Living Shoreline Professionals Advanced Training

August 24 & 31, 2017

Hosted by

Virginia Institute of Marine Science

College of William & Mary

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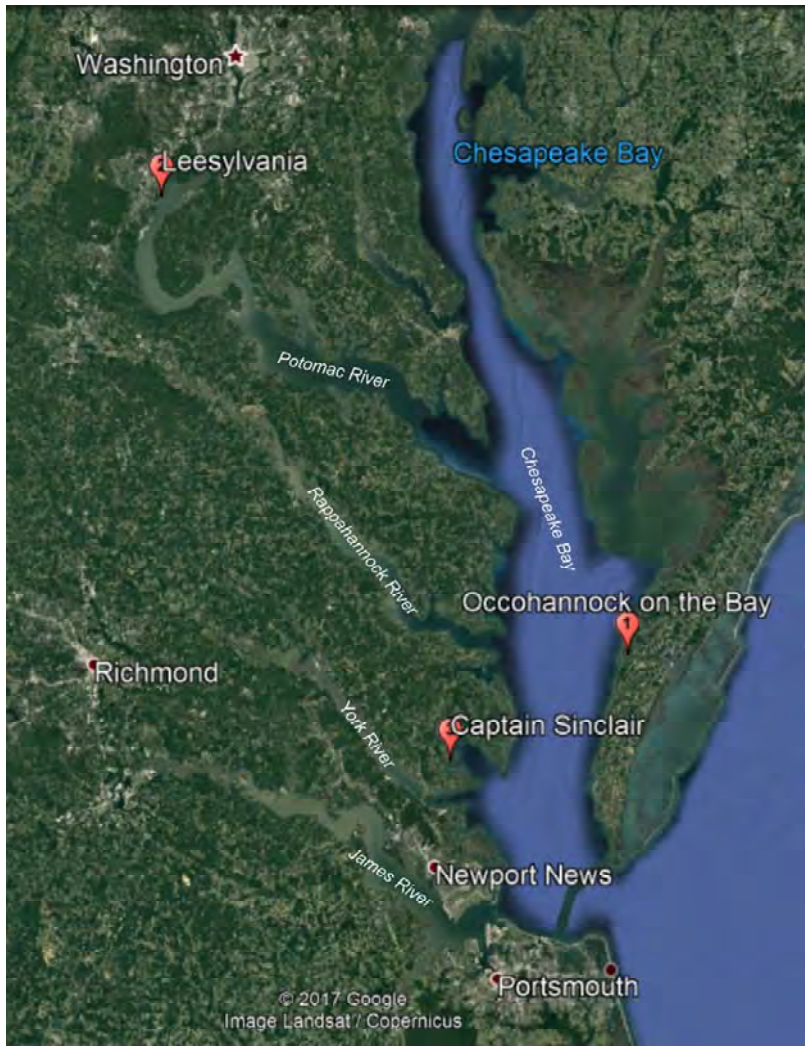
LIVING SHORELINE PROFESSIONALS
ADVANCED TRAINING
AUGUST 2017

Part 4

MARSH SILL DESIGN
CASE STUDIES

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA16NOS4190171 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

Living Shoreline Sites



Locations of demonstration sites discussed in this talk.

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Occohannock on the Bay

A shoreline management plan for the entire creek made conceptual shoreline management recommendations along every stretch of eroding shoreline [(Hardaway et al., 2008) https://publish.wm.edu/reports/232/)]. As a result, The Nature Conservancy came to the Shoreline Studies Program when they were looking to install a living shoreline system as a demonstration project for the United Methodist Camp and Retreat Ministry at Occohannock on the Bay. The mission of Occohannock On The Bay is to provide programs and facilities which make use of the natural setting of waterfront, woodland, and open spaces. They host summer camps as well as retreats.

Design Considerations

- Fetch
- Wave Climate
- Shoreline change rates
- Shoreline orientation
- Shore geometry
- Nearshore bathymetry
- SAV
- Sunlight (often over looked)

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Developing a Site Specific Design

- Survey existing conditions including elevations, existing structures and natural resources (SAV)
- Determine goals of landowner

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One of the main reasons for the project was that the access road between two sections of camp was being threatened and becoming unusable. Also, the camp wanted to make the shoreline more accessible and safer for the campers and employees to use.

Shoreline Change

Shore Change Data: 1937 to 2009

- Very High Accretion: > +10 (ft/yr)
- High Accretion: +10 to +5 (ft/yr)
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion

1937/38 Shoreline

2009 Shoreline

From Shoreline Studies Program
Shoreline Change Data Map Viewer

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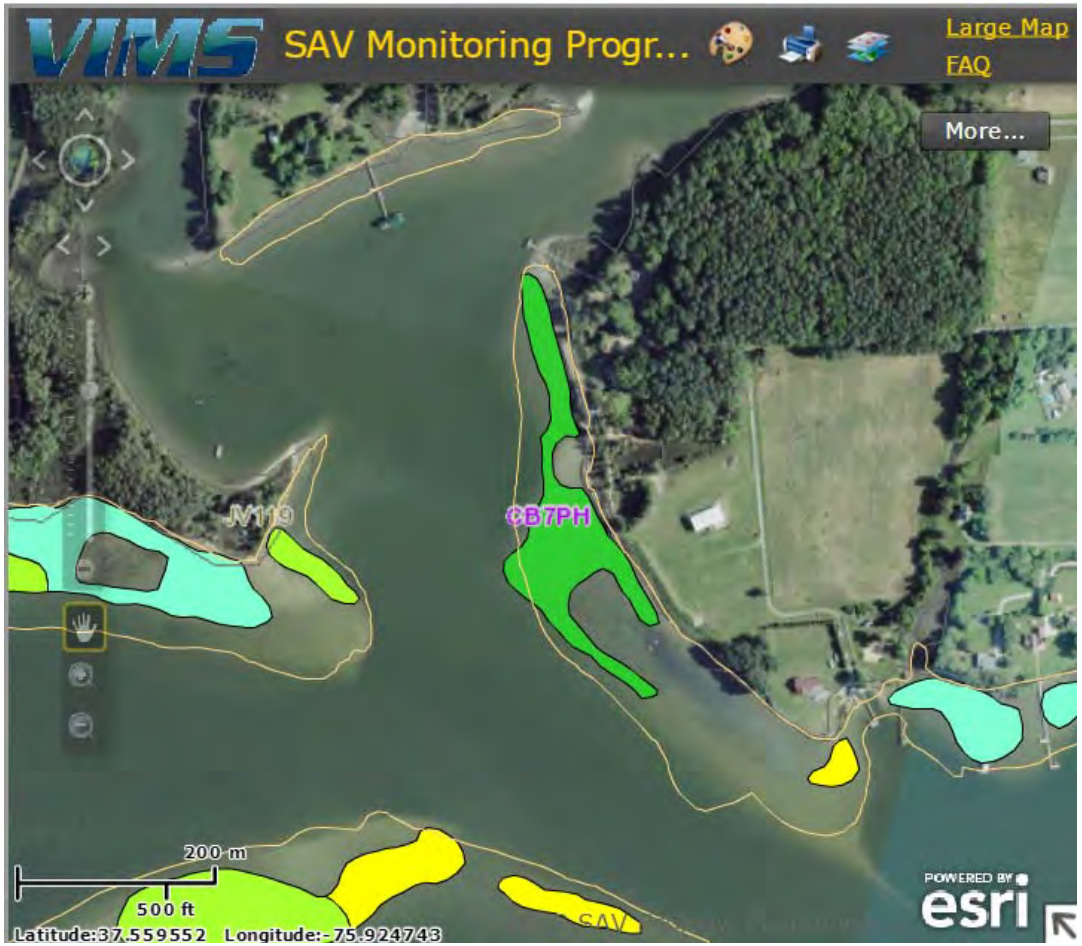
Most of the shoreline had a long-term very low erosion rate.
http://www.vims.edu/research/departments/physical/programs/ssp/gis_maps/index.php

SAV (Submerged Aquatic Vegetation)



From http://web.vims.edu/bio/sav/maps.html

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SAV existed along much of the shoreline. Because SAV generally cannot be disturbed by construction, it is crucial to consider its impact at the site in the design process.

Shore Survey

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The site was surveyed with a real-time kinematic global positioning system and a robotic total station because this was a research project in addition to a design project. Generally, a survey does not need to be as detailed for a project site. It is important to determine the elevation of the bank, especially if it will be graded, the nearshore depth, intertidal gradients, existing wetlands and SAV, and tide level.

Existing Structures

North End:
Stone placed at the end of a bulkhead that was being flanked.

South End:
Revetment placed along the eroding upland with a narrow marsh in front.

Existing structures that had to be considered in the design process. Photo date: Jan 18, 2012

Existing Conditions


North End: Eroding upland bank


North End: Eroding bank & recreation area


Tidal Creek

Erosional scarp in front of access road

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Additional considerations were the eroding upland bank, the kayak launch and recreation area, the tidal creek outlet and the access road.

Shore Considerations

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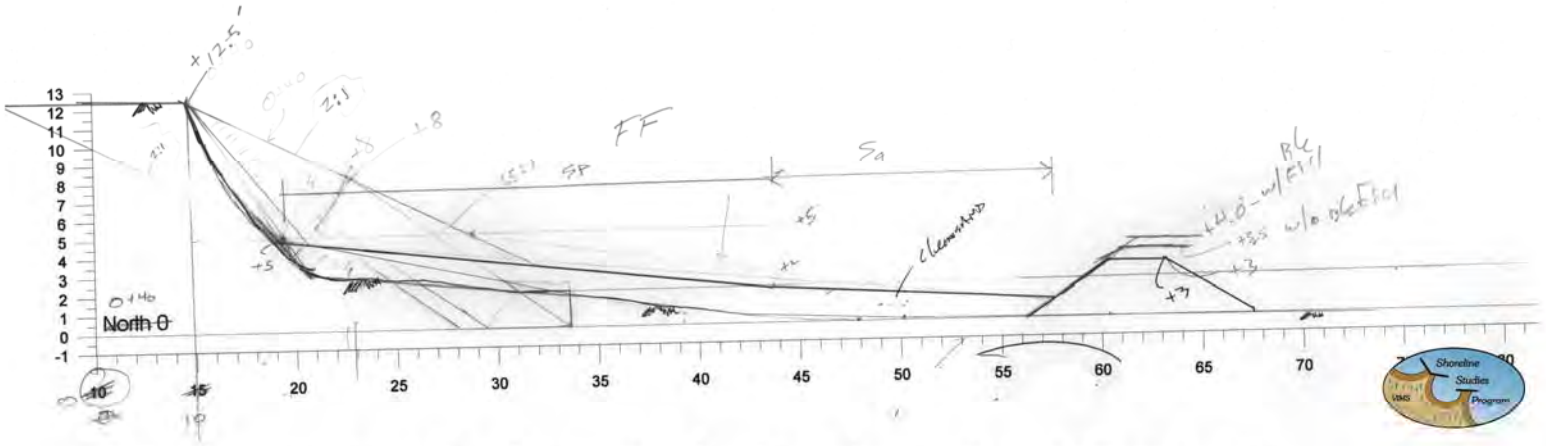
Cross-sections



Typical cross-section for the eroding bank on the north end. First design considerations included height of sill, filling in front of the eroding bank so that trees did not have to be removed.

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The design of the system can go through several iterations and change as new information becomes available or goals shift.

Design

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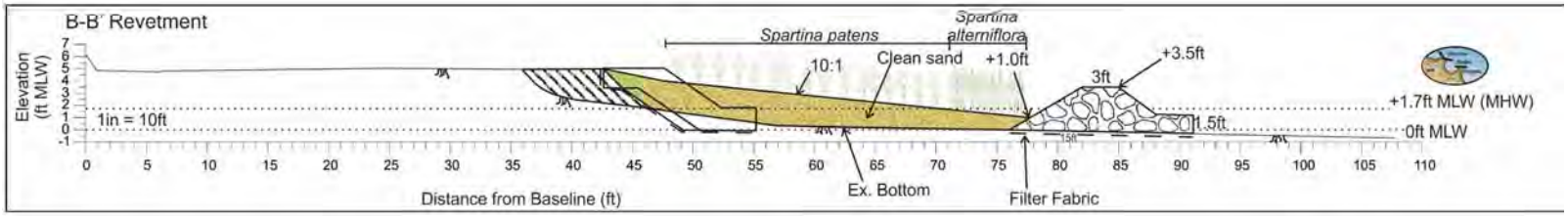
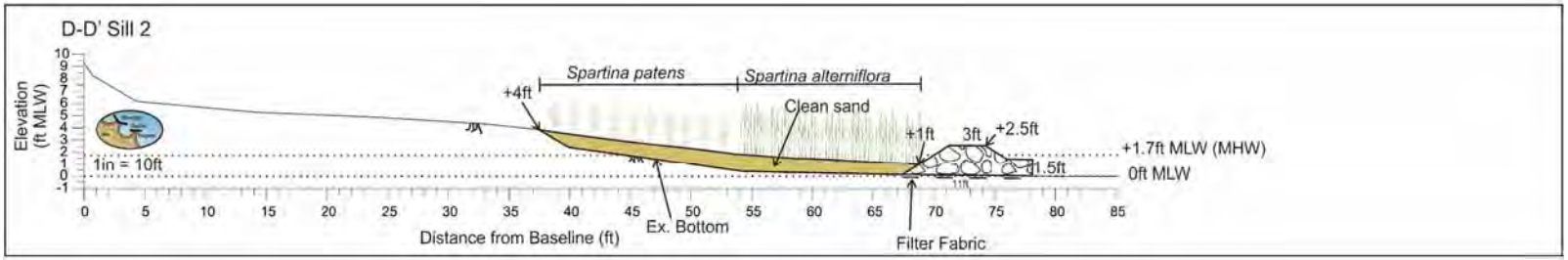
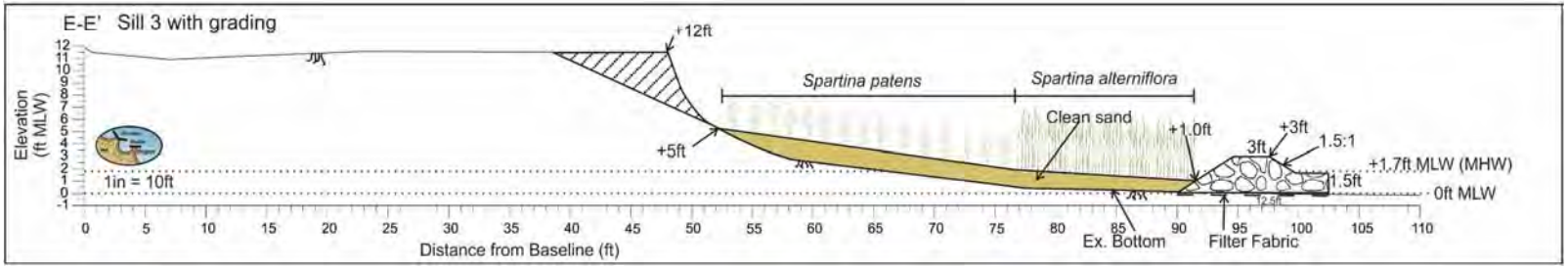
For the permit application, the conceptual design included three sills and a revetment along the most highly eroding section of shoreline. The gaps were spaced to allow for the tidal marsh channel to exit into the creek. In addition, the sills were angled to create more of an embayment between sills 2 and 3. This allowed for use as a canoe launch.

Final Cross-Sections







Typical cross-sections were developed to determine the dimensions of the system. Not all of the sills are the same size. They vary depending on site specific parameters. Z-Z' (Shown in Figure 5-4 of the Design Guidelines manual) was placed in the area that was most exposed and had the highest erosion rate so it is higher and wider as is the sill 3 (E-E') which will be in front of eroding bank. Sills 1 and 2 are more protected from incoming waves so they are lower and narrower. These sills are less than a foot higher than MHW. The cross-sections are also needed to estimate cost.

Original Cost Estimate
2013

Camp Occohannock Preliminary Cost Estimate				
	Amount	Unit	Cost ($/unit)	Total Cost ($)
Rock	1080	Tons	80	$86,400
Sand	1068	cy	45	$48,060
Cobble	111	cy	65	$7,215
Plants	7953	plants	1.5	$11,930
			SubTotal:	$153,605
			^25%	$30,721
			TOTAL:	$184,325
^site work, bank grading, tree removal, mob, and demob				

Actual cost estimate about $150,000; however, this did not include the cobble sill which wasn't built.

Habitat Created and Impacts

			Habitat Created		Impacts: Rock					Impacts: Sand					
		Length	Sa (ft^2)	Sp(ft^2)	Max	Max	Vegetated	Nonveg	Subaqueous	Fill	Veg.	Volume		Area	
Typical	Structure				MHW	MLW	Wetlands	Wetlands	Bottom		Wetlands	<MLW	>MLW	<MLW	>MLW
X-Section	Type	(ft)			(ft)	(ft)	(ft^2)	(ft^2)	(ft^2)	(cy)	(ft^2)	(cy)	(cy)	(ft^2)	(ft^2)
A-A'	Cobble Sill	405			12	3	1,920	1,620	50						
B-B'	new sill	185	1,260	4,140	45	18			2,520	360	290	360			5,400
C-C'	Sill	100	1,500		30	12		100	1,200	60		0	5	0	1,500
Bay A	Bay														
D-D'	Sill	120	1,800	1,800	50	25		660	660	192	100	1	70	20	3,600
Bay B	Bay									68	0	1	65	200	1,800
E-E'	Sill	220	3,300	5,500	45	20		5,280	2,640	484	612	1	242	20	8,360
Total		1,030	7,860	11,440	**182**	**78**	**1,920**	**7,660**	**7,070**	**1,164**	**1,002**	**363**	**382**	**240**	**20,660**

Sa=*Spartina alterniflora*

Sp=*spartina patens*

SAV Impact= 180 ft2 of intermittent widgeon grass

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This table was created for the permit application so that the required information was readily available and accurate. This includes impacts to subaqueous habitat as well as the amount of wetlands to be created.

Basic Construction Sequence

1. Clear site of debris and unstable trees
2. Remove derelict structures and dispose properly
3. Stage materials out of sensitive areas
4. Install construction mats where needed
5. Install sand containment structures (sills) then backfill with sand
6. Waiting period for settling before planting to verify tide levels
7. Temporary erosion and sediment control measures until vegetation cover is restored
8. Planting according to recommended schedules
9. Grazing exclusion devices
10. Inspection and corrections until stabilization is apparent

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Top Left: Loading rock onto site truck
Top Right: Installing filter fabric
Lower Left: Placing beach nourishment
Lower Right: Bringing in sand material

Planting Marsh Grass

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Volunteers planting marsh grasses on a 1.5’ x 1.5’ center. Steps include drilling the planting hole, adding fertilizer, installing peat pots/plants, and healing in each plant.

Pre & Post Construction

2013 VBMP Imagery

2014 NAIP Imagery

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The project was completed in 2014.

Before & After Marsh Planting

Access road reach, sill #1

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Before & After Marsh Planting

March 2012

April 2014

Upland bank, sill #3

September 2014

Post Construction

Sill #3 in foreground

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Habitat Created

Oysters on Rocks and SAV

Fiddler Crabs

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May 2017

After three growing seasons, the grasses have generally fared well at the site. Areas of marsh are lush and other plants (pine trees) are beginning to colonize the upper marsh and upland transition zone. However, one section of low marsh behind Sill 3 remains bare.

Replanting – July 2017

The bare spot was a concern so additional plants were planted in July 2017 and will be monitored to see how they fare.

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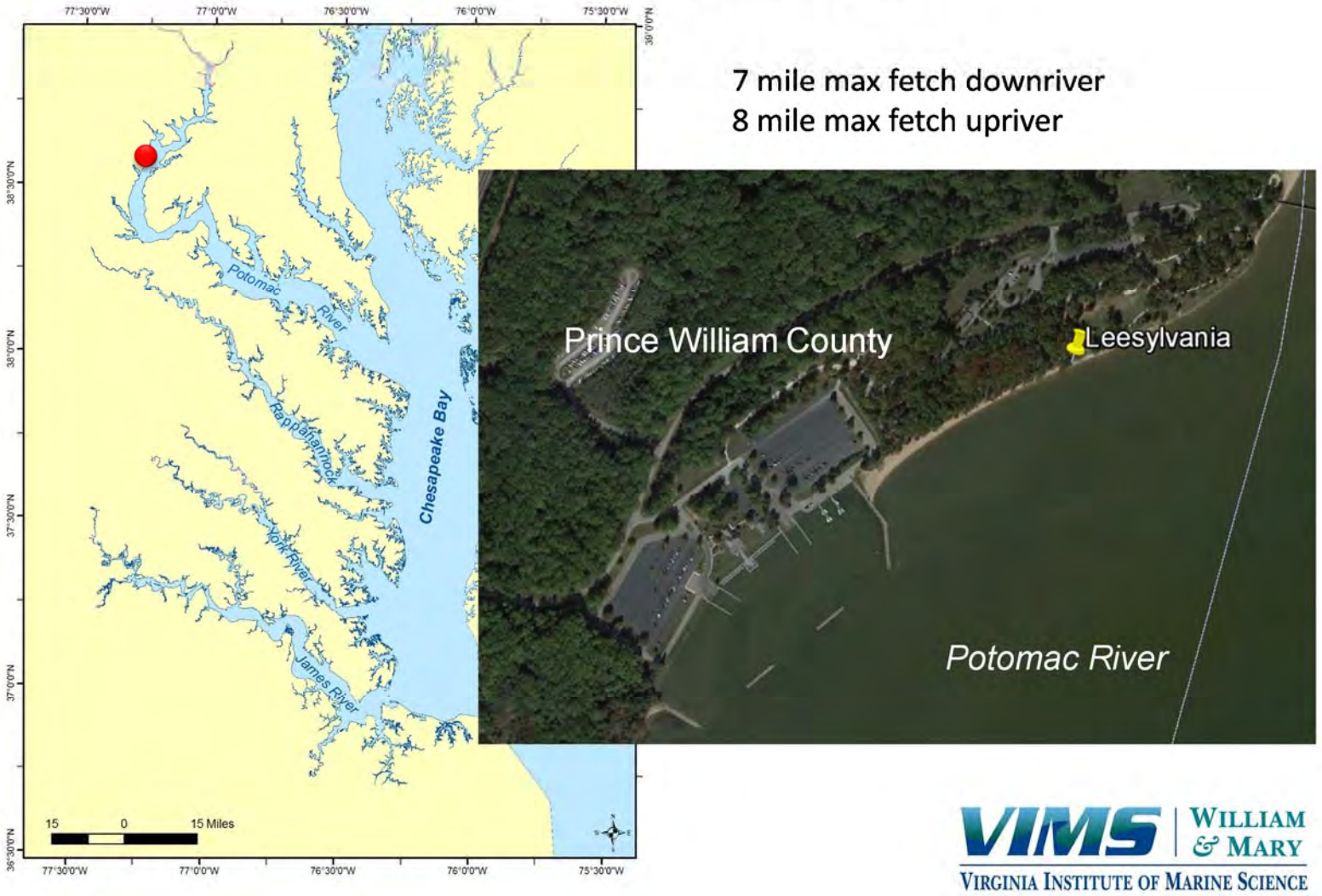
Leesylvania State Park



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Leesylvania State Park is nestled along the tidal shores of the historic Potomac River. Listed on the National Register of Historic Landmarks, this 543 acre park offers many land and water activities, including hiking, picnicking, fishing and boating. A universally accessible fishing pier, playground, boat launch, boat storage area, snack bar and store, visitor center and gift shop are available. A 20-station fitness trail and canoe and kayak rentals also are available. In 2016, the living shoreline project was designate a Virginia Treasure by Governor Terry McAuliffe.

Existing Conditions

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Erosion destabilized about 800 ft of shoreline on the Potomac river and threatened walkways and picnic areas. In addition, mature trees have to be removed every year because of exposed roots and safety concerns. Active erosion and stormwater runoff from upland areas contributes large amounts of fine sediments to the river. The area was unsafe for park users.

Maintenance & Upland Runoff

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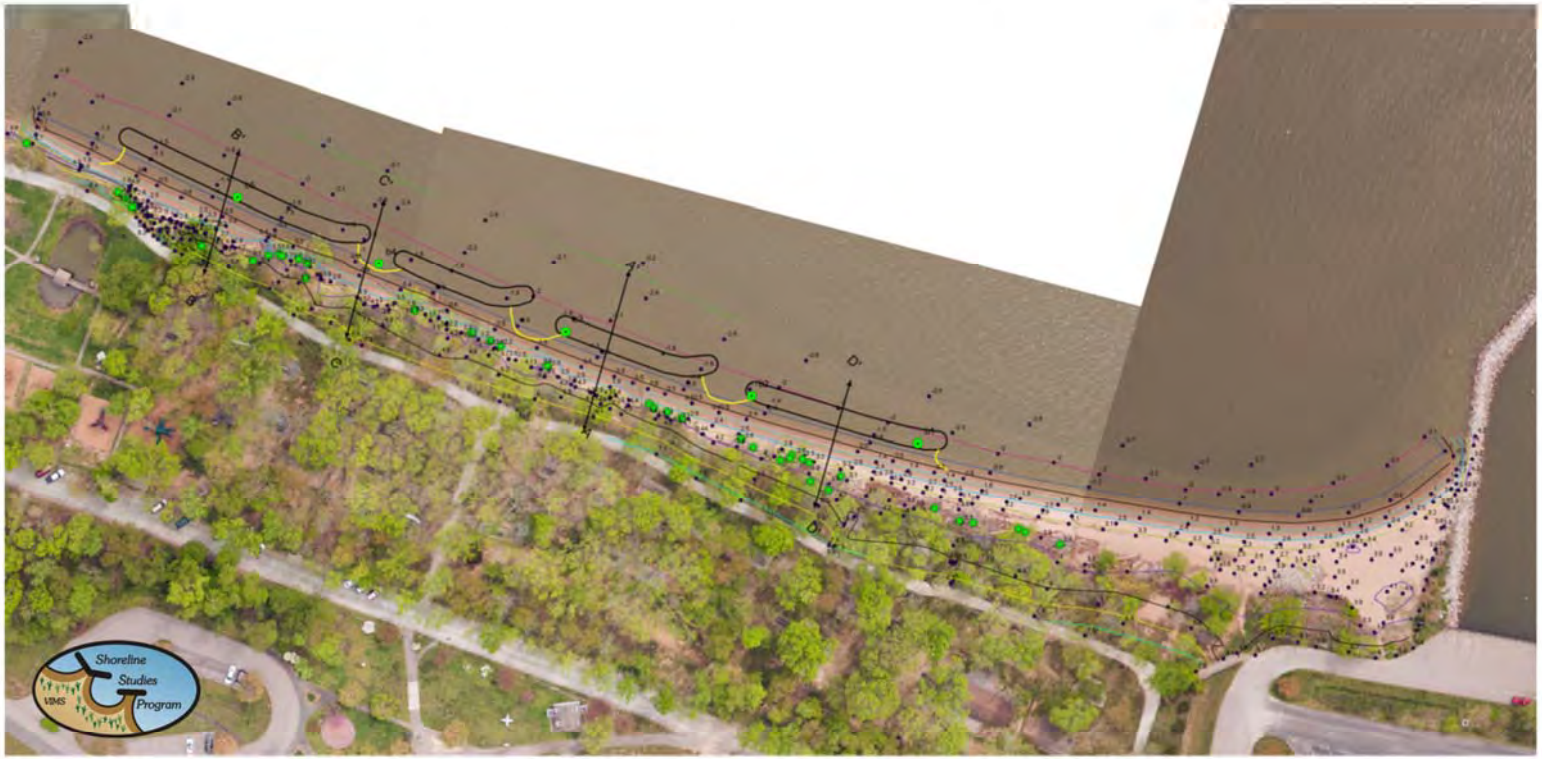
Maintenance will be a long-term issue for this site as logs wash up regularly along the shoreline. These will need to be removed from the marsh or it will kill the plants. Upland runoff was a consideration for this site because it is channeled and piped at the site.

Shoreline Plan and Survey



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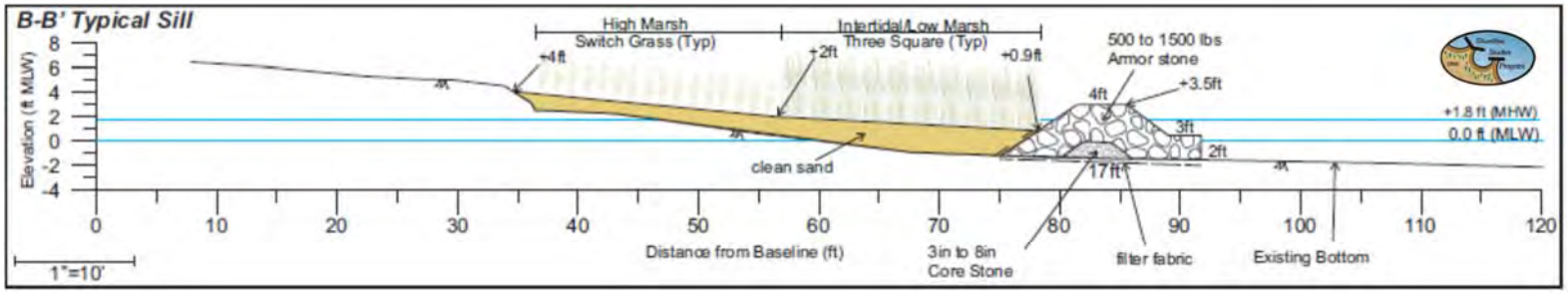
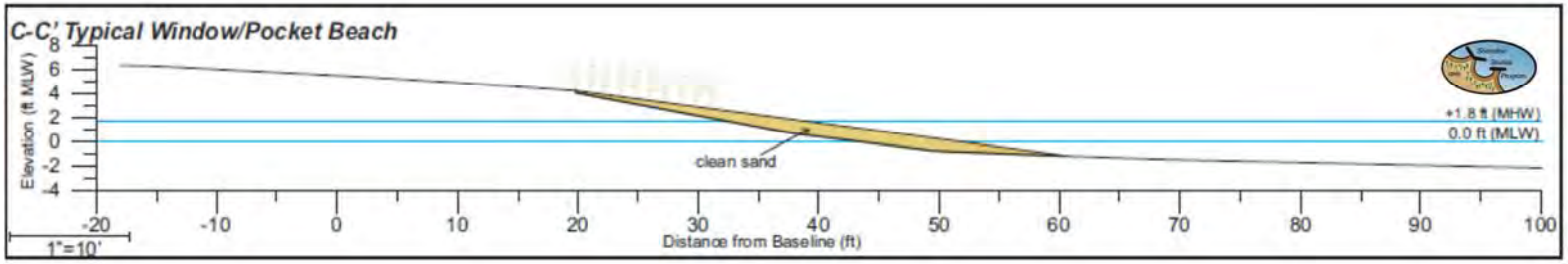
Typical Cross-sections





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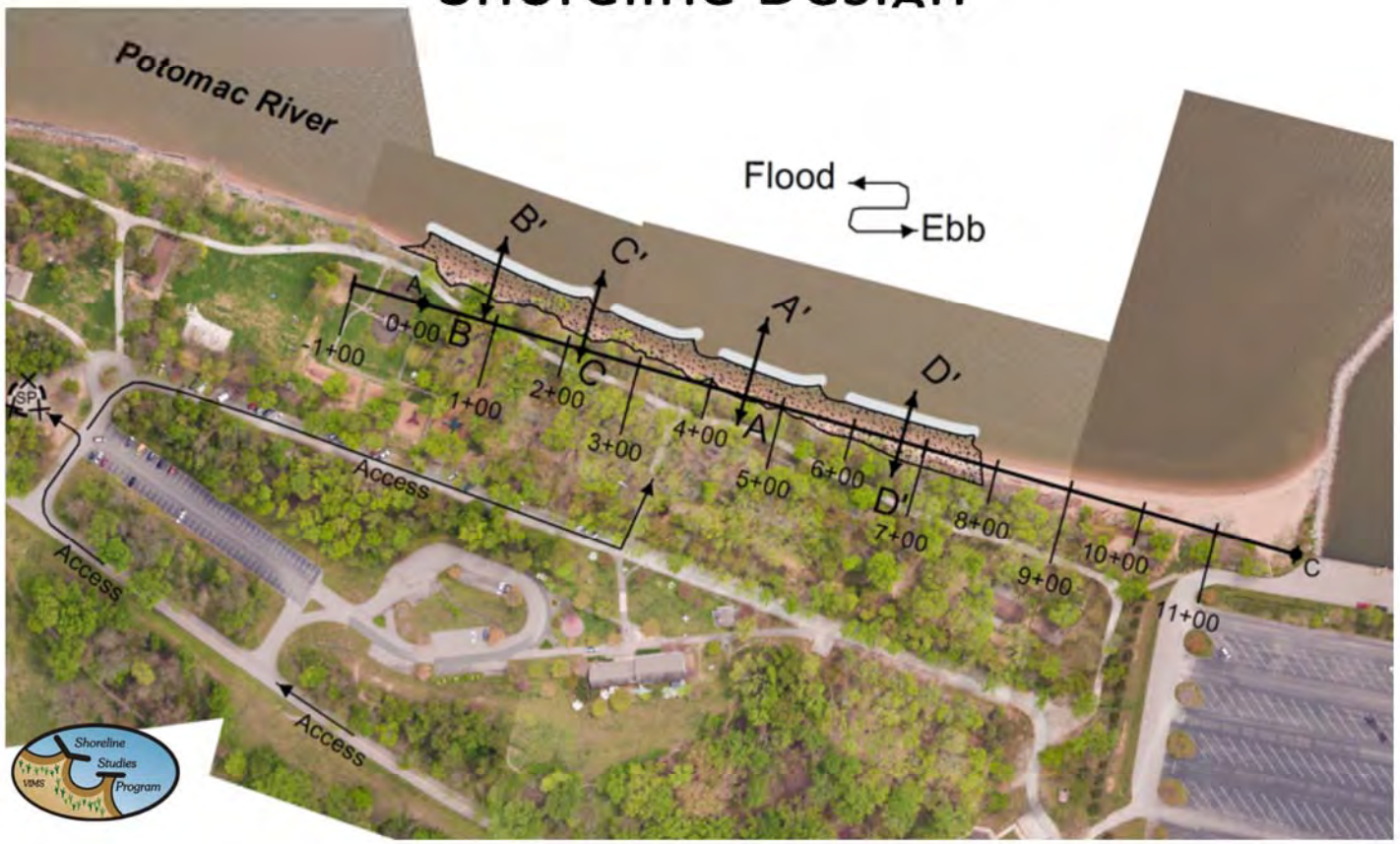
This site is has more energetic conditions than Occohannock so the sills are higher and wider as a result. They are almost 2 feet above MHW and the crest is 4 ft wide. This site has a very low backshore so it has to be understood that flooding will still occur. But the goal is that during higher water situations, the waves will break on the structure and attenuate over the marsh protecting the upland from direct wave attack.

Shoreline Design



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Even though this stretch of shoreline is not a beach, many people access the water. The design leaves several windows in the marsh so that people can still get to the water. Sunlight is an issue because of tree cover. Some of the trees along the shoreline had to be removed so that the planted marsh will get enough sunlight to grow.

Post Construction

The project was built in summer 2016. Upland runoff is indeed an issue at the site as shown in these post-construction photos top right and bottom left. Erosion of the placed sand fill occurred.

Upland Runoff Erosion Control

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To address the upland runoff, hay bales were placed along the shoreline to slow the water before it impacted the shoreline.

One Year Post Construction

The vegetation has taken hold at the site. There is a low spot behind northernmost sill that is completely submerged. The backshore zone has some bare spots in it, but it should fill in over time as new plants colonize the site. Photo date: 23 Oct 2017.

Oyster Bag Sill Construction

Middle Peninsula Public Access Authority Property

Funded National Fish & Wildlife Foundation

Existing stone sill demonstration site

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Oyster bag sills are a relatively new shore protection method. Oyster shells are packaged in mesh bags which are placed along the shoreline to create a sill. The goal is for new oyster spat to colonize the shell thereby cementing the structure into a reef. Research is presently underway by Shoreline Studies Program on this method. Shoreline Studies Program received a grant from the National Fish & Wildlife Foundation to build two oyster bag sills on public property and monitor the site. This presentation details installation at one of the sites.

Oyster Bag Sill Construction

- The marsh is eroding rapidly eroding along the point.
- The marsh shoreline is breaking through on the east side.
- Once that happens, erosion will accelerate within the marsh.

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The marsh point shoreline is actively eroding at this site. However, it was neither physically nor economically feasible to build a stone structure to protect the shoreline. The shallowness of the site and lack of access for construction as well as the soft nearshore made it an unfavorable site for a traditional rock sill. However, the marsh is an important habitat, and the site is used for recreation including kayaking, fishing, and duck hunting so some sort of protection to reduce erosion was desirable. It was determined that this site would be a good research and demonstration site for oyster bag sills.

Site Suitability

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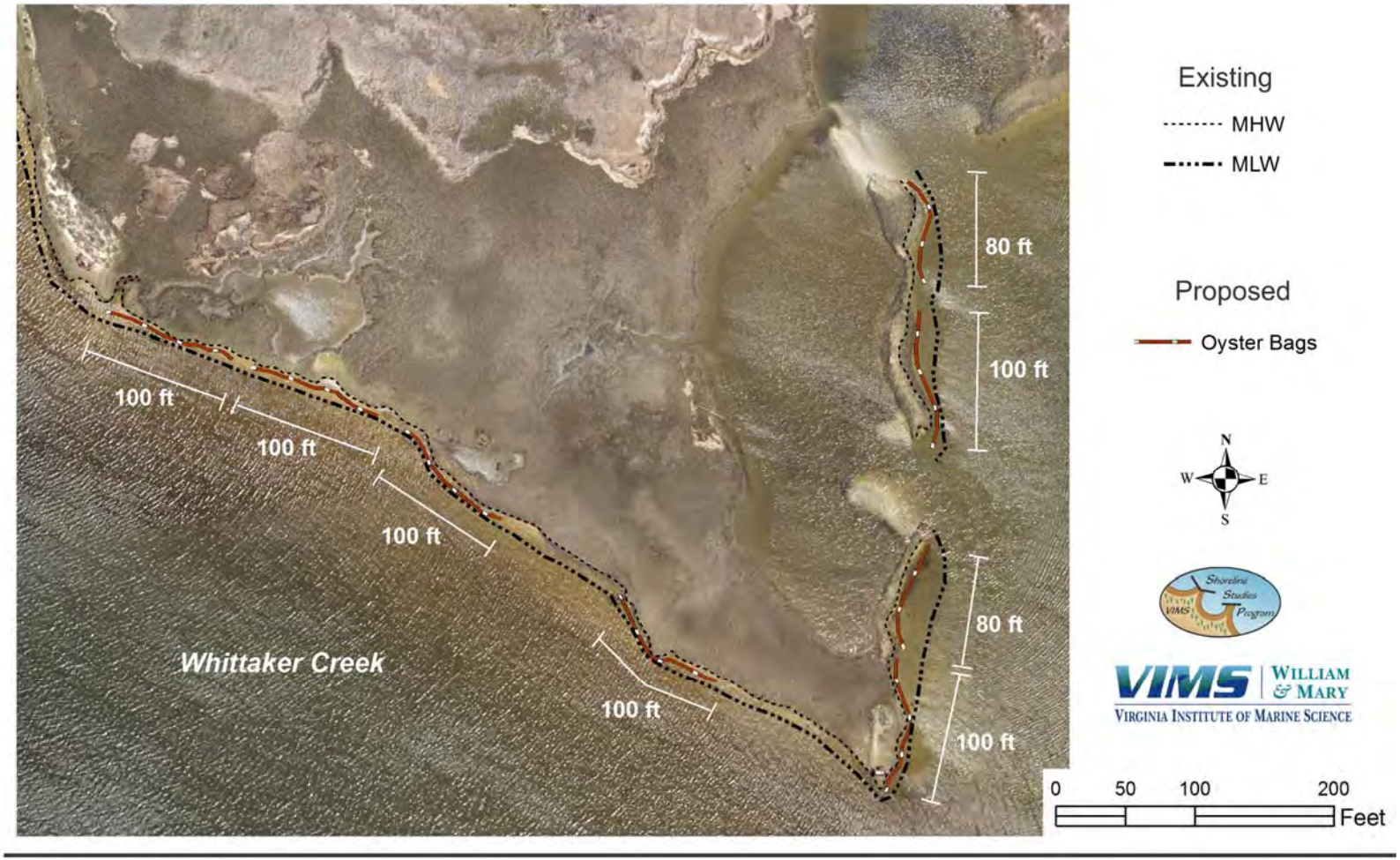
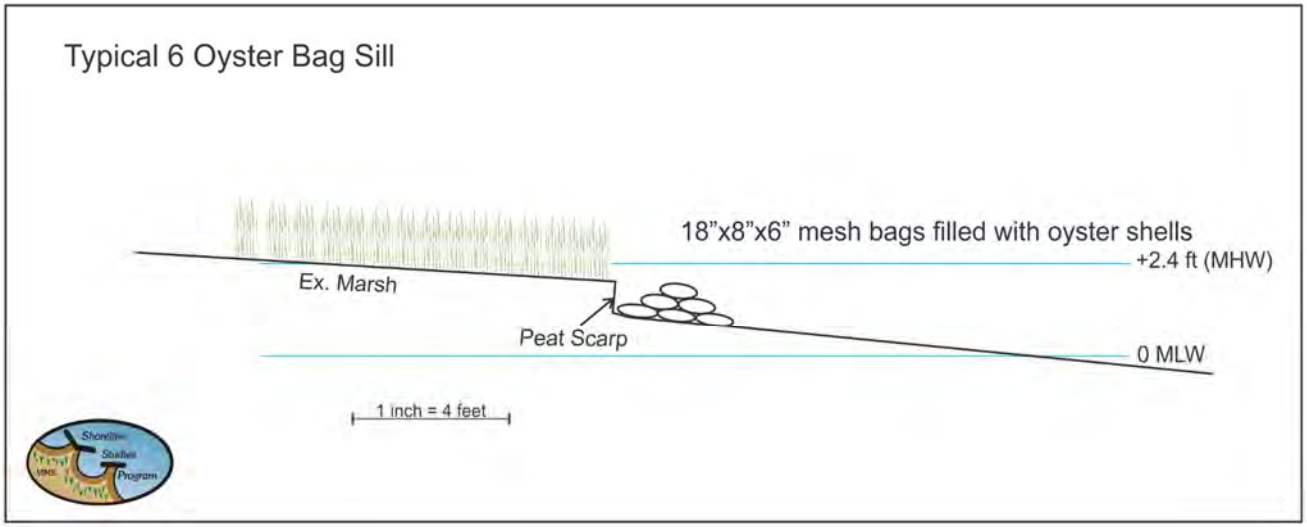
The marsh at Captain Sinclair has naturally-occurring oysters at the site where the oyster bag sill was proposed. This made it a suitable site because the idea is that spat in the water column will attach to the oyster bags to create a protective reef along the shoreline.

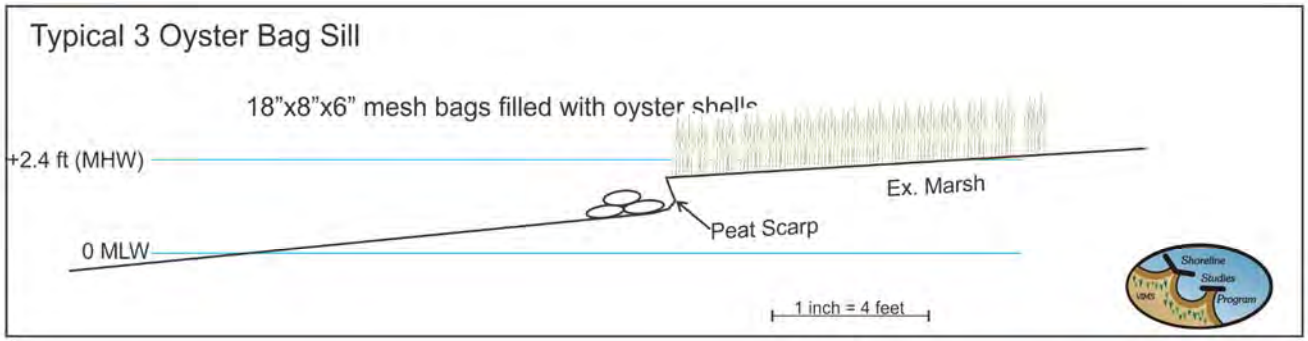
Design



The shoreline is eroding, but it is too shallow to bring rock in and there is no access from land. We sought funds to construct the sills and monitor them to see if they are effective at shore erosion control and how well they stay together. The sills on the east-facing shoreline have a longer fetch and were designed as 6 bag sills. The sills on the southwest-facing shoreline were designed as 3 bag sills.

Cross-Sections





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Bag Transport to Site

The pallets of bags were delivered via truck and forklifted to the shoreline. A wooden slide was created to slide the bags into the boats. Once the boat was full, it would deliver the bags to the people building the sill in the water. Each bag weighs about 25 lbs, and this project called for 2,000 bags.

Construction in the Water

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The shell bags were handed off the boat to people in the water. One person placed two bags side by side and another person came behind and placed the bag on top. Photo dates: Aug 15-16, 2017

Final Sill

Photos of the 6 bag sills along the shoreline. Photo dates: Aug 15-16, 2017

Summary

These Living Shoreline projects illustrate how to design and construct shore erosion control projects at sites with different fetch exposures, shore types, cost considerations, and land owner goals.

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