USFWS Eastern Neck
Living Shoreline
Design–Build Project
A Hurricane Sandy Funded Project

December 13, 2016

Mark Jaworski, CH2M
Project Location
Team Partners

Project Partners include:

- **USFWS** (Owner)
- **Ayuda** (8a Prime)
- **CH2M** (Engineer)
- **Virginia Institute for Marine Science** (Advisor to CH2M)
- **Coastal Design & Construction** (Builder)
Study Area & High Priority Habitat Protection Area

SAV Beds within the Project Area
Erosion History

According to the Eastern Neck National Wildlife Refuge Comprehensive Conservation Plan (March 2010)…..

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

- Project scope included:
  - Identify locations and causes of Shoreline Erosion
  - Bathymetric and Topographic Surveys
  - Hydrodynamic, Storm and Sediment Modeling
  - Geotechnical Investigations
  - Conceptual, 30%, 90% & Final Engineering Design
  - Cost Estimating and Scheduling
  - Cultural Resource Investigations
  - NEPA Envl. Assessment and State/Local Permitting
  - Construction of the Living Shoreline
Key finding was that shallow water depths limit barge access and dictate the distance from shore where breakwaters and sills can be constructed.
Nine geotechnical borings were advanced by hand augering to depths ~ eight ft below mudline.

The subsurface conditions include layers of peat, fine-grained deposits, and granular deposits.

Determined that rock breakwater at the site are to be supported on a geotextile fabric to assure no loss of rock within the soft cohesive soils.
- Data collection and analysis
- Wind extremes determination → MIKE EVA, MIKE by DHI
- Wave and current modelling → MIKE 21 SW FM, MIKE by DHI
- Beach stability modelling → Storm Induced BEACh Change model (SBEACH by USACE)
- Conceptual design based on 25yr return period storm
Wind Data Analysis

Station 44043 Wind Rose (2007-2013)

EVA Analysis (based on TPLM2 but correlated with 44043)

<table>
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<th>Directions (°N)</th>
<th>Omni</th>
<th>0</th>
<th>22.5</th>
<th>45</th>
<th>67.5</th>
<th>90</th>
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<th>202.5</th>
<th>225</th>
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<td>26.3</td>
<td>22.6</td>
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<td>44.1</td>
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25 Year Extreme Waves – SOUTH Direction
At USFWS’s request, we analyzed waves and currents when Segment 8 is eventually eroded.

Increase in wave height at Shoreline Segments 7 and 9 with the absence of Shoreline Segment 8.
Prioritizing Shoreline Areas
Water Currents after Removal of Shoreline Segment 8

Increase in peak storm current speed at Shoreline Segments 4, 7, and 9 with the absence of Shoreline Segment 8
Prioritizing Shoreline Areas
Erosion Severity Map

- Key study output was identifying shoreline areas exposed to greatest erosive wave forces
- Erosion priority areas were identified by modeling and validated through time lapse aerial photography
Living Shoreline Applications Considered
Headland breakwater tombolos were the selected design option based on the numerical modeling results (metocean “forces”), living shoreline principals, construction constraints, engineering judgment and costs.

Design wave based on 25-year return period
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.
Design – Plan View of Breakwater 2-1

<table>
<thead>
<tr>
<th>BREAKWATER NAME</th>
<th>BREAKWATER LENGTH (FT)</th>
<th>BREAKWATER WIDTH (FT)</th>
<th>AREA ROCK BREAKWATER (SQ.FT)</th>
<th>AREA CLEAN SANDFILL (SQ.FT)</th>
<th>AREA HIGH MARSH (SQ.FT)</th>
<th>AREA LOW MARSH (SQ.FT)</th>
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<td>300</td>
<td>20.8</td>
<td>6,480</td>
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Design – Plan View of Breakwater 9-1

<table>
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<th>Breakwater Name</th>
<th>Breakwater Length (FT)</th>
<th>Breakwater Width (FT)</th>
<th>Area Rock Breakwater (SQ.FT)</th>
<th>Area Clean Sandfill (SQ.FT)</th>
<th>Area High Marsh (SQ.FT)</th>
<th>Area Low Marsh (SQ.FT)</th>
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Design – Representative Design Sections

PROFILE C (BREAKWATER 4-1)

SCALE 1’=8’

REPRESENTATIVE DESIGN SECTIONS
Construction Mobilization
Layout of Breakwater and Tombolo Location
Stone Transfer from Shuttle Barge
Stone Placement from Spud Barge
Armor Stone Placement over Core Stone
Armor Stone and Sand Placement
View of Completed Breakwater 2-1
View of Completed Breakwater 2-1
View of Completed Breakwater and Tombolo
View of Tombolo (to be planted in the Spring)
As-Builts
How Project Costs were Reduced

- **Dynamic Cone Penetrometer (DCP) Testing instead of barge/boat mounted geotechnical drilling**
  - The DCP uses a 15 lb. steel mass falling 20 inches to strike an anvil. Blow counts for achieving every 1.75 inch (44mm) penetration increment were recorded.
  - The DCP test results, recorded as blows/increment (bpi) were interpreted to obtain equivalent Standard Penetration Test (SPT) N-values using published correlations.

- **Replacing 60% Design Submittal with Response to Comments on 30% Design**

- **Assemblage of small but highly effective team**

- **Evaluated landside construction techniques but found they were more expensive bc of access road construction**

- **Phased the construction work so future segments will be installed once funding is available**
Lessons Learned

- Work closely with experienced construction firms and have them perform a constructability review(s) of your project (including costs)
- Leverage local knowledge and expertise (VIMS)
- Although permitting process was long, proactive engagement with regulatory agencies saved time
- Hydrodynamic modeling was effective in prioritizing shoreline areas and future conditions
- Bathymetry can change so having an adaptive management plan ready
- Understand your construction windows and in-water work restrictions
Thank you!

December 13, 2016

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