



Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide

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Nature-based Solutions



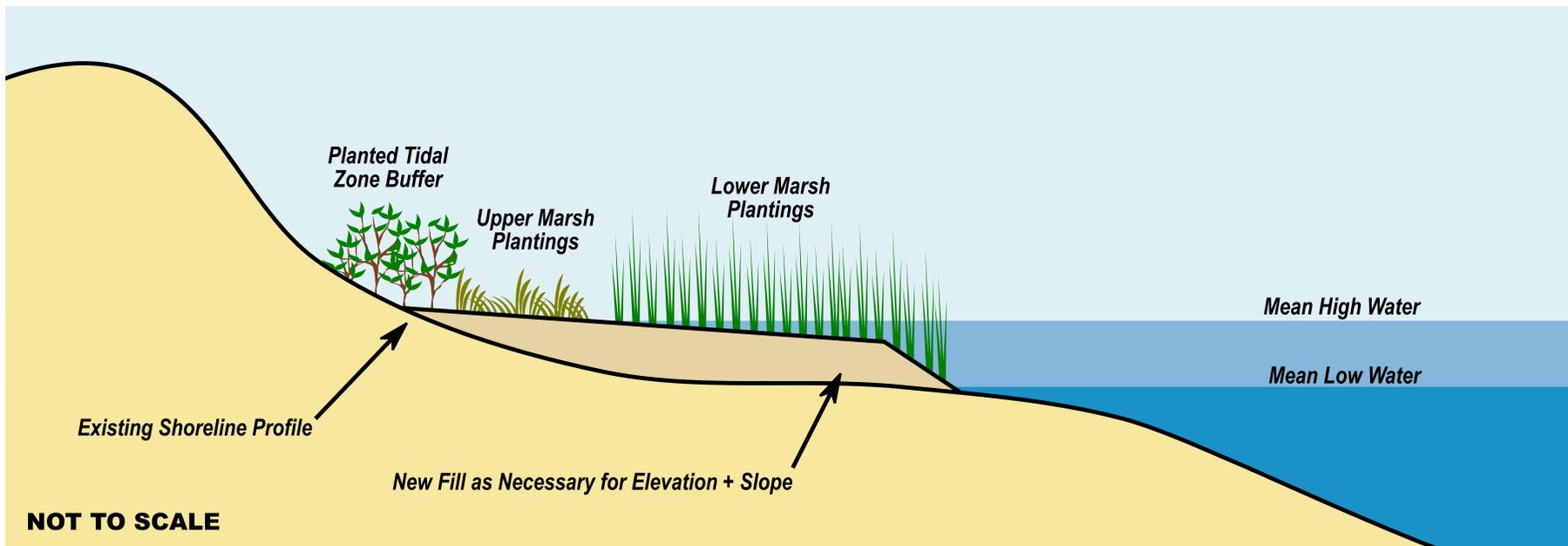
U.S. Department of Transportation
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Use of natural materials and processes as alternatives to, or ecological enhancements of, traditional shoreline stabilization and infrastructure protection techniques.



Credit: Bret Webb

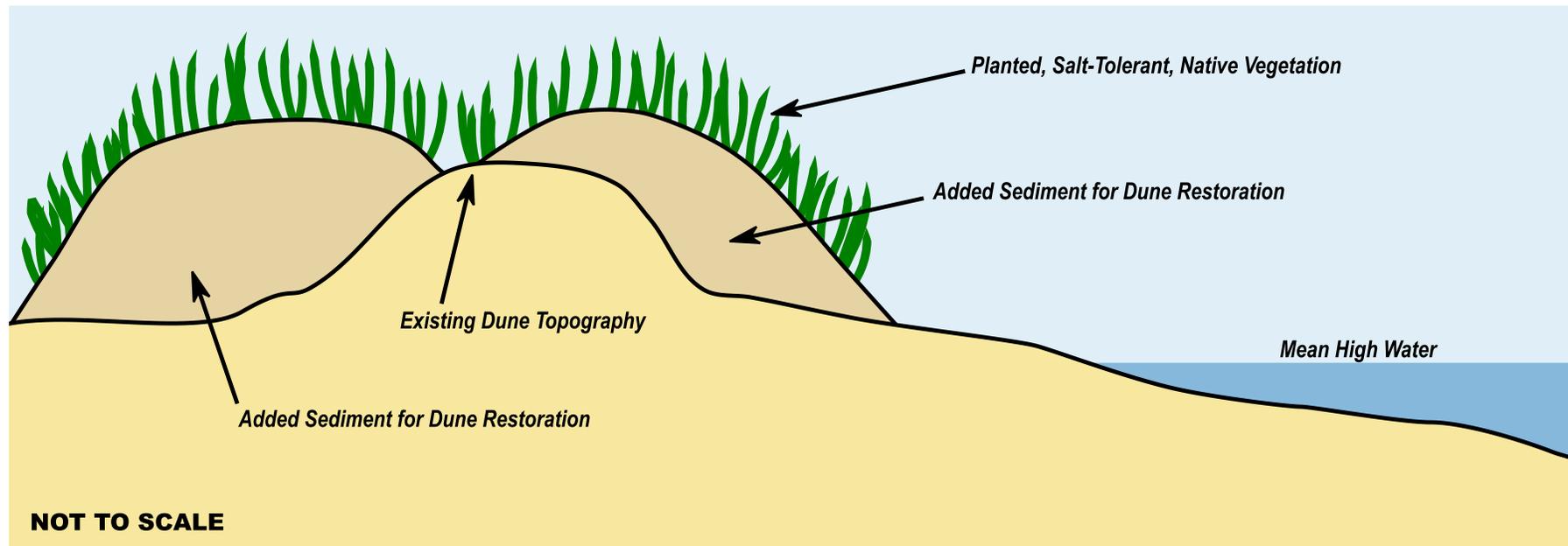
Example: Marsh



Example: Dune Restoration



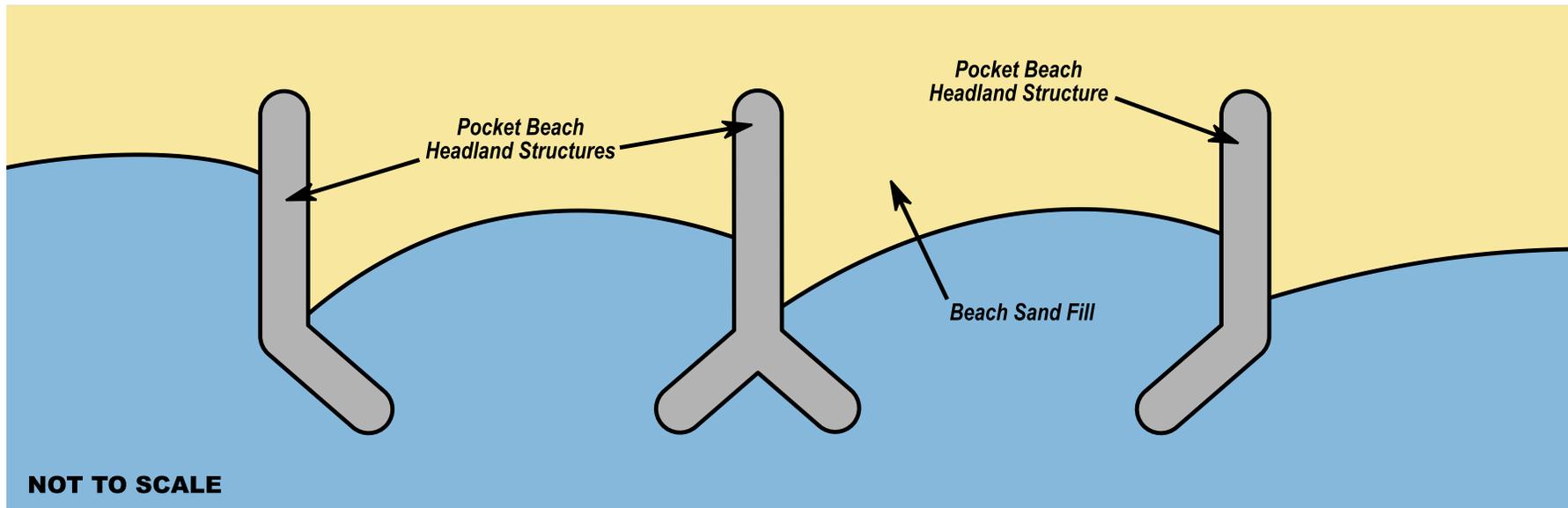
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Example: Pocket Beach



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FHWA's Eco-Logical Approach

Eco-Logical Framework

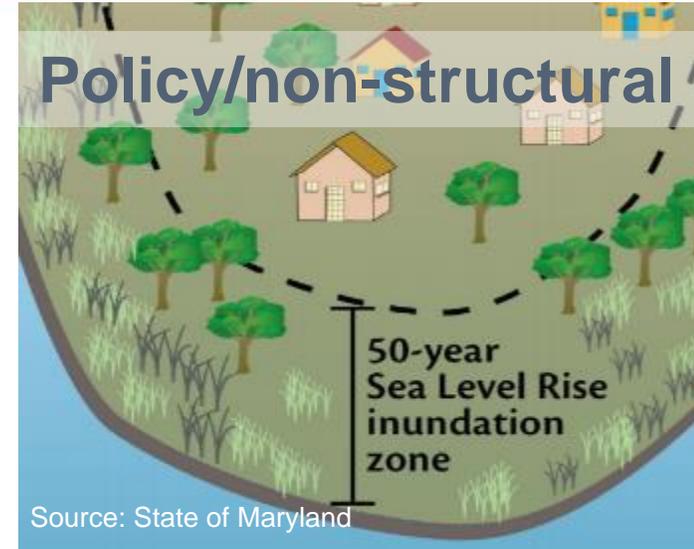


Research Gap: Nature-based Solutions and Integrated Approach

Structural solution



Policy/non-structural



Nature-based solution



- Natural features
- Nature-based features
- Hybrid approaches

Nature-Based Solutions for Coastal Highway Resilience

- 5 pilot projects
 - OR DOT
 - ME & NH DOTs jointly
 - MS DOT
 - DE DOT
 - US Army Corps of Engineers in NJ
- White paper
- Regional peer exchanges
- Implementation Guide

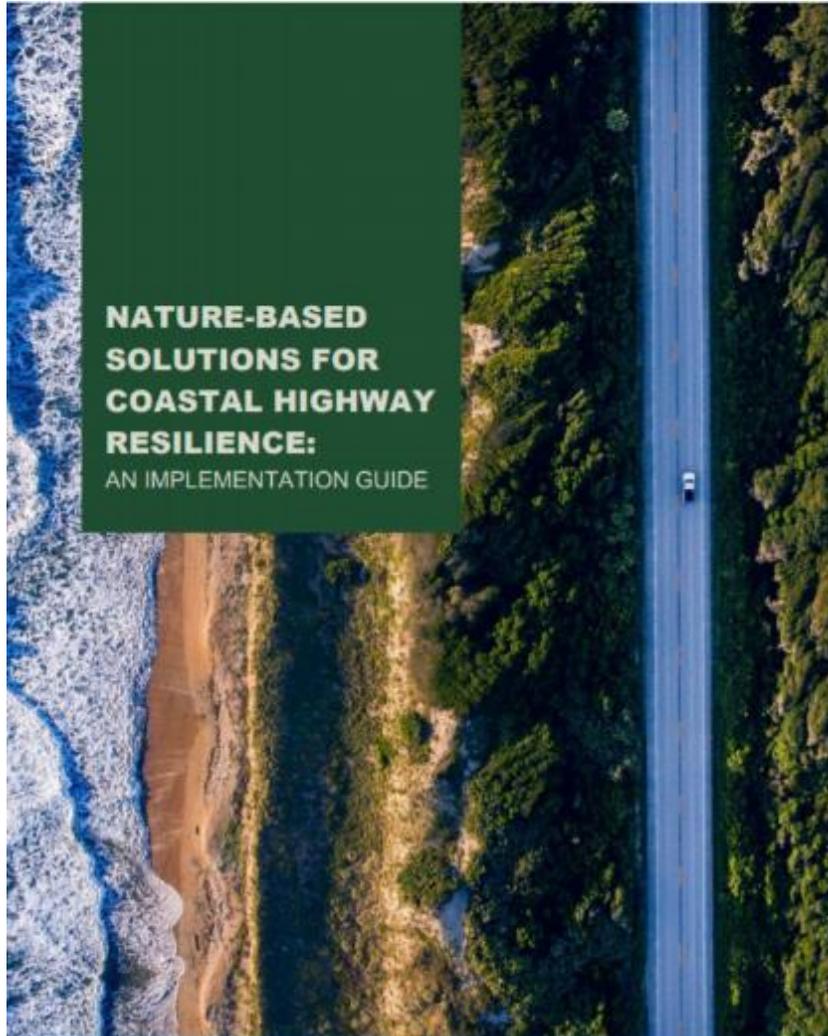


U.S. Rt 1B, New Hampshire. Credit: NH DOT



Participants at Alabama Peer Exchange. Credit: FHWA

FHWA Nature-based Resilience for Coastal Highways Website:
https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/



- Implement nature-based solutions to enhance the resilience of coastal highways
- Overview
 - Technical factsheets
 - Benefits and typical costs
 - Implementation considerations

https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/implementation_guide/

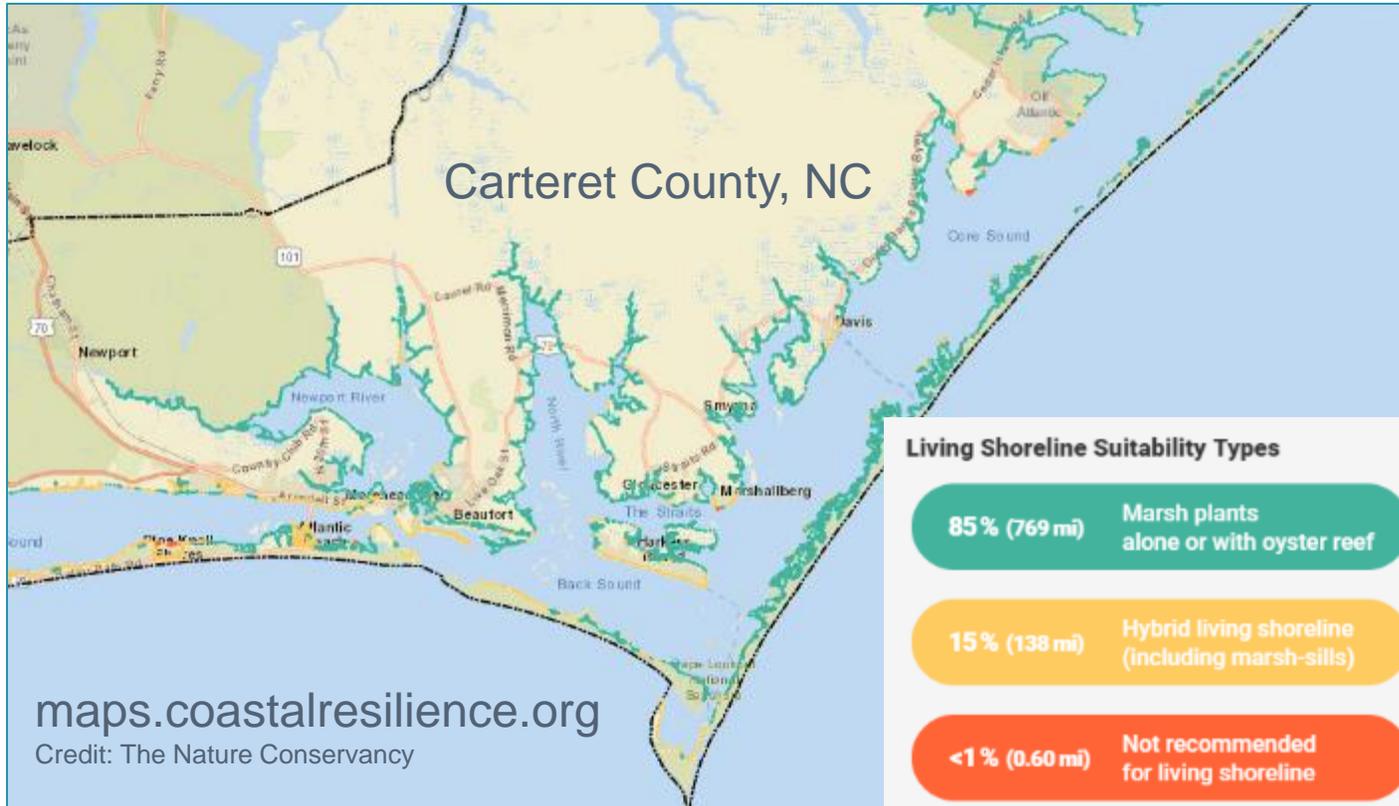
Benefits

- ✓ Reduction in coastal flooding, wave heights, and erosion
- ✓ Ecological, water quality, habitat benefits
- ✓ Reasonable costs
- ✓ Naturally adapt to sea level rise
- ✓ Tourism and recreation benefits



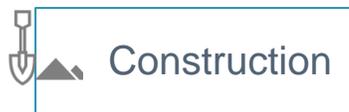
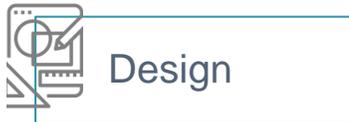
Coastal habitats can reduce wave heights by 35-70% and are often less expensive than armoring.

- Planning & Funding
- Site Assessment
- Design
- Permitting
- Construction
- Monitoring



Incorporating into transportation planning can help:

- Address both resilience and environmental objectives
- Allows systematic consideration
- Mobilize larger projects
- Take advantage of analyses by partners



- Funding opportunities:
 - Transportation
 - Coastal restoration
 - Hazard mitigation
- Example: [National Coastal Resilience Fund](#) (NOAA & NFWF) funds nature-based solutions to protect coastal communities



Site Assessment



Planning & Funding



Site Assessment



Design



Permitting

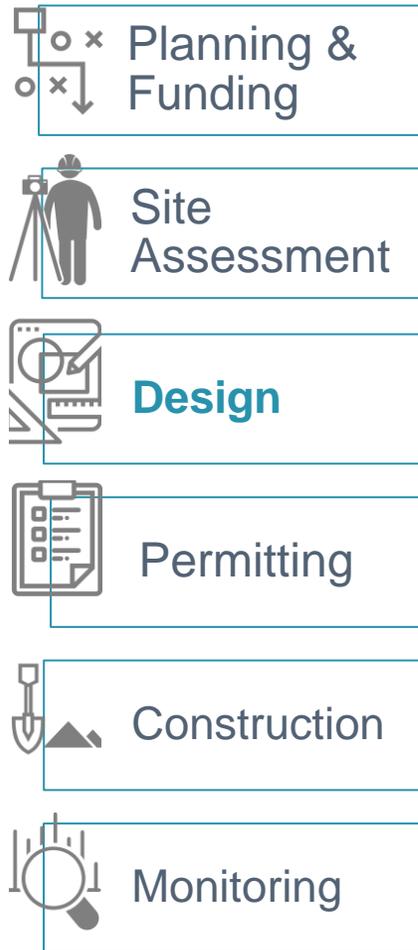


Construction



Monitoring

System Parameters	Hydrodynamic Parameters
<ol style="list-style-type: none"> 1. Shoreline Type 2. Infrastructure 3. Erosion Rate 4. Sea Level Rise 5. Tide Range 	<ol style="list-style-type: none"> 1. Wind Waves 2. Boat Wakes 3. Currents 4. Ice 5. Storm Surge
Terrestrial Parameters	Ecological Parameters
<ol style="list-style-type: none"> 1. Upland Slope 2. Shoreline Slope 3. Width 4. Nearshore Slope 5. Water Depth 6. Soil Strength 	<ol style="list-style-type: none"> 1. Water Quality 2. Soil Type 3. Sunlight 4. Salinity
Additional Parameters	
<ol style="list-style-type: none"> 1. Permits 2. End Effects 3. Constructability 	<ol style="list-style-type: none"> 4. Species 5. Debris 6. Monitoring



- Illustrative lessons learned:
 - Loose substrate (e.g., oyster shell), coir fiber logs, and woody debris have not performed well when exposed to wave action.
 - Protection structures should primarily address the most common water level and wave conditions, in addition to considering infrequent but extreme events.
 - One common mistake is placing structures at sites where they may exacerbate shoreline erosion.

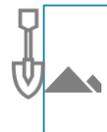
Design: Mobile Bay, AL

 Planning & Funding

 Site Assessment

 **Design**

 Permitting

 Construction

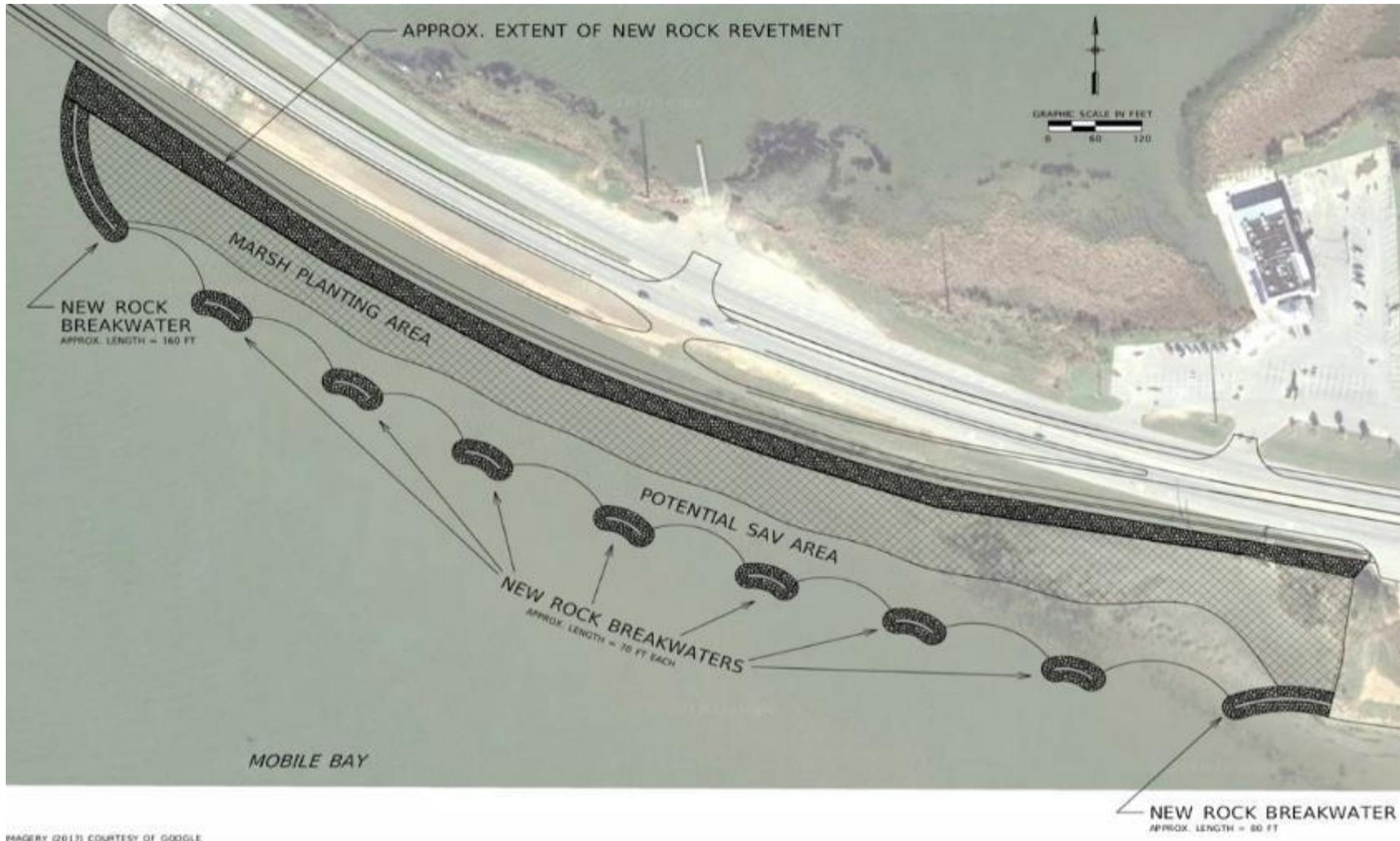
 Monitoring



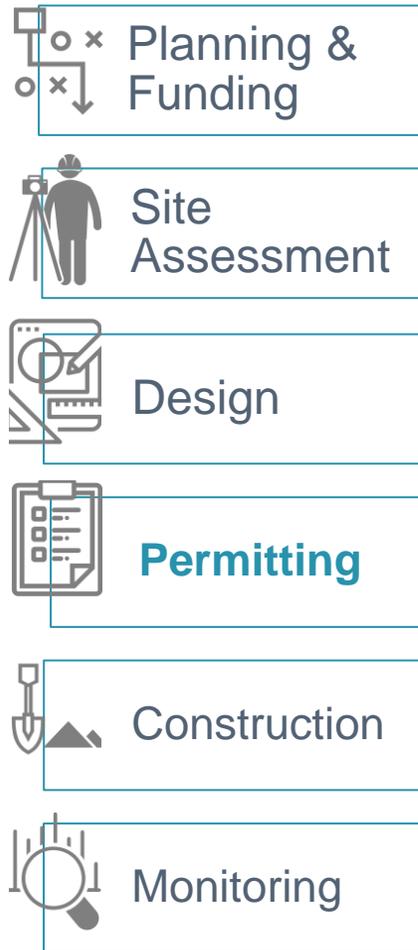
An existing concrete seawall serves as bank stabilization for the Mobile Bay causeway.

Design: Mobile Bay, AL

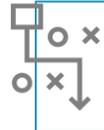
Conceptual planform diagram of a constructed marsh and breakwater system for Mobile Bay, AL.



Permitting



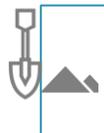
Permit Type:	Nationwide Permit	General Permit	Individual Permit
Project Complexity	Low to moderate	Moderate	Moderate to high
Permit Requirements	Strictly defined	Generally defined	Undefined
Benefits	Short review period	Moderate review period	Few design constraints
Challenges	Many design constraints	Some design constraints	Long review period

 Planning & Funding

 Site Assessment

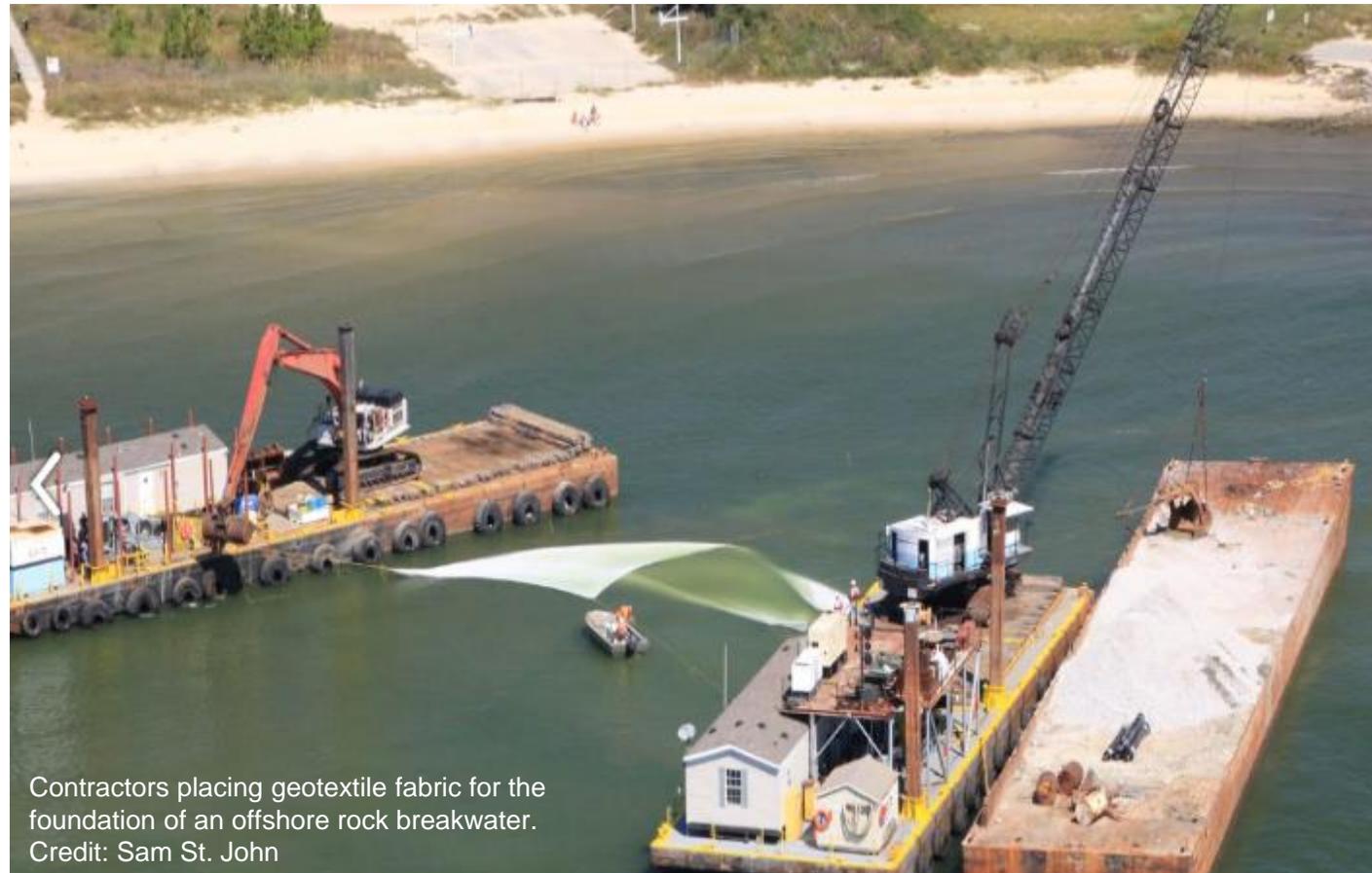
 Design

 Permitting

 **Construction**

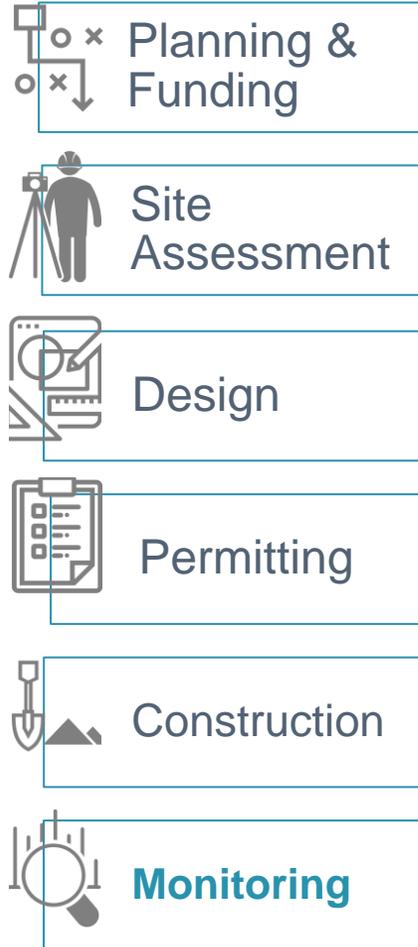
 Monitoring

- Recommend the use of performance-based contracts



Contractors placing geotextile fabric for the foundation of an offshore rock breakwater.
Credit: Sam St. John

Monitoring, Maintenance, & Adaptive Management



- Measure and assess project performance and impacts
- Maintain to continue to provide expected benefits
- Implement adaptive management practices



Work with Nature

