

Soft Engineering Approaches for Shoreline and Coastal Protection

Jon K. Miller

*Davidson Lab Assistant Director for Coastal Engineering
NJ Sea Grant Coastal Processes Specialist*



Alternative ~~Soft~~ Engineering Approaches for Shoreline and Coastal Protection

Jon K. Miller

“Living Shorelines”

- Not a one size fits all solution
- Can range from “hard” to “soft”
- Application of principles rather than technique
 - Slope, Sinuosity, Texture, Material

Innovative Techniques

VERTICAL APPROACHES



Gabion

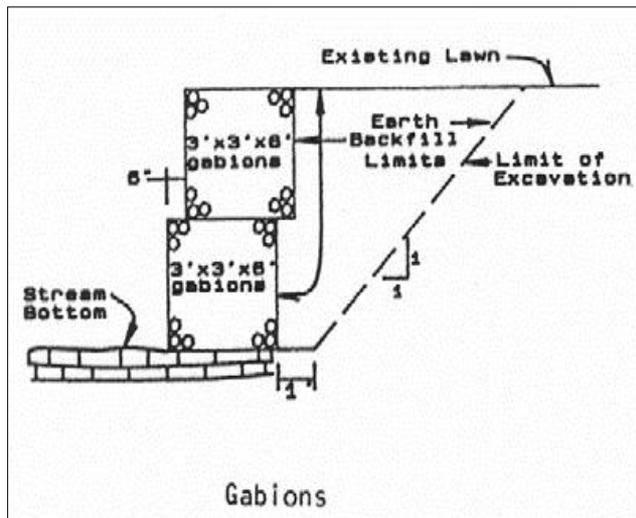


Terraced gabion wall (NRCS, 2011).

Stone filled wire mesh containers that are used to form retaining walls, sea walls, channel linings or revetments.

The purpose is to allow the use of smaller, cheaper stone which would be unstable if placed directly on the bank.

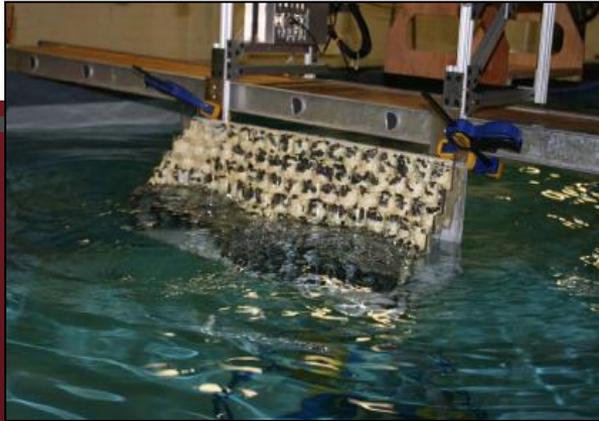
Typical gabion cross-section (NYS DEC, 2005).



The labor involved with basket closure can be substantial.

Gabions typically have a limited lifespan (5 to 15 yrs)

Green (Bio) Walls

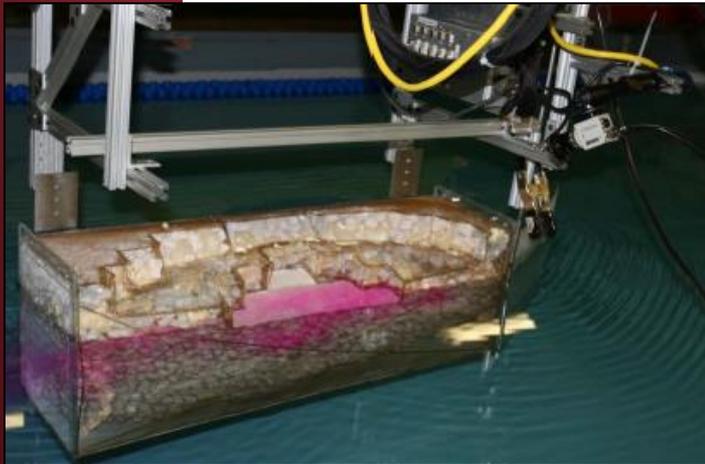


(Herrington, et al., 2005) Generic term used to describe hard sheer structures which are modified to provide ecological enhancement.

Examples include:

- Incorporating terraced or roughened edges using alternate materials
- Introducing undulations along the length of a bulkhead, gabion, or block wall.

Improve the aesthetic and ecological value of the structure, while providing the same high-level of protection.

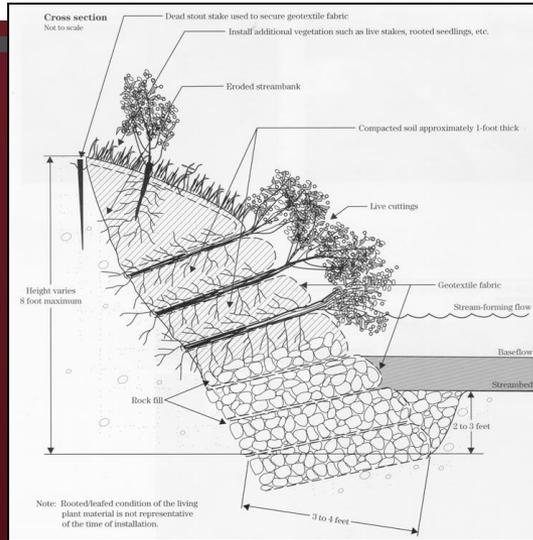


(Herrington, et al., 2005).

Popular in urban settings where a high level of protection is required and space is limited.

Vegetated Geogrid

Typical vegetated geogrid (Iowa DNR, 2006).



Made up of successive soil lifts that are separated by and wrapped in a synthetic control fabric.

Branch cuttings are then placed between each layer.

The cuttings act as a buffer to reduce wave energy and shear stress.

The branches serve to bind the geogrids together and provide a root structure behind the wall, attaching it more securely to the shore.



(<http://www.fxbrowne.com/html>)



Innovative Techniques

SLOPED APPROACHES



Cable Mats

Precast concrete blocks connected by flexible linkages.

Originally used in low-energy applications, but designs have been modified for extreme (3-6m wave heights, with ice) conditions.

Size of blocks ranges from 0.3m to over 1m square and from 0.1m to 0.3m thick.

Linkages can be wire, synthetic rope, steel, geotextile.



Coconut Fiber / Coir Roll



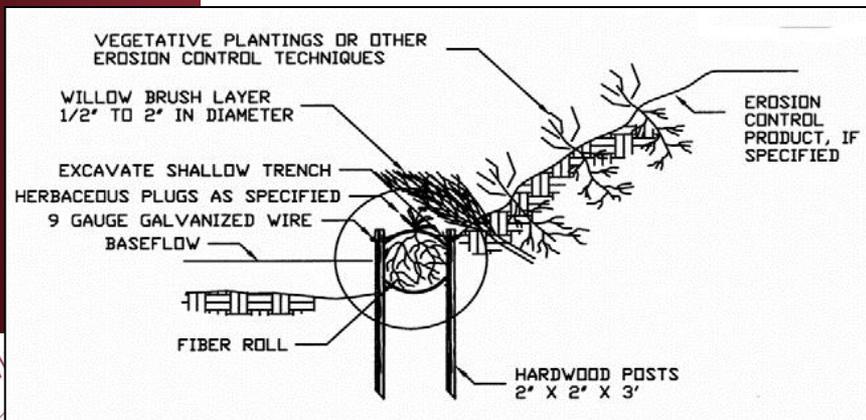
Close up of a coconut fiber roll (USDA, 1996).

Long, cylindrical structures, constructed from the fibers of a coconut.

Commonly constructed with diameters around 12 inches and lengths between 18 and 24 inches.

The standard lifespan of a coconut fiber roll is 6 to ten years.

Do not perform well in high energy environments



Typical coconut fiber roll installation (NYS DEC, 2005).

Live Stakes

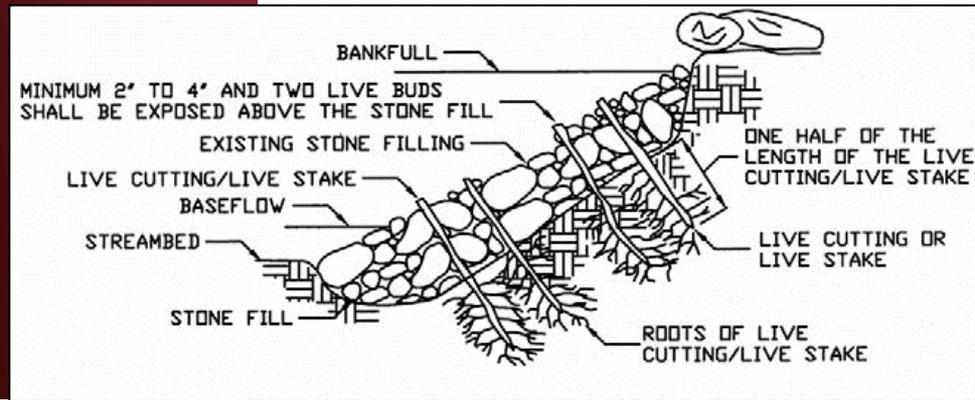


<http://www.goldenvalleymn.gov/>

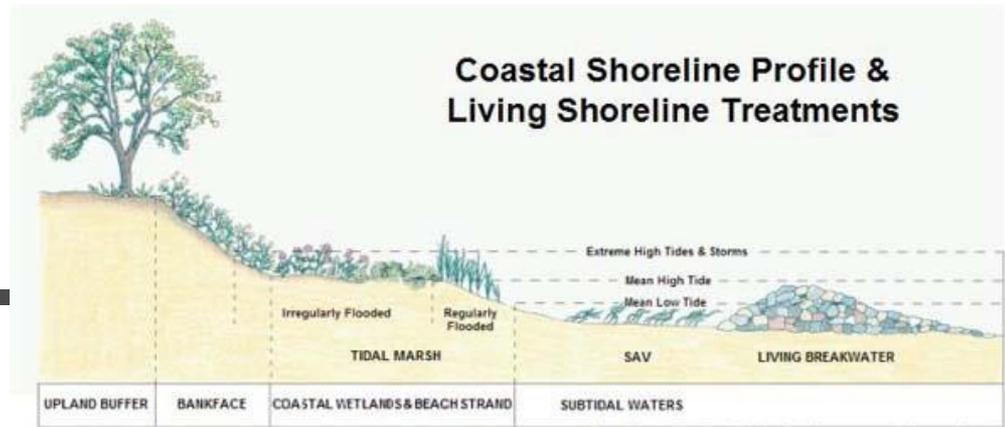
Live stakes or vegetation are planted into the open spaces, or joints, of an existing rip-rap or rock covered slope.

Alternatively, the stakes can also be placed at the same time as the rock reinforcement.

Roots creates a living mat beneath the rocks, binding the soil and preventing washout of the soil and fine material, while also providing habitat.



Typical joint planting (NYS DEC, 2005).



Graphic courtesy Burke Environmental Associates

UPLAND BUFFER	BANKFACE	COASTAL WETLANDS & BEACH STRAND	SUBTIDAL WATERS
		Tidal Marsh Enhancement	Living Breakwater
Riparian Vegetation Management		Tidal Marsh Creation	
	Bank Grading	Beach Nourishment & Dune Restoration	Offshore Breakwater System
		Marsh Toe Revetment	
Fiber Logs		Marsh Sill	Oyster Reef
		Marsh With Groins	

Innovative Techniques

“LIVING SHORELINES” APPROACHES



http://tom-samp-journal.blogspot.com/2009_09_06_archive.html

Breakwater

Shore parallel structures designed to reduce the amount of wave energy reaching the area behind them.

Sediment is frequently deposited in the lee of a breakwater.

Construction materials include rubble, concrete, and wood.

Oysters and mussels have been utilized to create living breakwaters.



<http://www.seafriends.org.nz/oceanology/beacheng.htm>



Established oyster reef (Chesapeake Bay Program).

Living Reef

Submerged aquatic habitat that works in a similar manner to breakwaters or sills.

Typically constructed by using oysters or mussels as the dominant species.

As they develop, the living reefs serve as critical aquatic habitat while also acting as a natural breakwater.

Deposition occurs and vegetation takes root in the quiescent areas created behind the reefs.



Established mussel reef (Partnership for the Delaware Estuary).

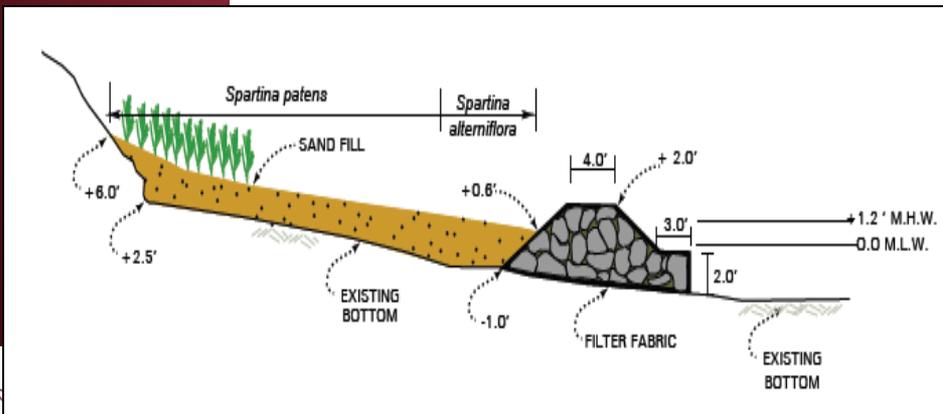
Sills



Sill and marsh shore protection project. (Jefferson Paterson Park & Museum).

Similar in function to a breakwater, sills are low elevation structures that help reduce wave energy and bank erosion.

The calm area generated behind a sill allows sand and sediment to accumulate.



Typical sill/perched beach cross-section (Jefferson Paterson Park & Museum).

Typically marsh restoration/planting is performed at the same time.

The resulting perched beach and marsh helps dissipate wave energy.

Innovative Techniques

CASE STUDIES





NYC Parks Department Designing the Edge Project

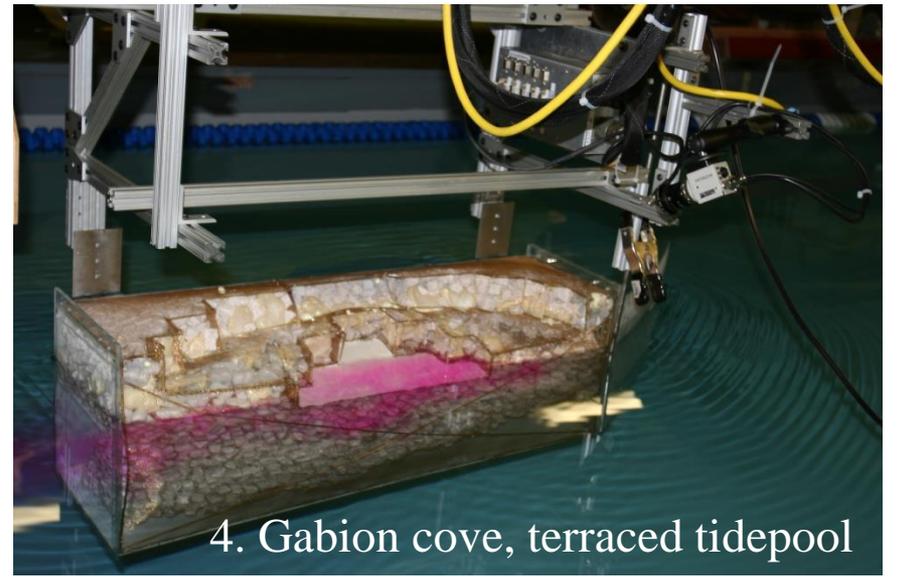
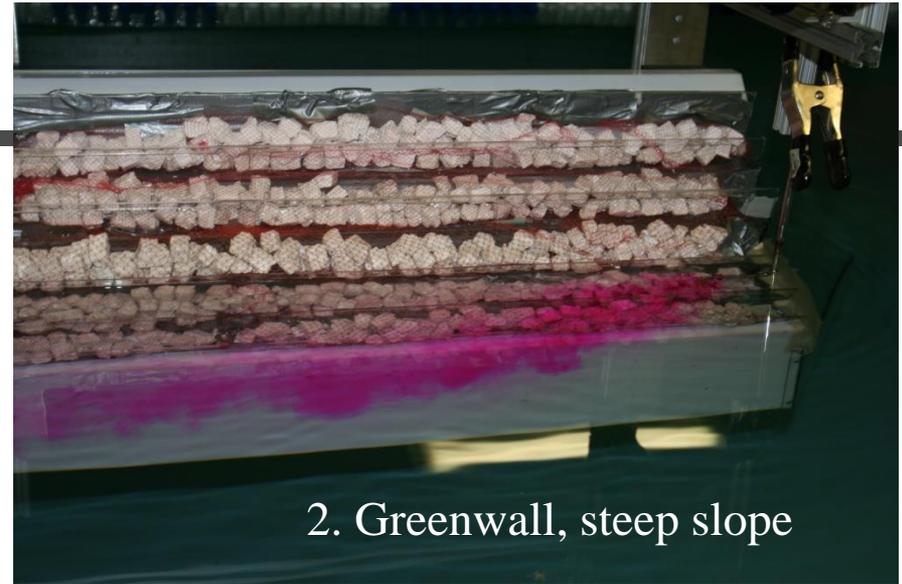
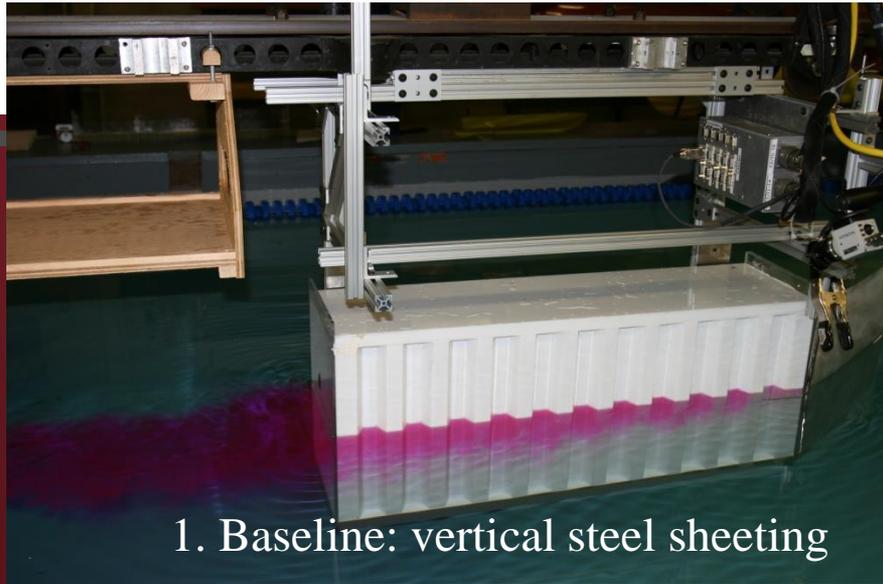


Goals:

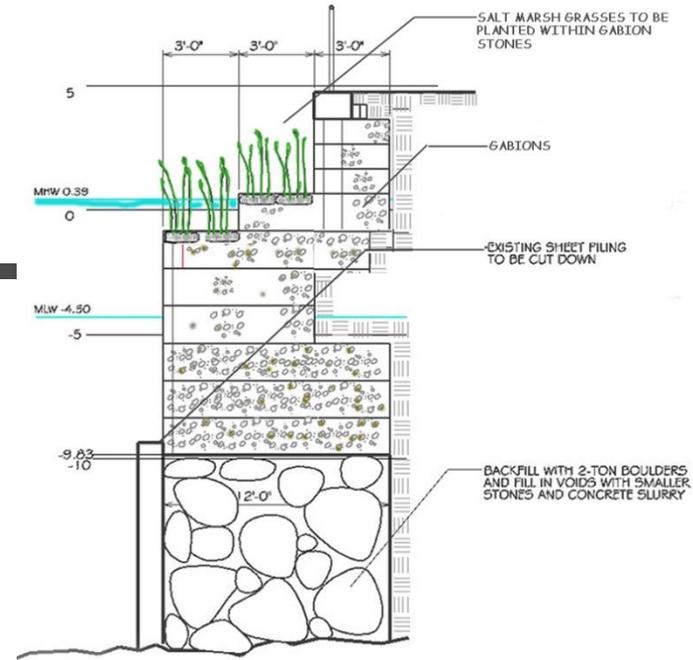
- Improve ecological value of urban shore
- Modify the waterfront edge to enhance safe access to the water by the public
- Increase compatibility with recreational uses



Physical Modeling Studies



Designing the Edge Harlem River Park



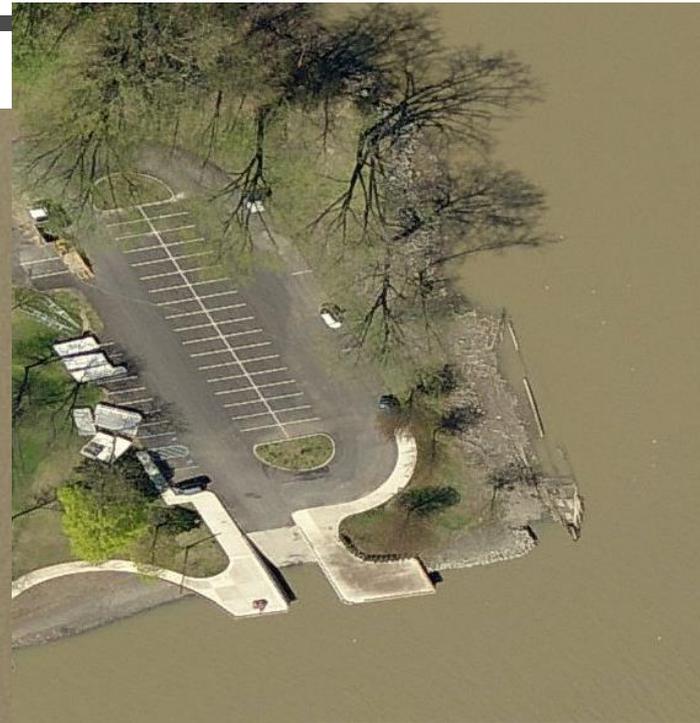
Harlem River Park - Gabion Shoreline

Reza Mashayekhi, Structural Design
Ricardo Hinkle and Marcha Johnson - Landscape Architects



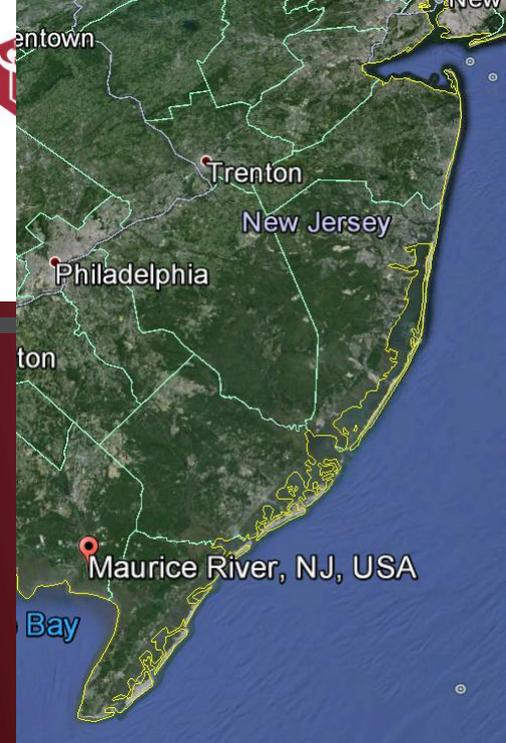


Cossackie, NY



Coxsackie, NY





Maurice River, NJ



June 2011

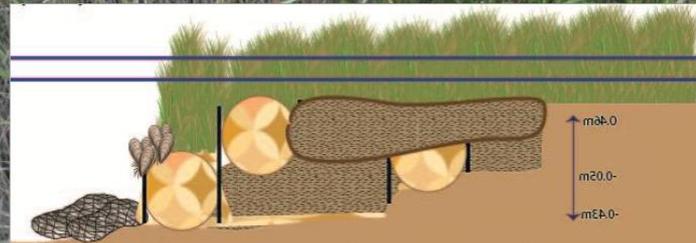
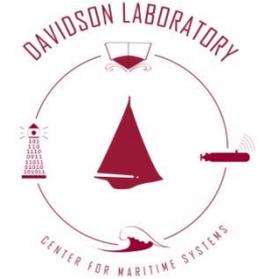
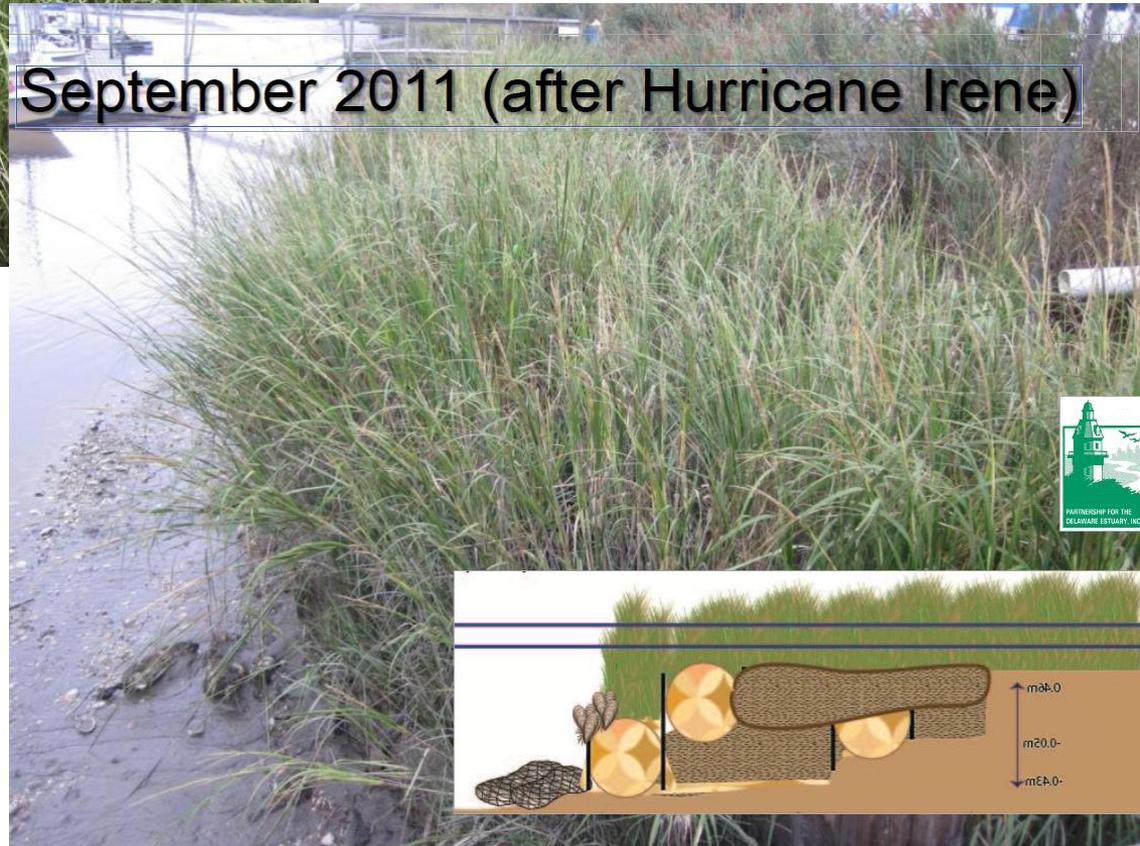


Maurice River

April 2010

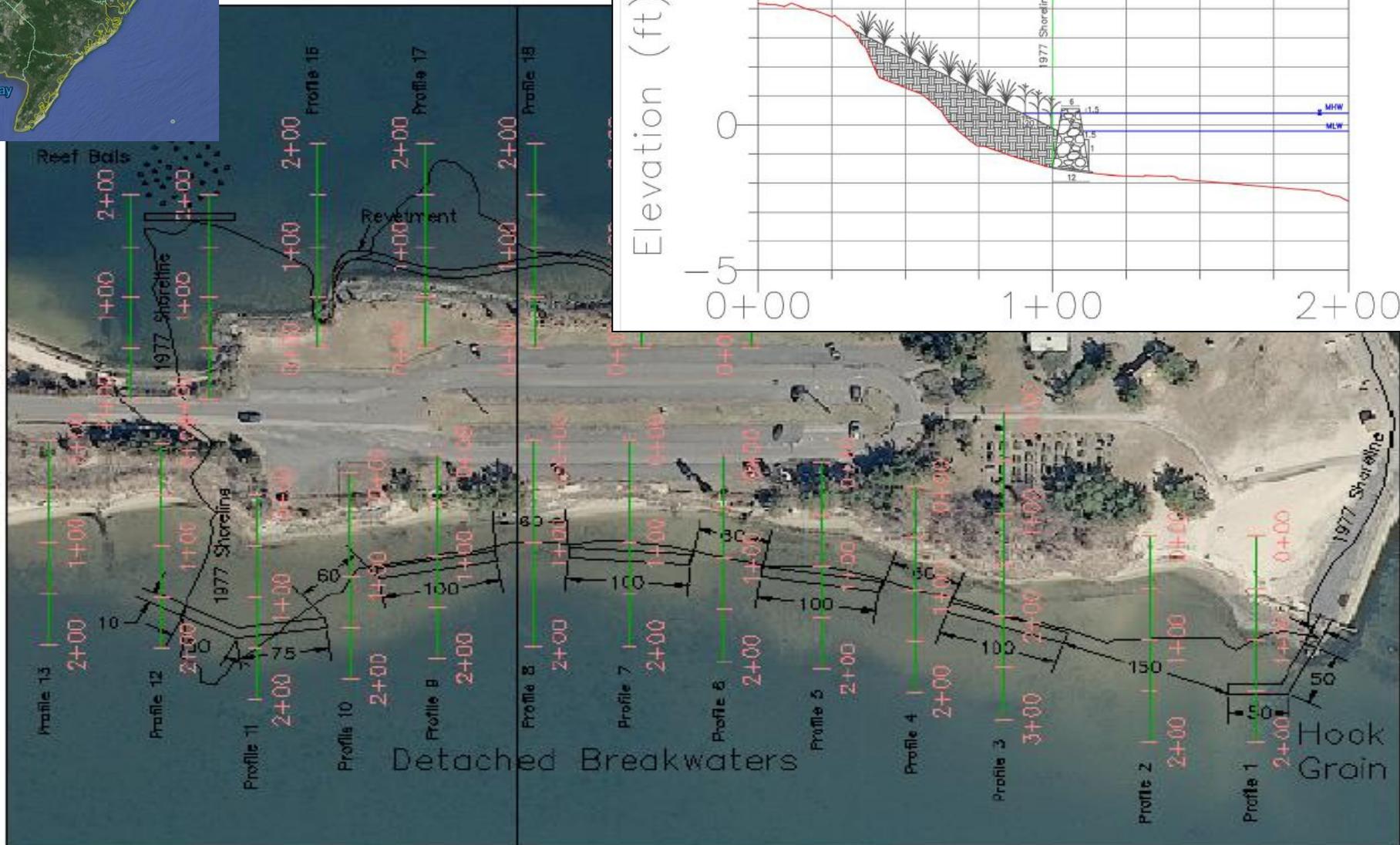
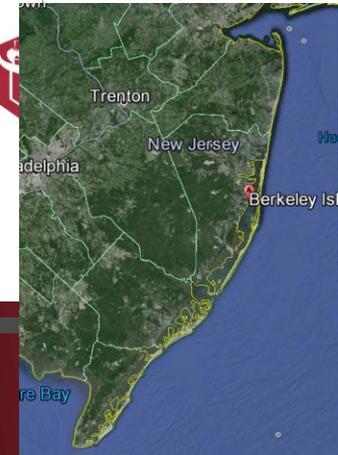


September 2011 (after Hurricane Irene)





Berkeley Island, NJ



DAI

Some Exciting Developments

- Engineering Design Guidelines (NJ & AL)
 - Berkeley Island
- Forensic Analysis (NY)
- DOI/NFWF Grant Program
- Natural and Nature-Based Features Workgroup
- Green Infrastructure Research Plan for NYC (NY)

Questions???



Jon K. Miller
Stevens Institute of Technology
jmiller@stevens.edu
(201) 216-8591
@NJBeachProf