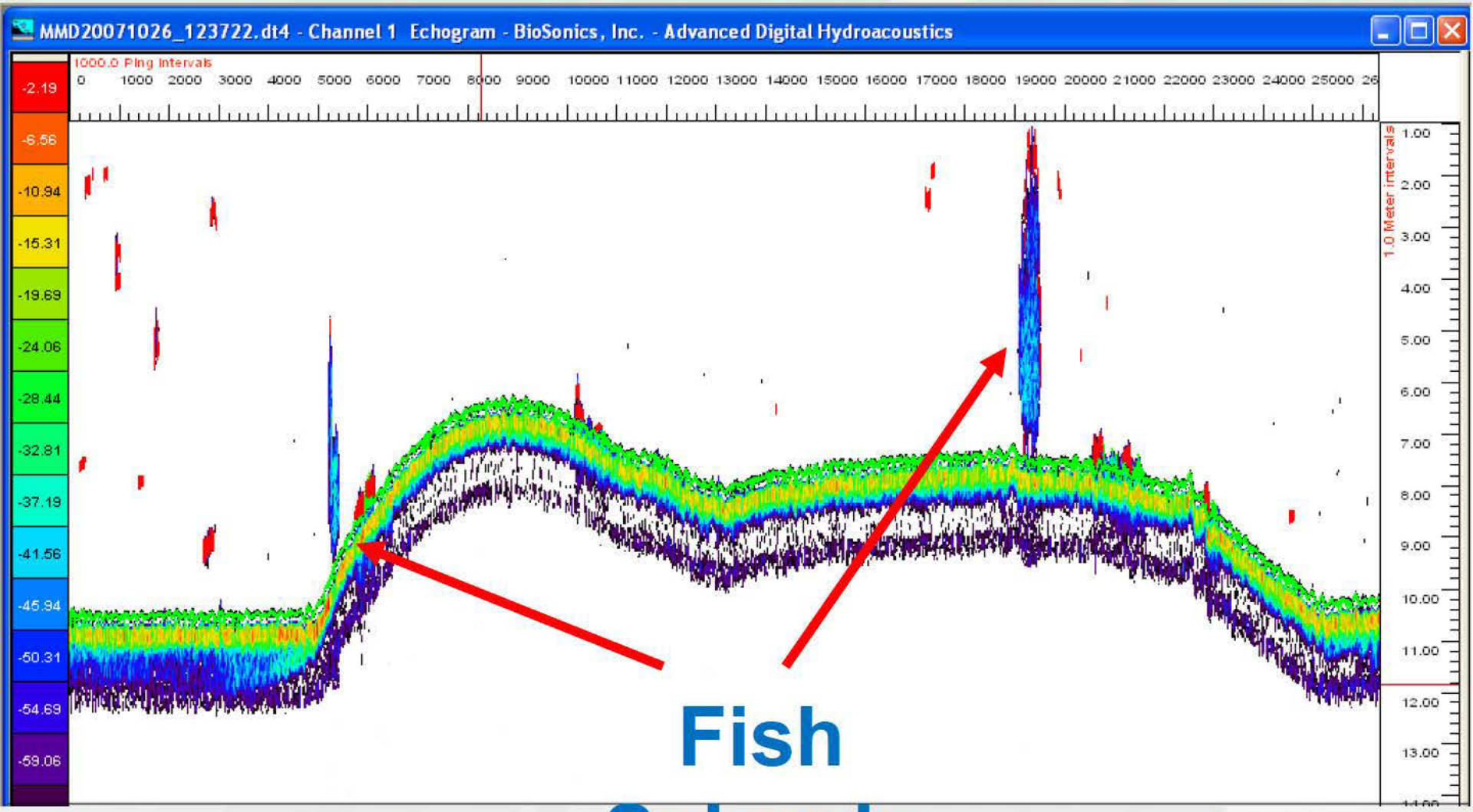
Poplar Island

Times Beach, NY

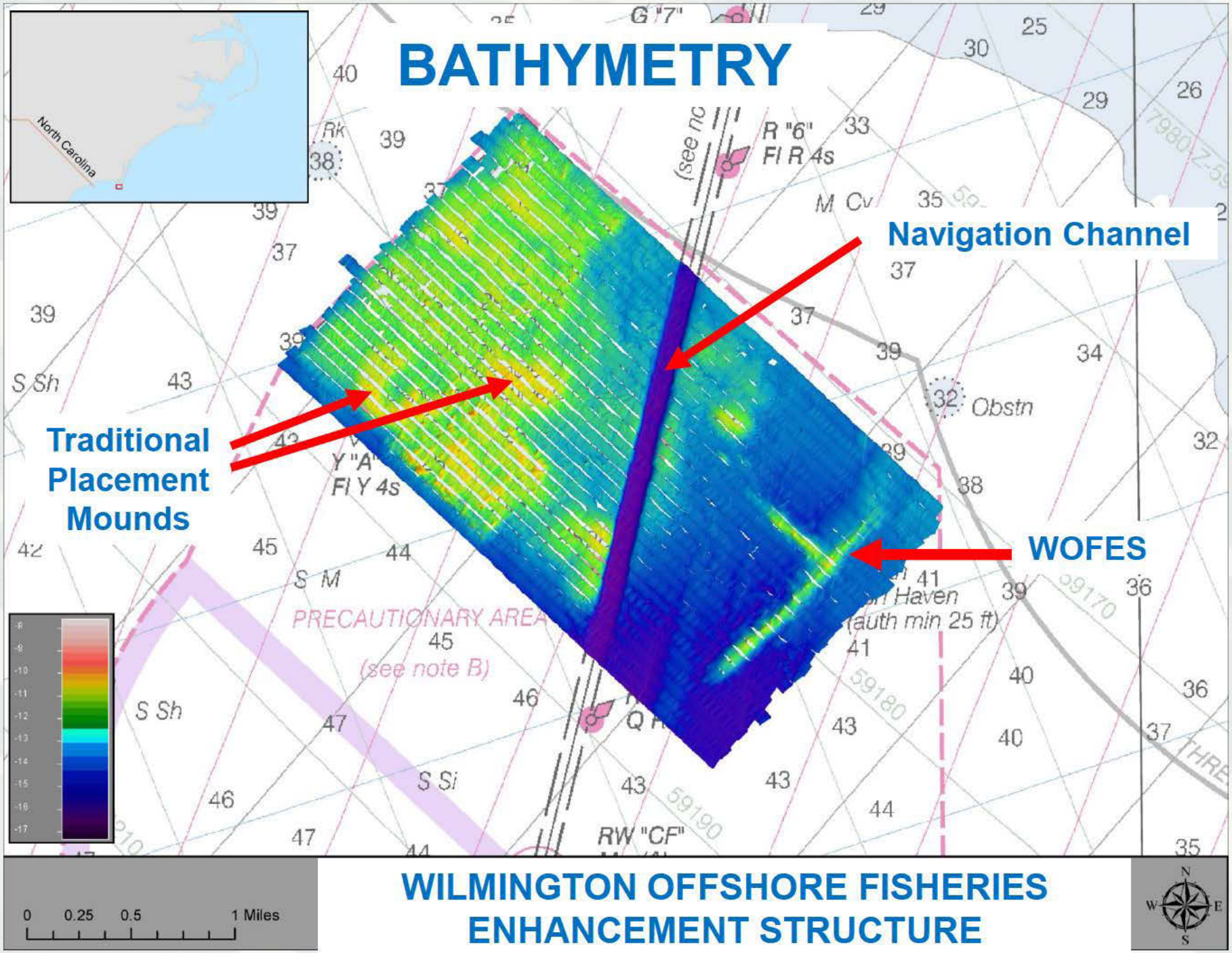
Hart-Miller Island

Bird Island in Le Havre, France

MOBILE OFFSHORE DREDGED MATERIAL MOUND

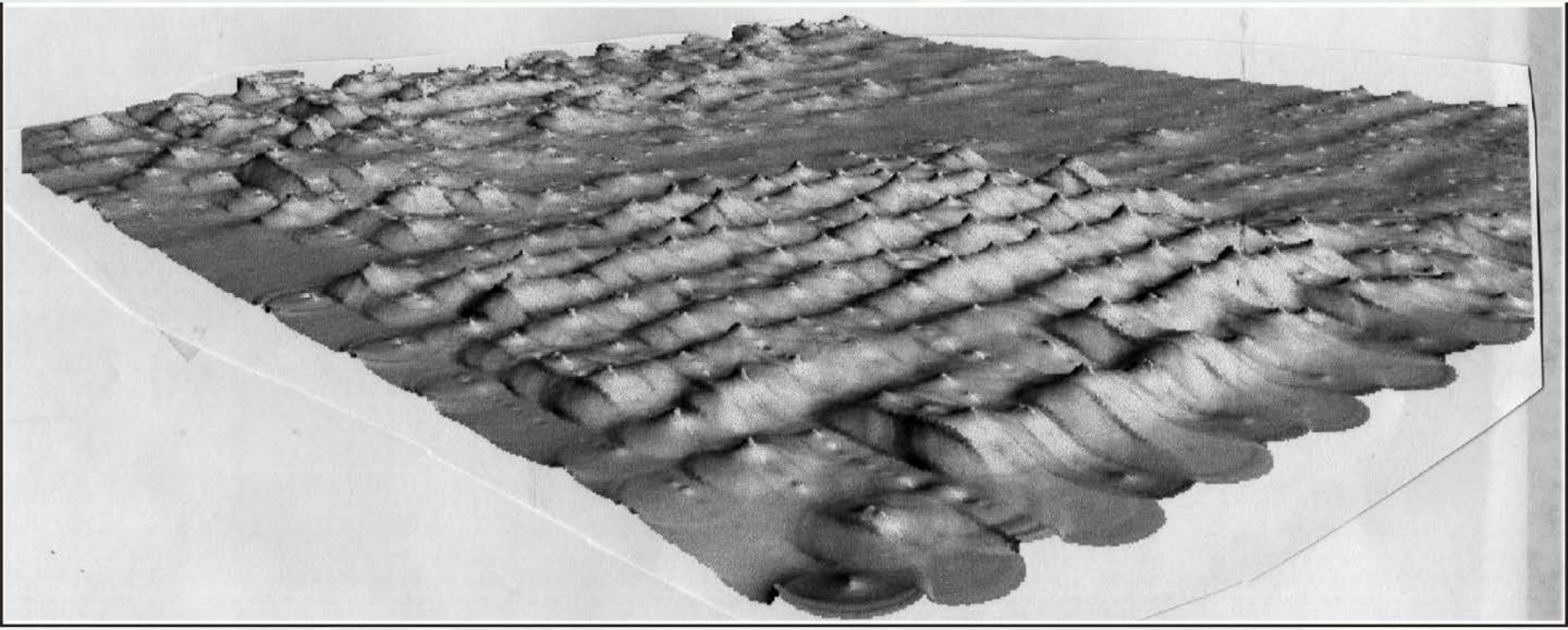


Fish Schools


BATHYMETRY
North Carolina
Navigation Channel
Traditional Placement Mounds
WOFES
PRECAUTIONARY AREA
(see note B)
R "6"
Fl R 4s
Y "A"
Fl Y 4s
Obstn
RW "CF"
0 0.25 0.5 1 Miles
WILMINGTON OFFSHORE FISHERIES ENHANCEMENT STRUCTURE
N
S
E
W

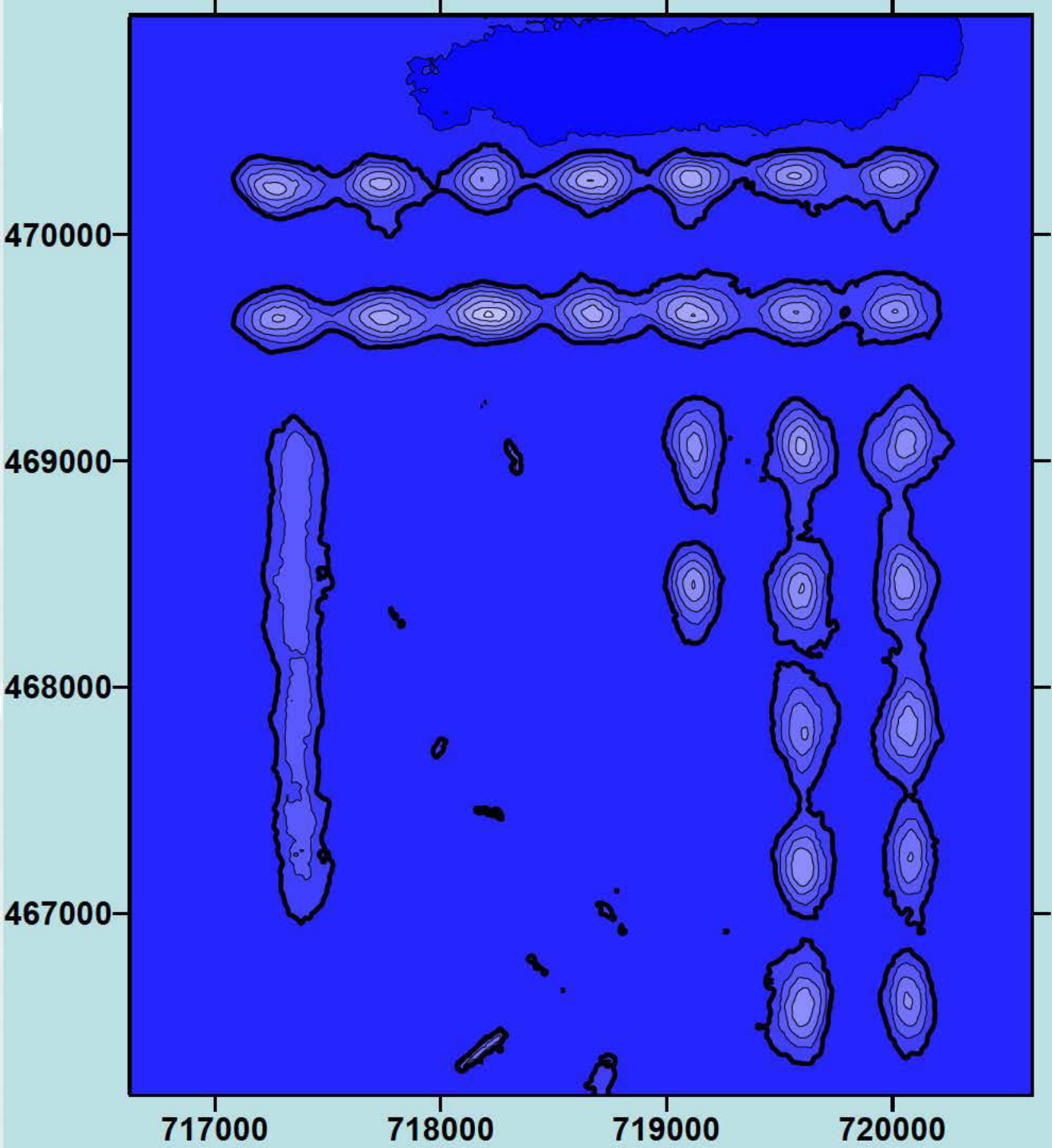
Bathymetry of Galveston Offshore Berm

Constructed of dredged material placed as single hopper barge loads



Shark River Reef

Constructed of Rock from the Kill van Kull Waterway Deepening Project



Working with Nature
Inland River Systems

- Dike notching/chutes
- Nature-inspired fish ladders
- Groove articulated concrete mats
- Chevron notching

Figure 5.7. Bendway Weirs

Photograph 2.12. A Series of Chevrons on the Mississippi River

Photograph 2.13. A Series of Chevrons Aligned To Split Flow Between the Main Channel and a Side Channel, While Protecting the Existing Shoreline

River Training Structures

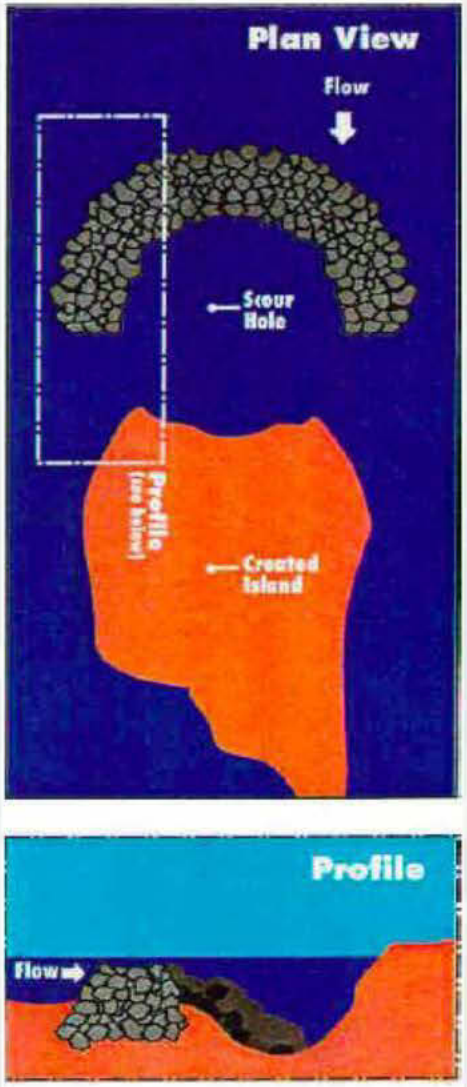


Figure 5.10. Blunt Nosed Chevron

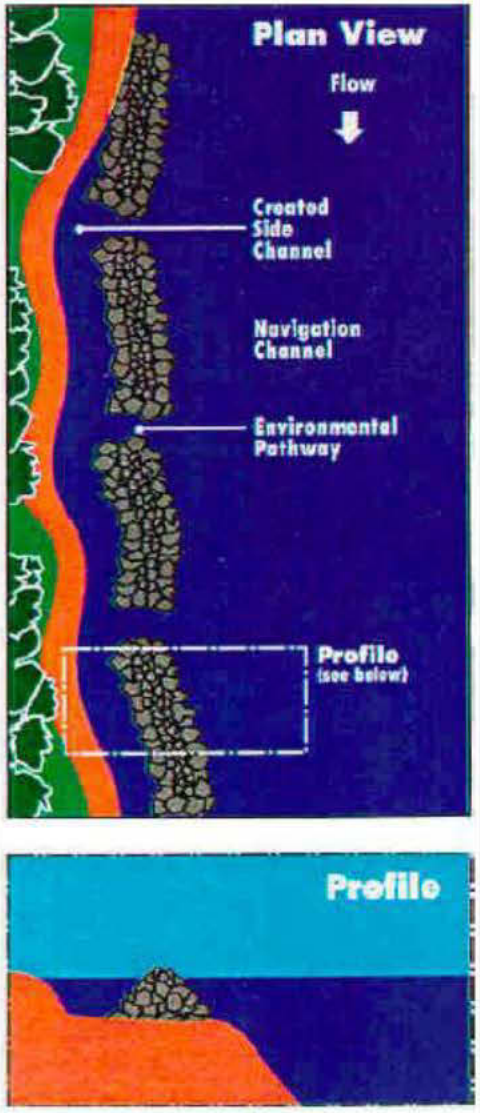
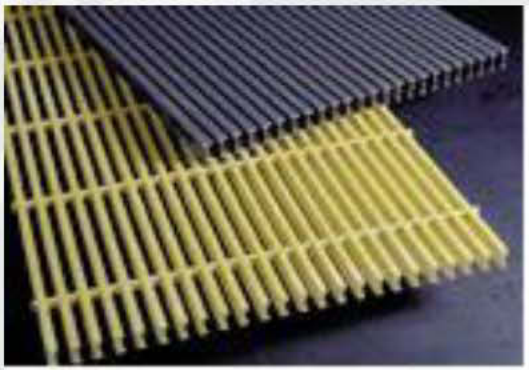


Figure 5.11. Off-Bankline Revetment

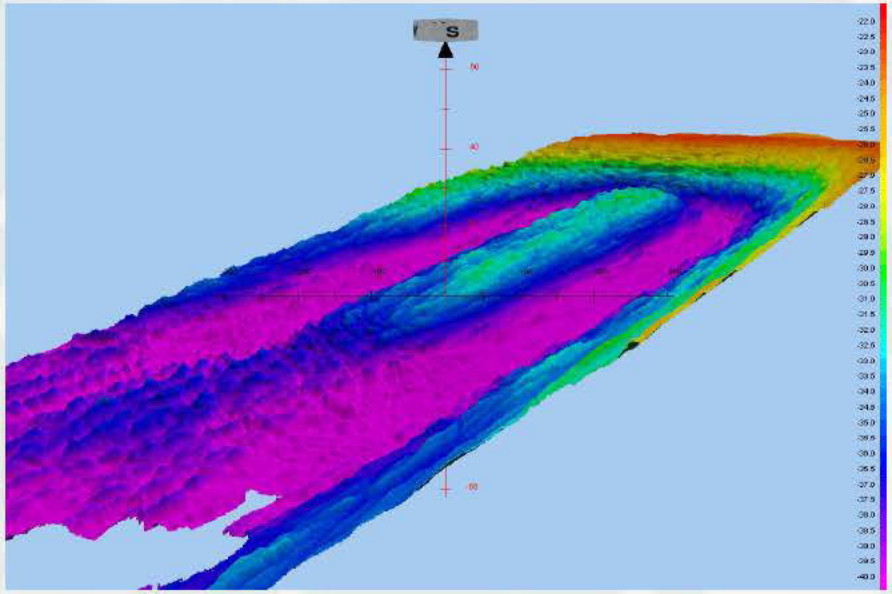
Working with Nature
Coastal Systems

- Pea gravel around toe of breakwater for fish spawning
- Eelgrass planting in anchorage
- Shaped breakwater to create habitat variety
- Light transmitting dock materials
- Dredged material island topped with oyster shell for tern habitat

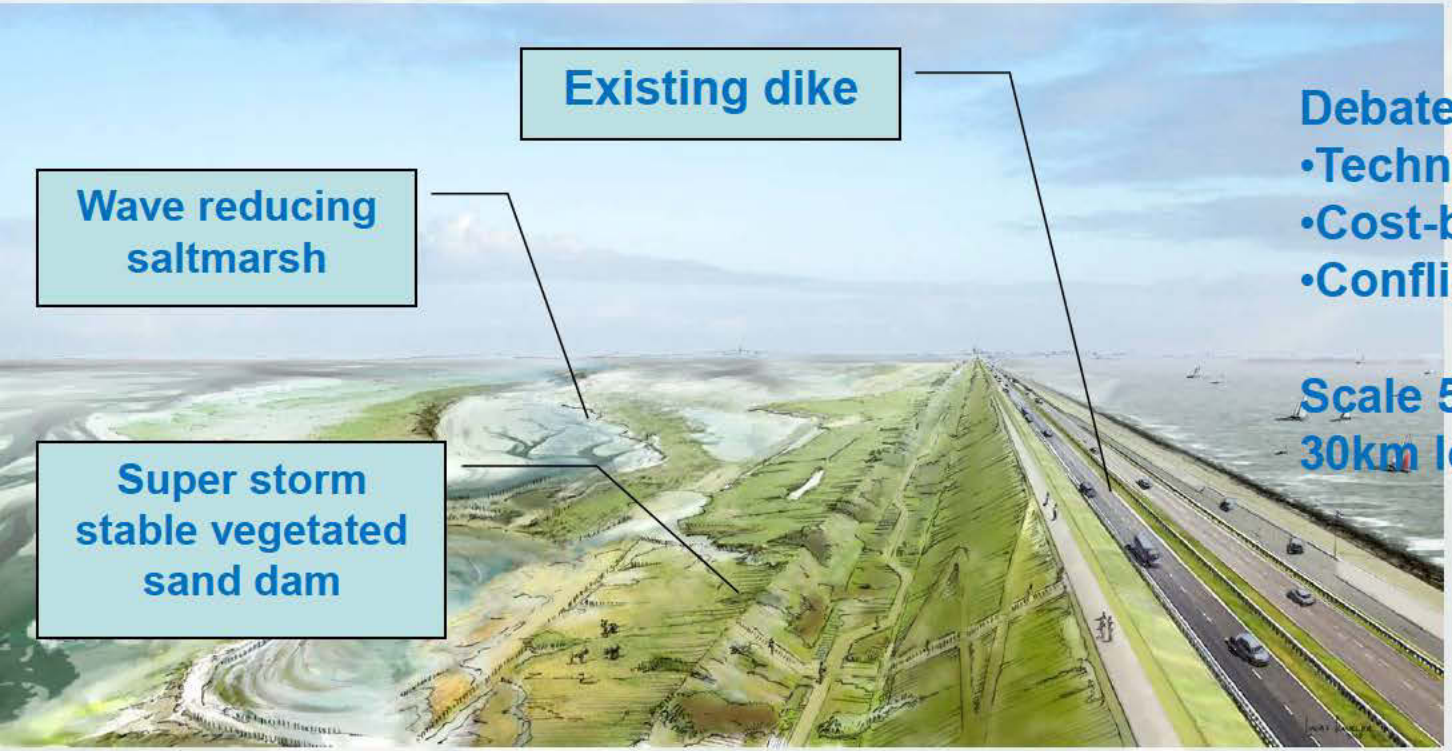


Working with Nature
Coastal Systems

Sand mining for the Maasvlakte 2 development at the Port of Rotterdam



Wadden Sea Soft Infrastructure



Debate:
- Technical feasibility
- Cost-benefit
- Conflict with Natura 2000

Scale 500m wide
30km long

Saltmarsh grows with sea level and maintains stability and safety
Flexible, low tech, low maintenance cost, longshore connectivity

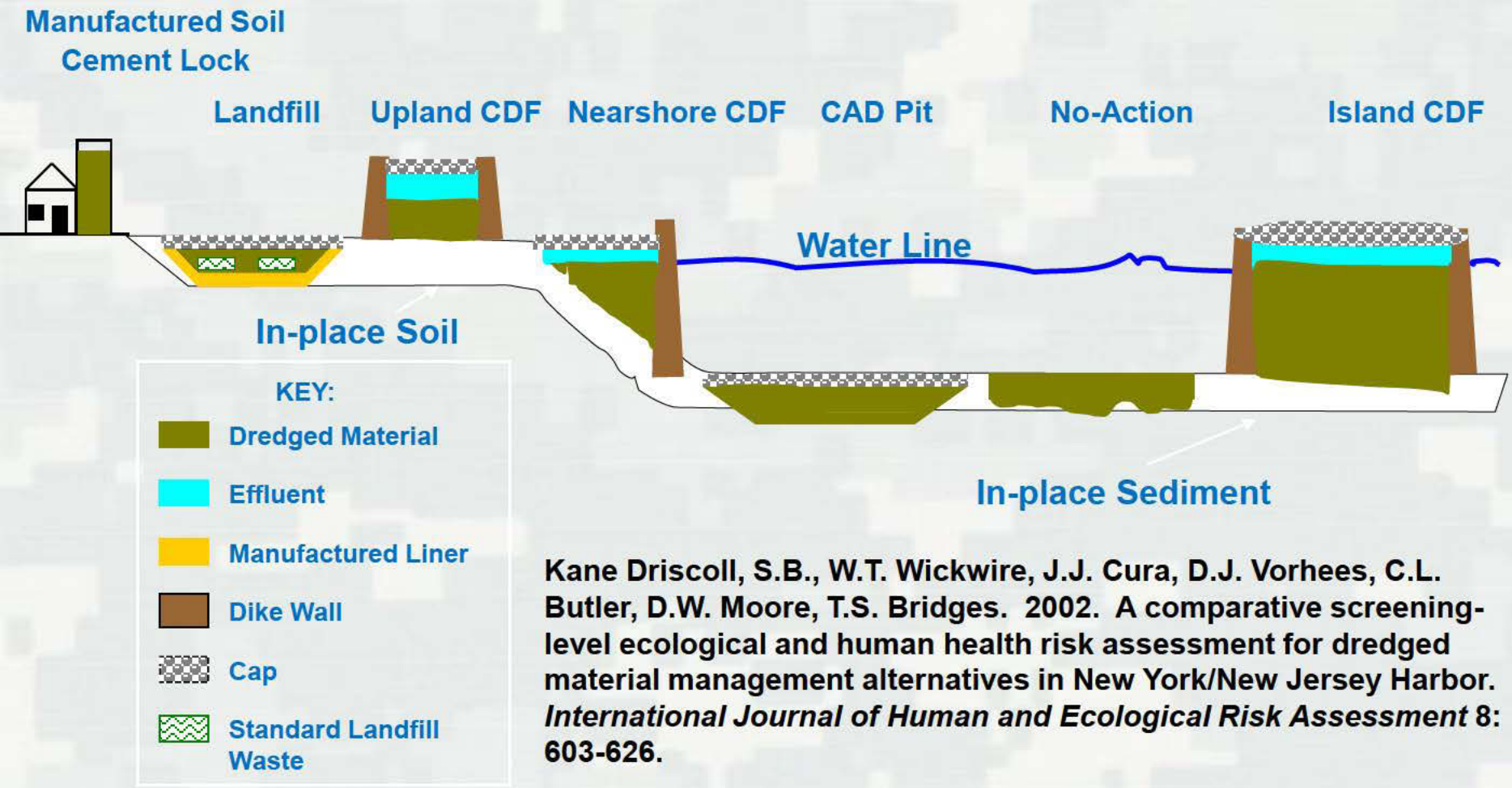
Other WwN Opportunities

- Modify breakwater toe, rock sizes, cross section, etc. to create habitat variety
- Oyster shell incorporated into hard structures to encourage colonization
- Terraces in channel side slopes for sea grass
- Marine mammal haul-out shelves incorporated into jetties
- Osprey nesting platforms in structures

Working with Nature "Enablers"

- Science to quantify environmental benefits or values
  - Input to design principles
  - No "green-washing"
- WwN Engineering Guidelines
  - Developing synergy between natural and engineering processes
- Strategies for addressing regulatory "hurdles"
  - National policy
  - Regional collaborations and partnerships
- Life-cycle focus
  - Supported by life-cycle analysis

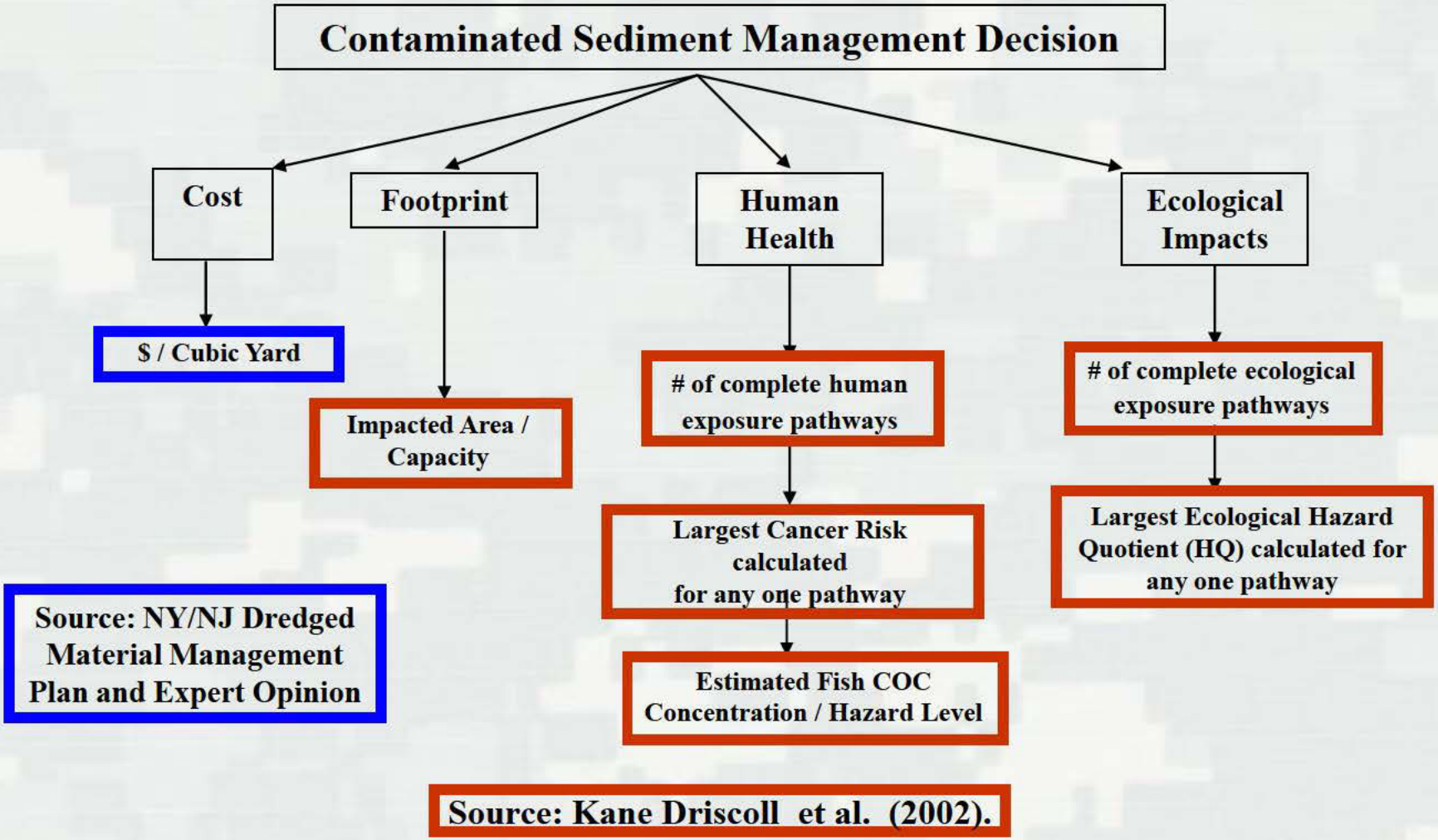
A Decision-Making Example



Kane Driscoll, S.B., W.T. Wickwire, J.J. Cura, D.J. Vorhees, C.L. Butler, D.W. Moore, T.S. Bridges. 2002. A comparative screening-level ecological and human health risk assessment for dredged material management alternatives in New York/New Jersey Harbor. *International Journal of Human and Ecological Risk Assessment* 8: 603-626.

G. A. Kiker, T. S. Bridges, J. B. Kim. 2008. Integrating Comparative Risk Assessment with Multi-Criteria Decision Analysis to Manage Contaminated Sediments: An Example From New York/New Jersey Harbor. *Human and Ecological Risk Assessment* 14:495-511.

Decision Criteria: NY/NJ Harbor



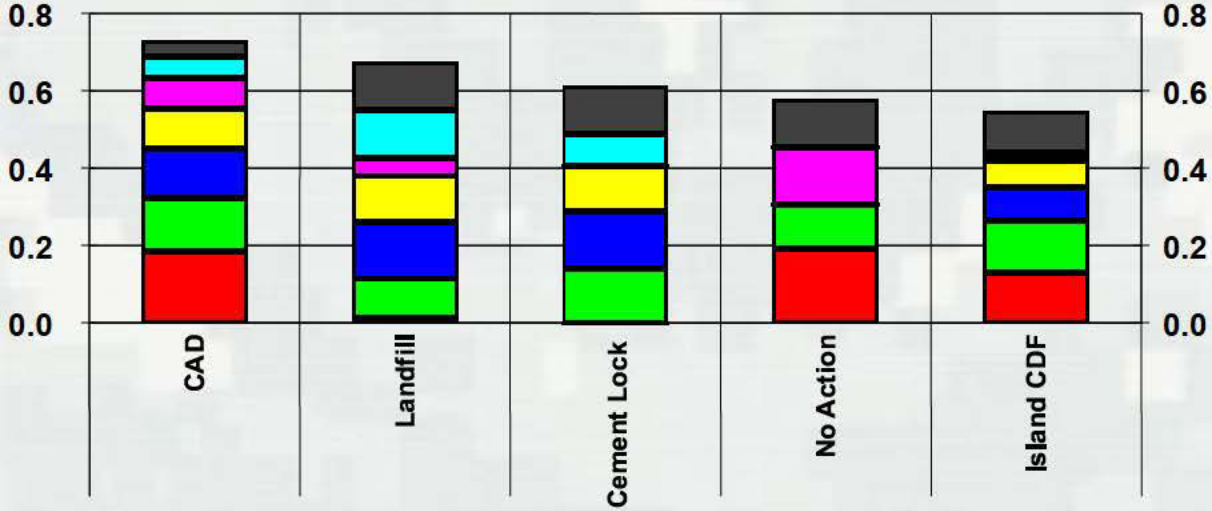
Criteria Levels for Each DM Alternative

	Cost	*Footprint*	*Ecological Risk*		*Human Health Risk*		
DM Alternatives	($/CY)	Impacted Area/Capacity (acres / MCY)	Ecological Exposure Pathways	Magnitude of Ecological HQ	Human Exposure Pathways	Magnitude of Maximum Cancer Risk	Estimated Fish COC / Risk Level
CAD	5-29	4400	23	680	18	2.8 E -5	28
Island CDF	25-35	980	38	2100	24	9.2 E -5	92
Near-shore CDF	15-25	6500	38	900	24	3.8 E -5	38
Upland CDF	20-25	6500	38	900	24	3.8 E -5	38
Landfill	29-70	0	0	0	21	3.2 E –4	0
No Action	0-5	0	41	5200	12	2.2 E –4	220
Cement-Lock	54-75	0	14	0.00002	25	2.0 E -5	0
Manufactured Soil	54-60	750	18	8.7	22	1.0 E –3	0

USACE/EPA Criteria Weights (%)

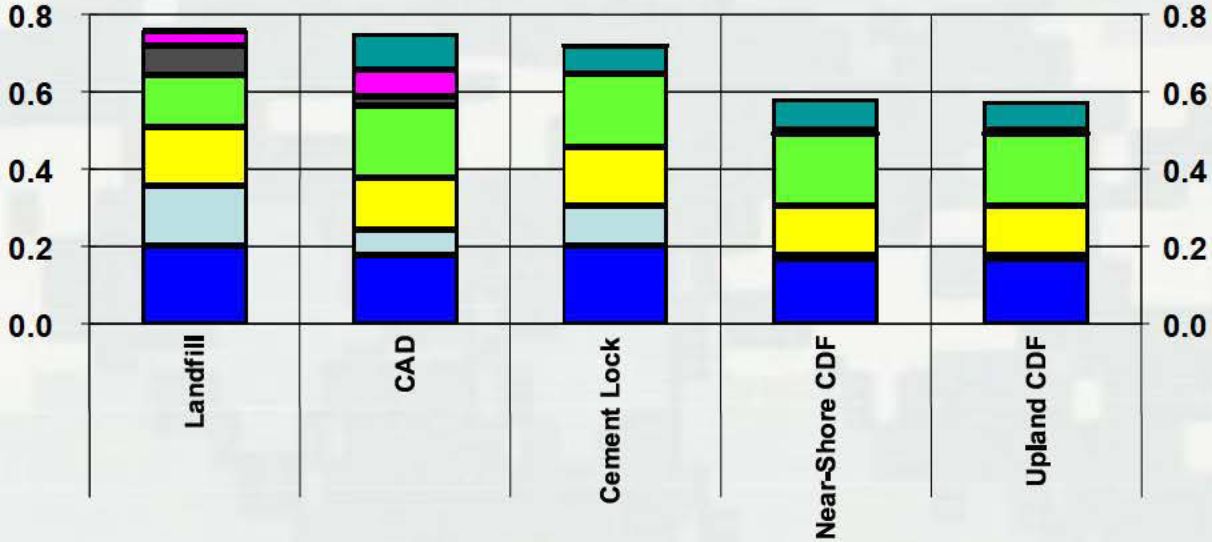
	EPA	USACE
Footprint	7.4	12.5
Ecological Health	35.6	27.1
Human Health	47.0	40.7
Cost	10.0	19.7

MCDA Rankings



USACE weighting

- Cost
- Maximum Cancer Probability (Non-Barge Worker)
- Ecological Hazard Quotient
- Est. COC Conc in Fish / Risk-based Conc
- Complete Human Health Exposure Pathways
- Complete Ecological Exposure Pathways
- Ratio of Impacted Area to Facility Capacity



EPA weighting

- Cost
- Maximum Cancer Probability (Non-Barge Worker)
- Ecological Hazard Quotient
- Est. COC Conc in Fish / Risk-based Conc
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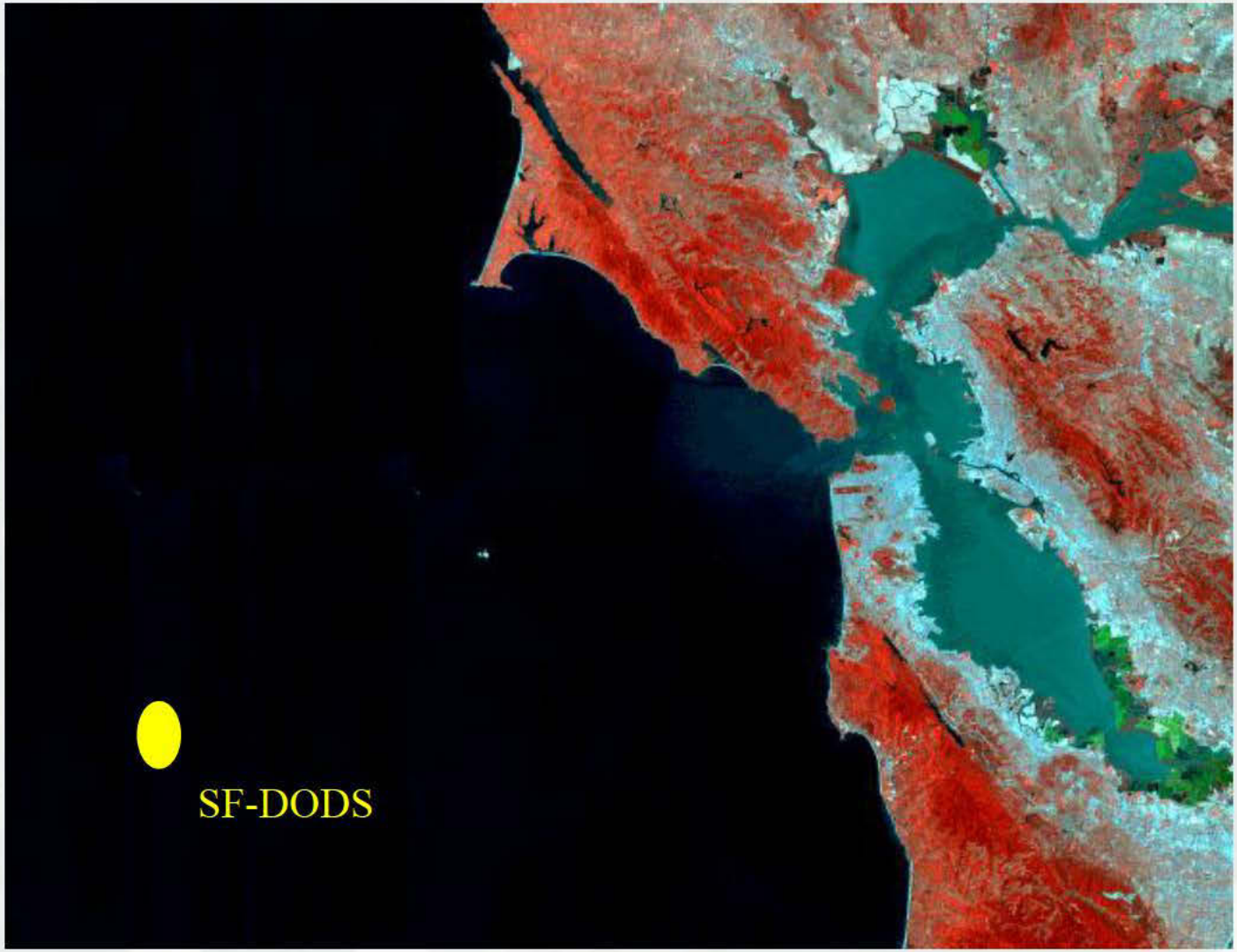
The Poster-Child for WwN:
We need a better way to do business