Living Shorelines - Evolving Design Considerations for Sustainable Projects

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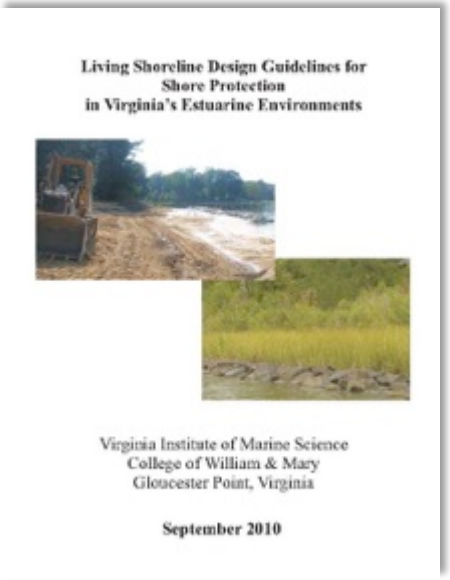
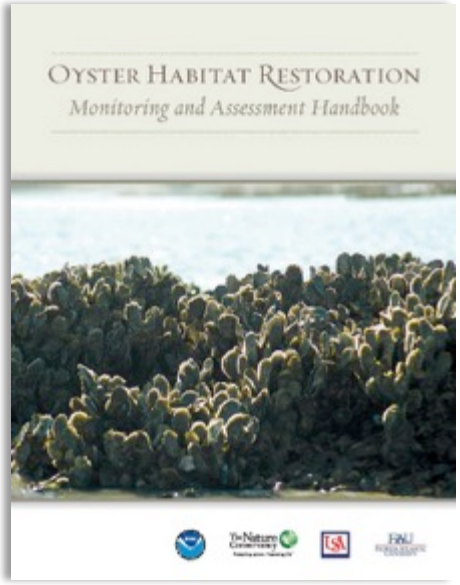
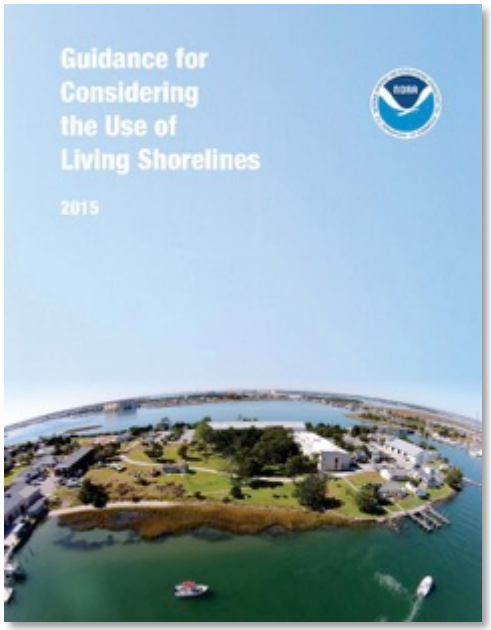
ch2m

Living shorelines are no longer new!

- Many projects have now been installed across the US
- Most have been small to medium sized projects
- Larger and more expensive projects are emerging
- ***More emphasis on measuring success and demonstrating ecological and economic value***







Living Shorelines design considerations…there are many!

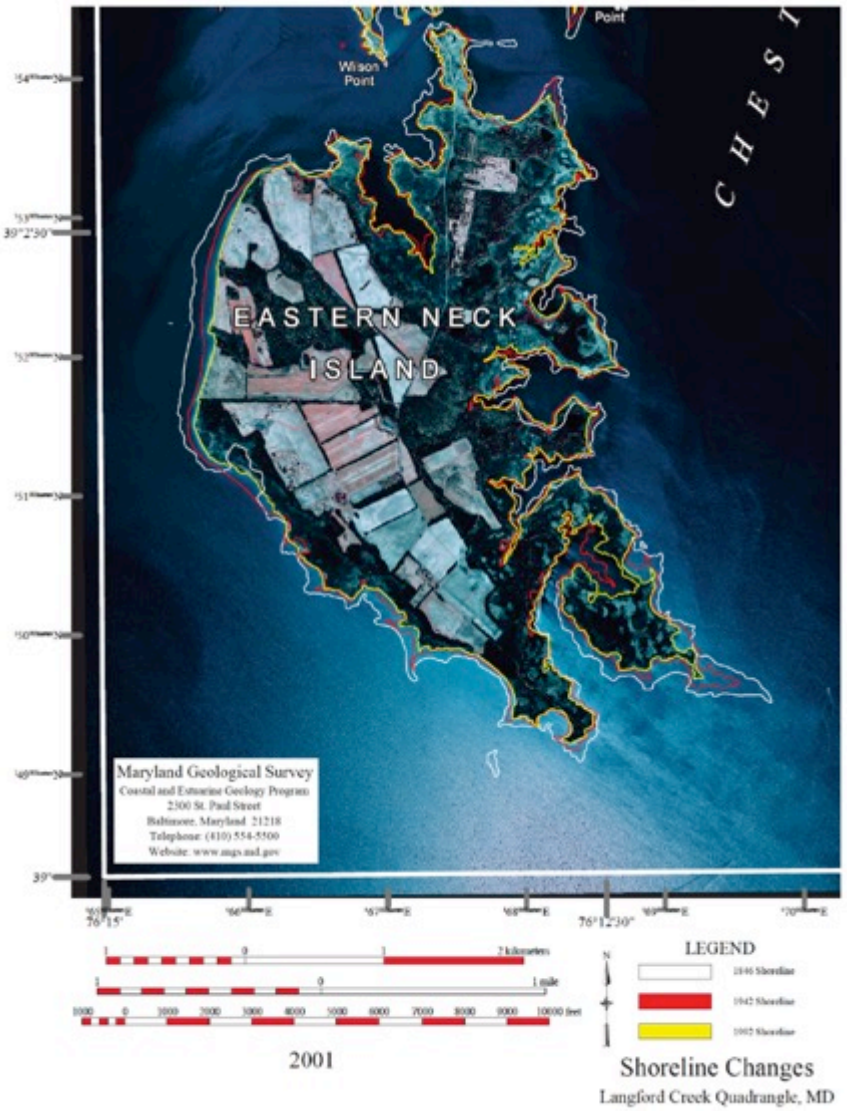
- Existing erosion rate
- Existing shore morphology
- Depth offshore
- Nearshore morphology & substrate stability
- Wave climate
- Presence of submerged aquatic vegetation (SAV)
- Tide range
- Storm surge
- Vegetation
- Sediment transport

The same coastal processes that apply to design of traditional engineering solutions apply to living shorelines…

Understanding coastal processes is key to project success!

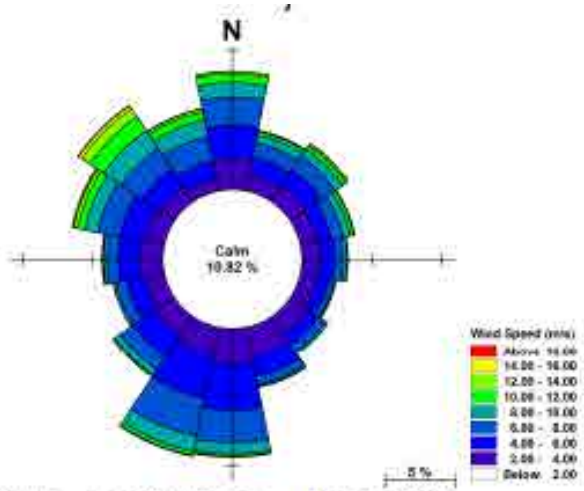
Eastern Neck National Wildlife Refuges has a history of erosion issues

- "The USFWS highest priority over the next 15 years is to protect against additional refuge shoreline erosion and loss of refuge tidal marsh…."



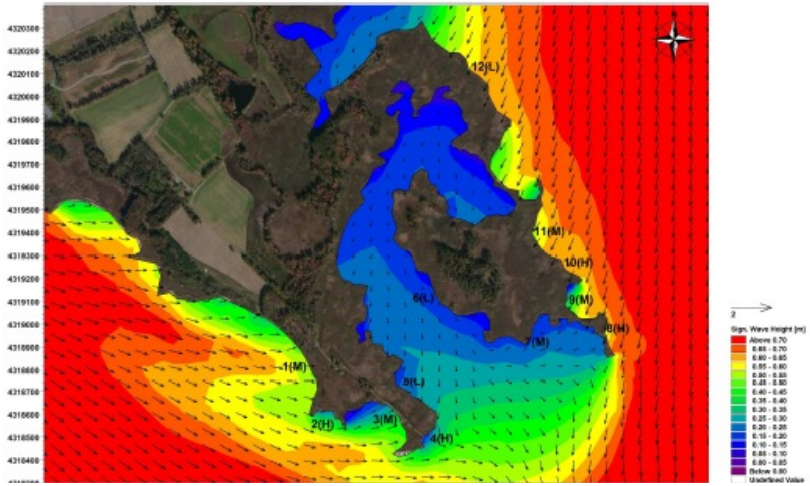
In-depth coastal studies completed to support project design

- Data collection and analysis
- Wind extremes determination → MIKE EVA
- Wave modelling → MIKE 21 SW FM
- Current modelling → MIKE 21 HD FM
- Beach stability modelling → Storm Induced BEAch Change model (SBEACH by USACE)
- Conceptual design based on 25yr return period storm

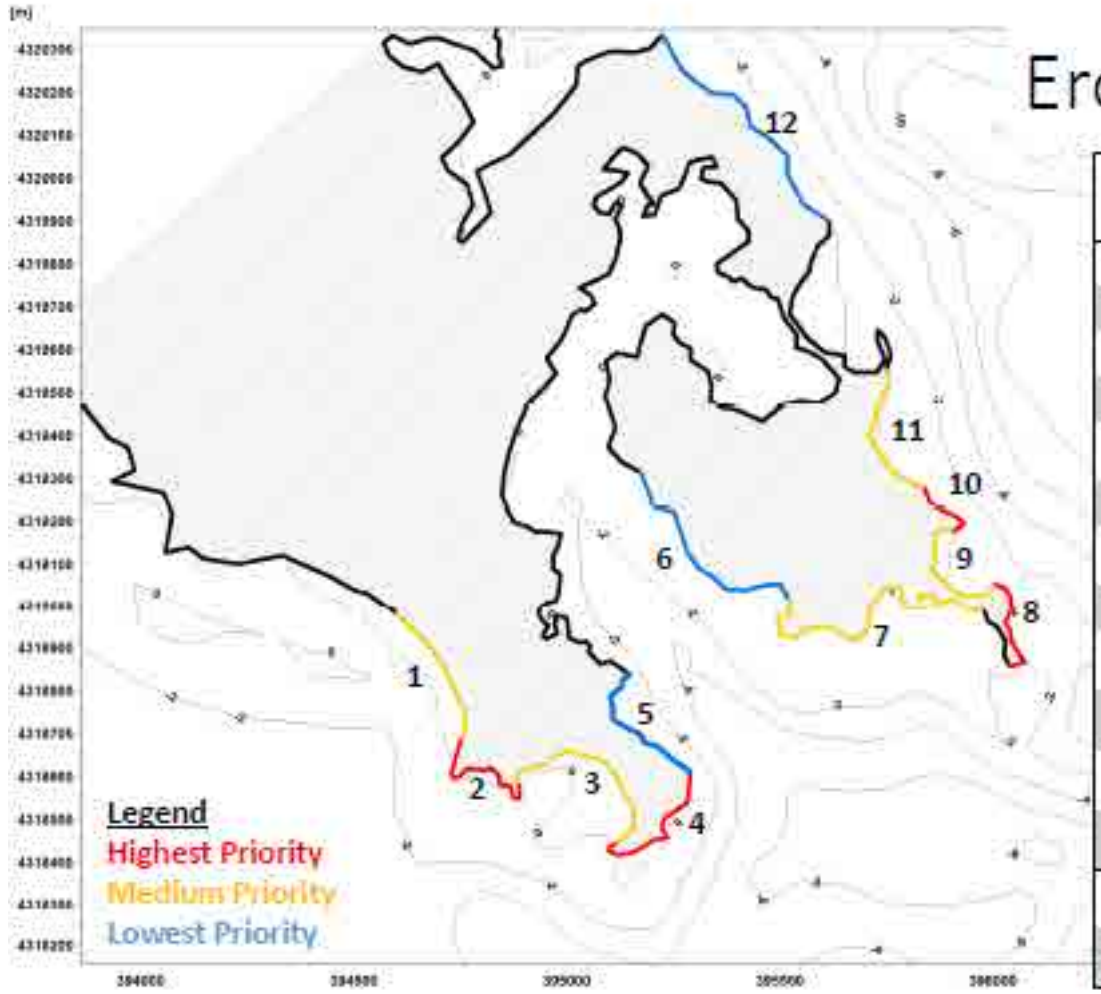


Station 44043 Wind Rose (2007-2013)

25yr Extreme Waves from N Direction



Coastal process evaluation identified priority areas for restoration



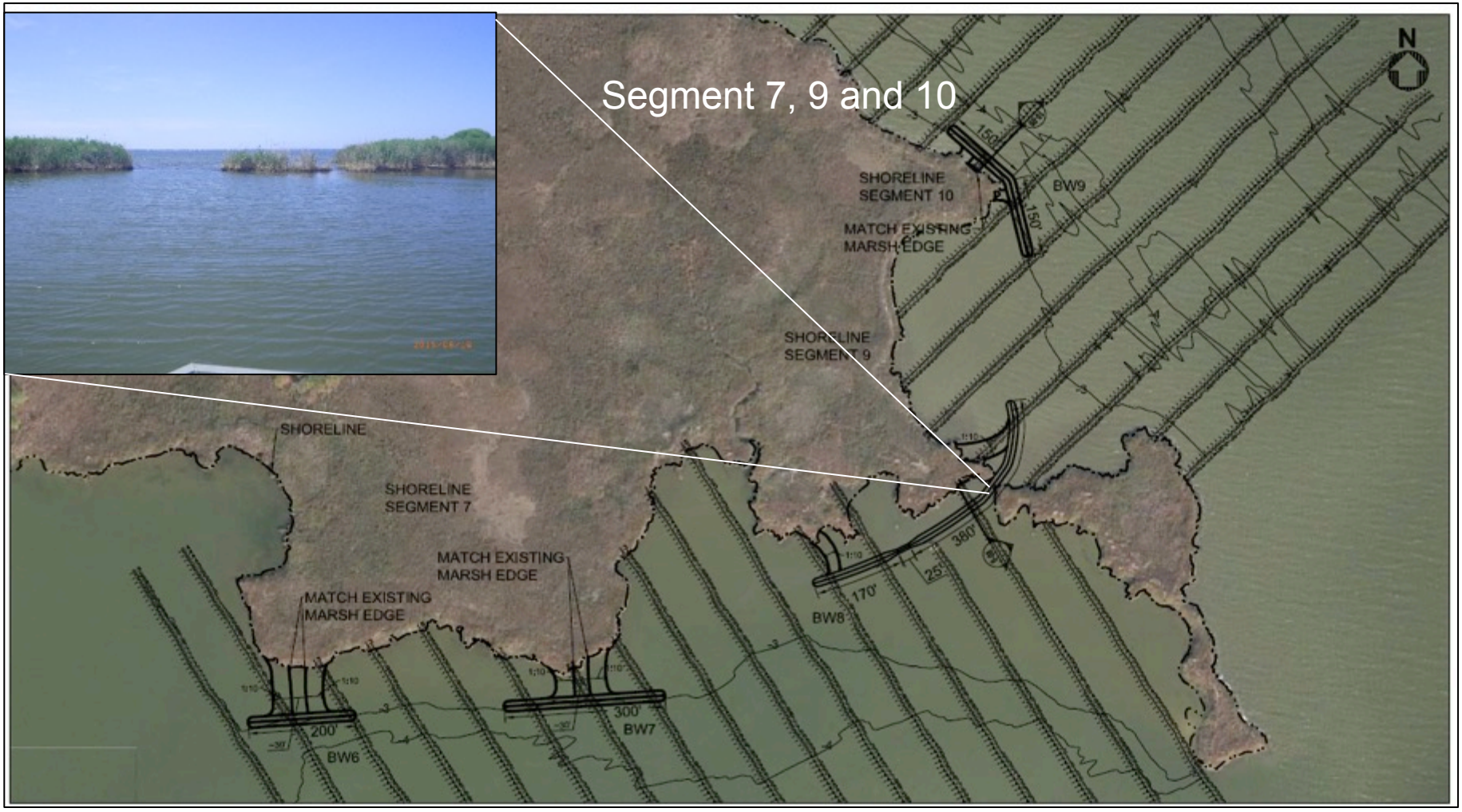
Erosion Severity Map

Shore Segment No	Shoreline length (ft)	Erosion Severity Level	Design Alternatives
1	1130	Medium	Beach Nourishment
2	1135	Highest	Marsh Sill
3	1585	Medium	Beach Nourishment
4	1193	Highest	Marsh Sill
5	1143	Lowest	Tidal Marsh Enhancement o Marsh Sill
6	1747	Lowest	Tidal Marsh Enhancement
7	2700	Medium	Marsh Toe Revetment or Marsh Sill
8	866	Highest	Marsh Sill
9	1051	Medium	Marsh Sill or Beach Nourishment
10	542	Highest	Marsh Sill or Marsh Toe Revetment
11	1125	Medium	Marsh Toe Revetment or Marsh Sill
12	2059	Lowest	Marsh Toe Revetment or Marsh Sill
Total: Highest	3743		
Total: 2, 4, & 10	2877		

Geotechnical survey conducted at key locations

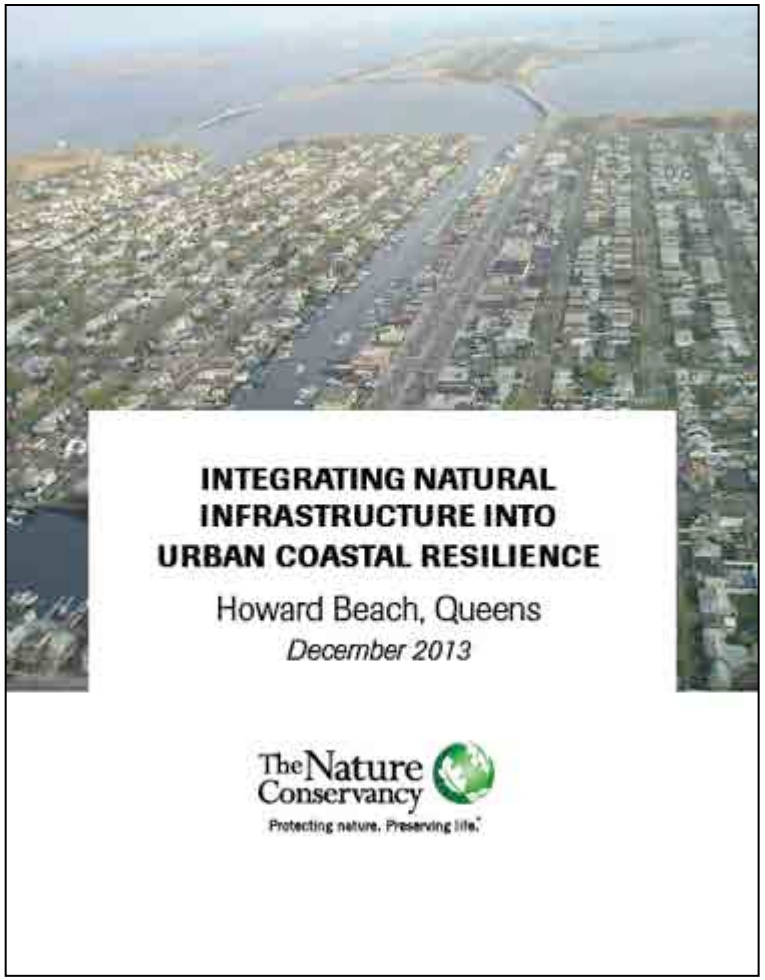
- Sediment cores collected in January
- Used hand augers with casing to collect samples
- Subsurfrace soil density was determined using Dynamic Cone Penetrometer (DSP) tests
- Results used to determine potential for substrate to support construction materials

Conceptual Design – Headland Breakwater Tombolos



These alignments are considered headland control since they are placed sufficiently close to existing hard points extending seaward from the shoreline. The purpose of these structures is to protect these shoreline headlands which help shape the bay shoreline by wave diffraction.

Evaluating project benefits is becoming more critical



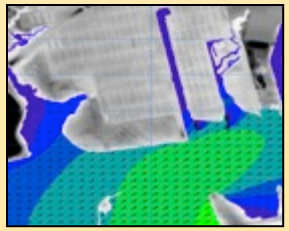
Howard Beach, Queens Natural Infrastructure for Coastal Resilience Project

- CH2MHILL supported TNC on a case study examining a range of natural infrastructure solutions to reduce climate risks in the Howard Beach Neighborhood
- ***Goal was to compare the financial costs and benefits of a range of Natural-Grey engineering solutions under alternative climate change scenarios***
- Project was completed to provide input into the City of New York's Post Hurricane Sandy planning process

Approach integrated modeling platforms to document flood risk reduction and ecological benefits

1 Hydrodynamic Modeling

MIKE by DHI



- Storm surge
- Wave/wind calculations
- Water depths
- Bathymetry
- Topography
- Develop hydrodynamic characteristics of 1-in-100 year storm
- Apply hydrodynamic input to alternatives

2 Water Depth Flood Analysis

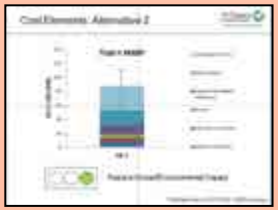
Flood Modeller *Pro*

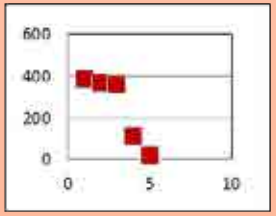
- Develop extent of coastal flooding & upland flood depths

3 Demographic & Economic Losses

- 2000 Census
- Building inventory
- Physical damage
- Economic loss
- Social impact

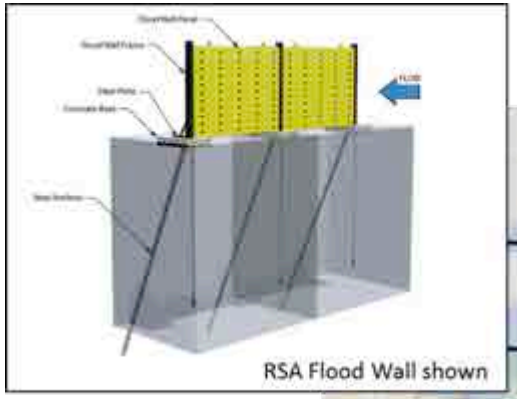
4 Cost Benefit Analysis

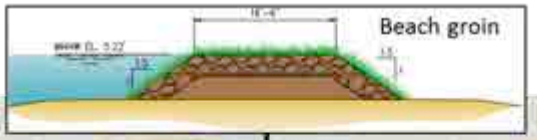


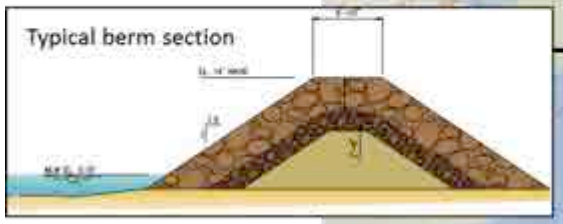


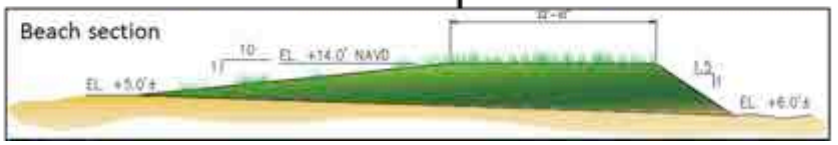
- Cost estimates
- Cost benefits
- Avoided cost
- Economic analysis

Natural and Grey Infrastructure Needed to Meet Flood Reduction Goals (Alternative 3)

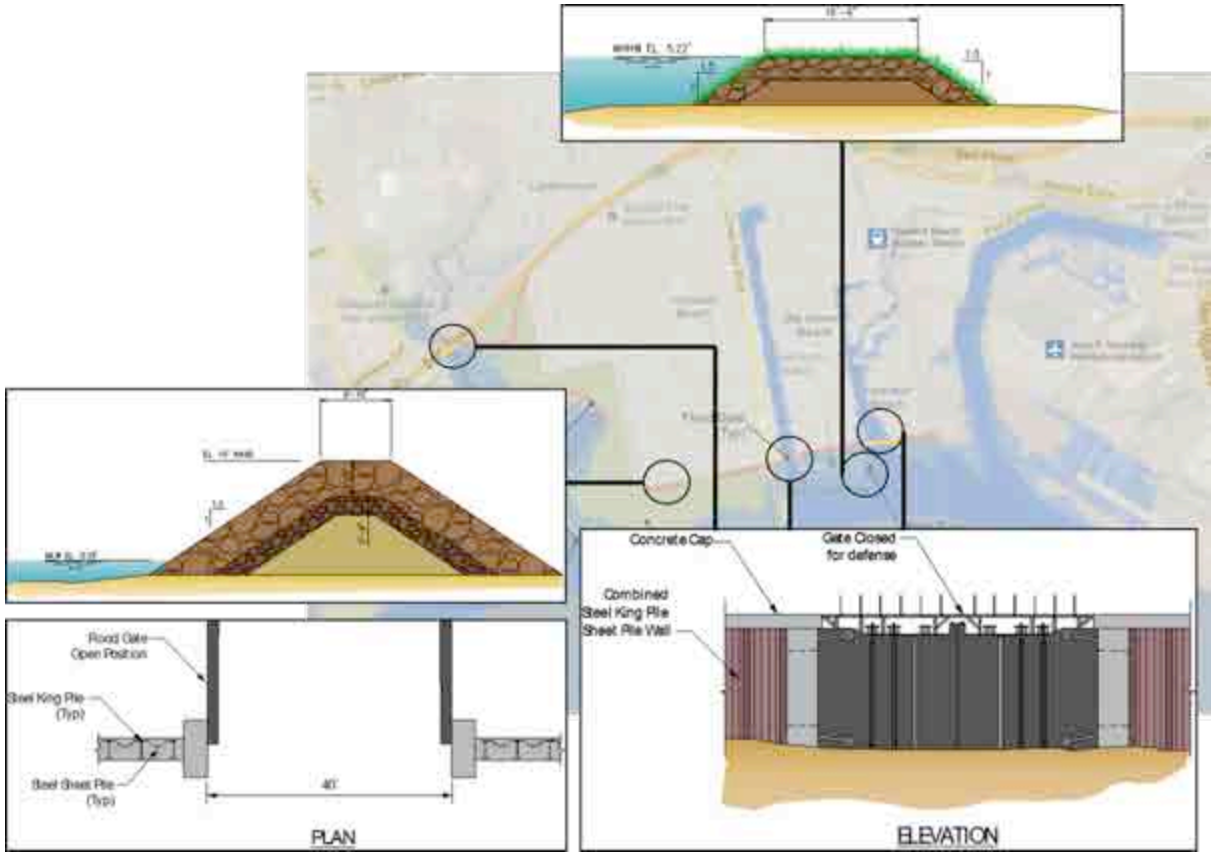








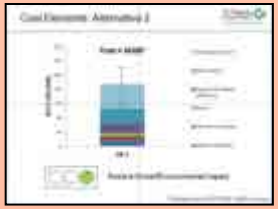
Additional Grey Structures Needed for Full Protection (Alternative 4)

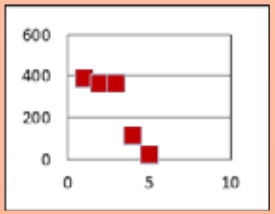


Cost-Benefit Methodology Facilitated Integration of Economic Impact

4

Cost Benefit Analysis





- Cost estimates
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Benefits

- Avoided damages compared to base case damages using Hazus —results in net "damage avoided"
- Ecosystem Service benefits from benefit-transfer of secondary literature

Costs

- Estimates based on CH2M HILL cost estimating database
- ± 30% precision
- Natural Infrastructure O&M costs from NYC Parks and Recreation

$$\frac{B}{C}$$

Benefit/Cost ratio is a key output of benefit cost analysis

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/climate-energy/natural-infrastructure-study-at-howard-beach.xml

Living shoreline design considerations vary by location, scale, and project objectives

- Success of larger projects dependent on:
  - Adequate analysis of coastal processes
  - Sufficient geotechnical data
- Demonstration of project benefits:
  - Needs to include flood risk, wave attenuation, and ecological measures

Thank You