

Atlantic Ocean

**Stage Harbor
Lighthouse**

**Morris
Island**

Crescent Beach

Stage Harbor Inlet

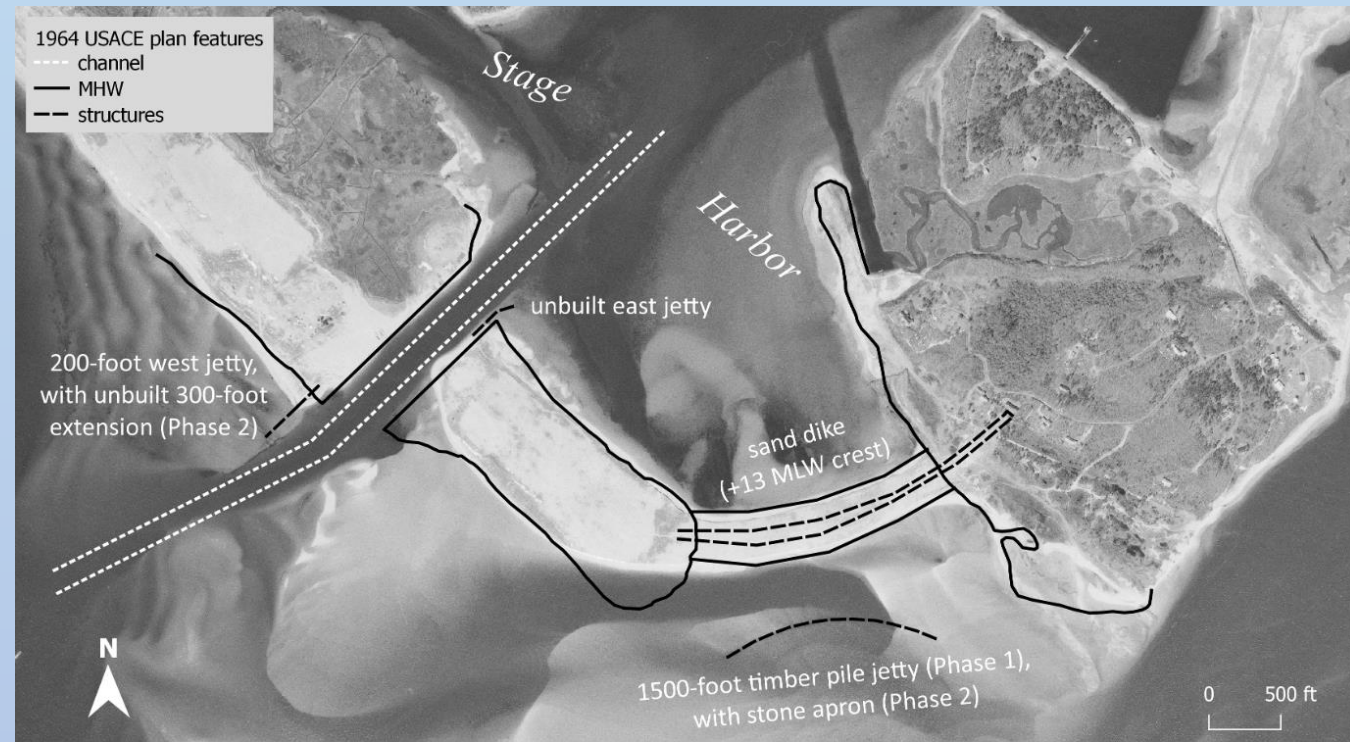


Nantucket Sound

***Use of Temporary Flow Training
Structures and Beach Nourishment to
Mitigate Coastal Erosion***

Background

- 1964: Plan developed (USACE) to relocate Stage Harbor Inlet
 - Moved 2,800 feet west through Harding Beach Point
 - Constructed 1,800-foot sand dike to fill existing inlet
- 2017: Formation of Fools Cut
 - Infilling of Stage Harbor Inlet channel
 - Increased shoreline erosion along Morris Island and Crescent Beach



Shoreline Change

- Rapid Erosion due to tidal exchange through Fools Inlet

- Tide range between Nantucket Sound and Atlantic Ocean differ by 3+ feet
- Peak Velocities in Fools Inlet ~ 4 ft/sec (2.4 knots)
- Flood currents into Nantucket Sound are 1.5 to 2 times faster than ebb currents



- Sediment Transport is nearly unidirectional toward Stage Harbor Inlet
- Maximum erosion rates are greater than 19 ft/yr

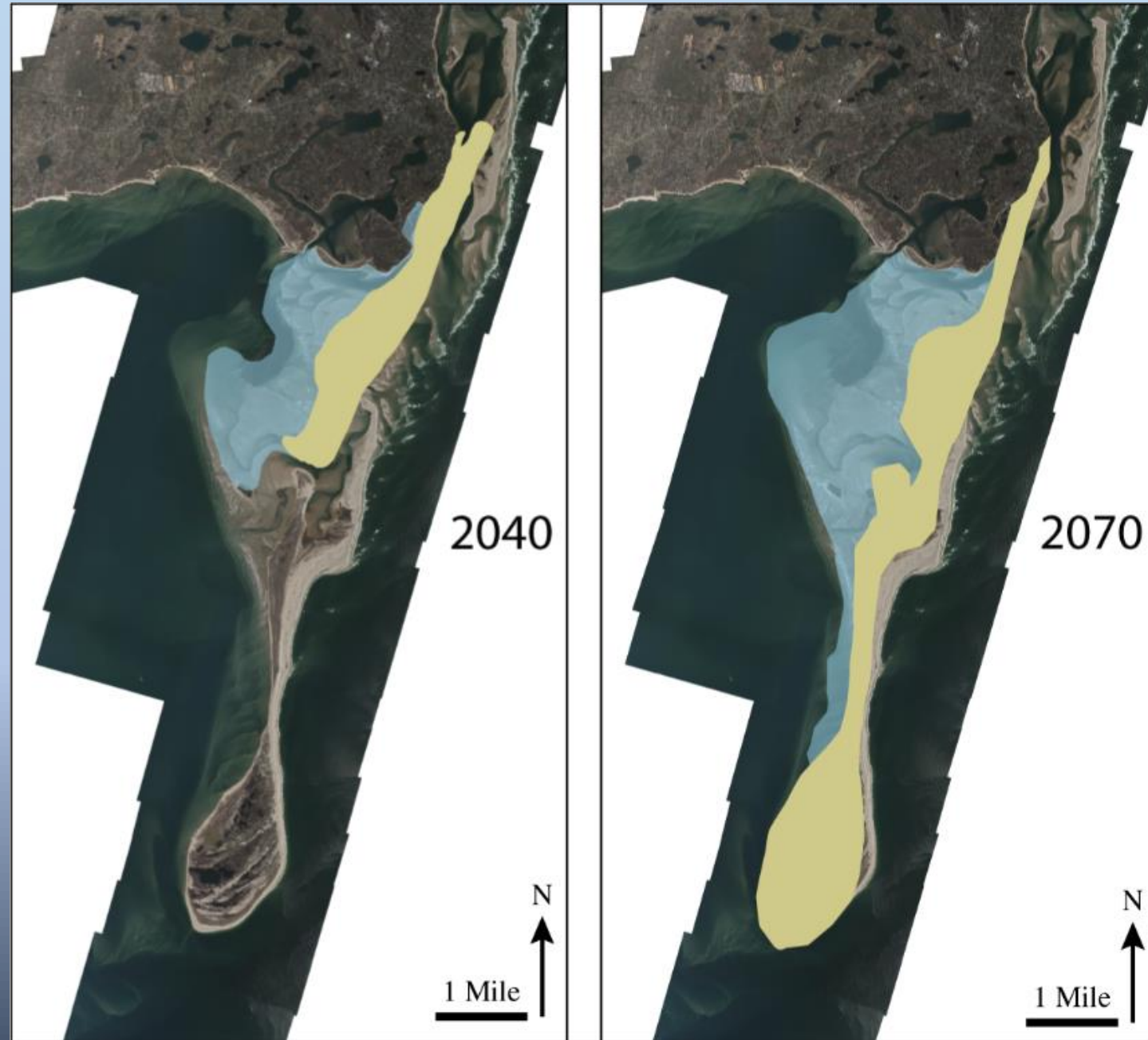
Views of Fools Cut and Morris Island Cut



Dredge Working to Clear
Stage Harbor Channel

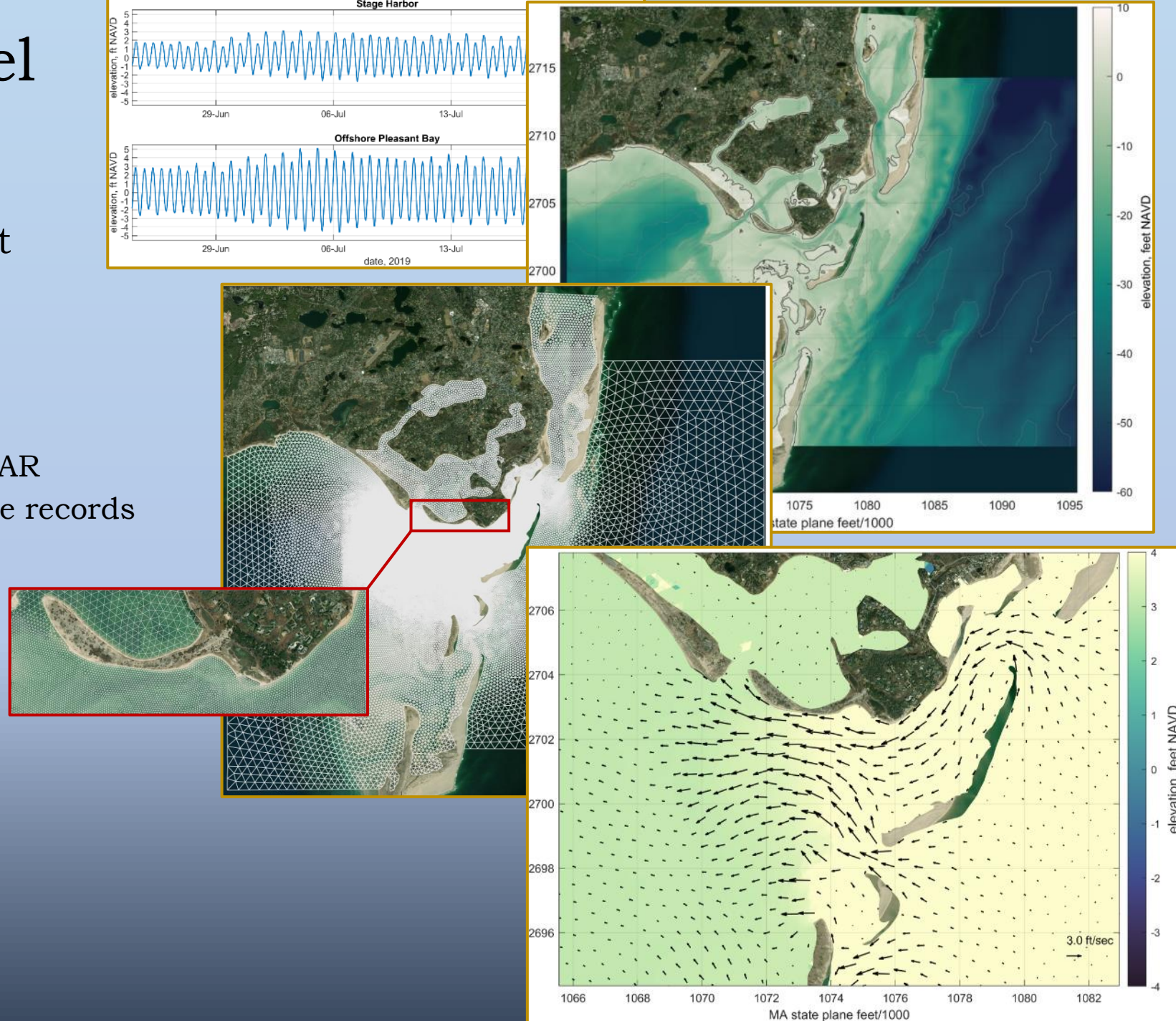
Future Projections

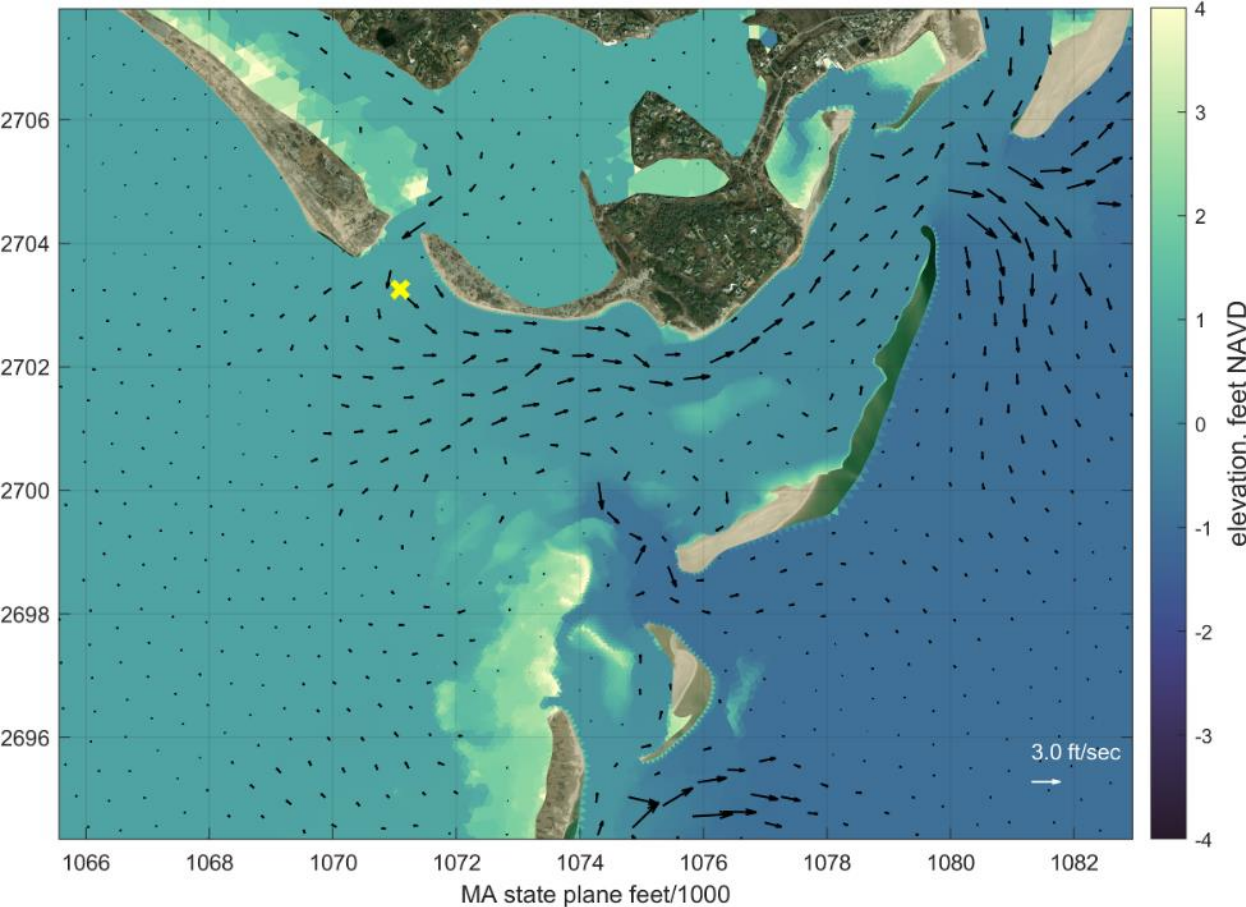
- By 2040: Pleasant Bay will become a single inlet system
 - The 2007 inlet will be the primary inlet and the 1987 inlet will have closed
 - South Beach will be attached near present-day Lighthouse Beach
- By 2070: South Beach will have connected to Monomoy Island
 - Narrowing of the northern section will result from spit elongation and southward migration of the 2007 inlet
 - Will likely breach again due to narrow low-lying areas



Morphological Model

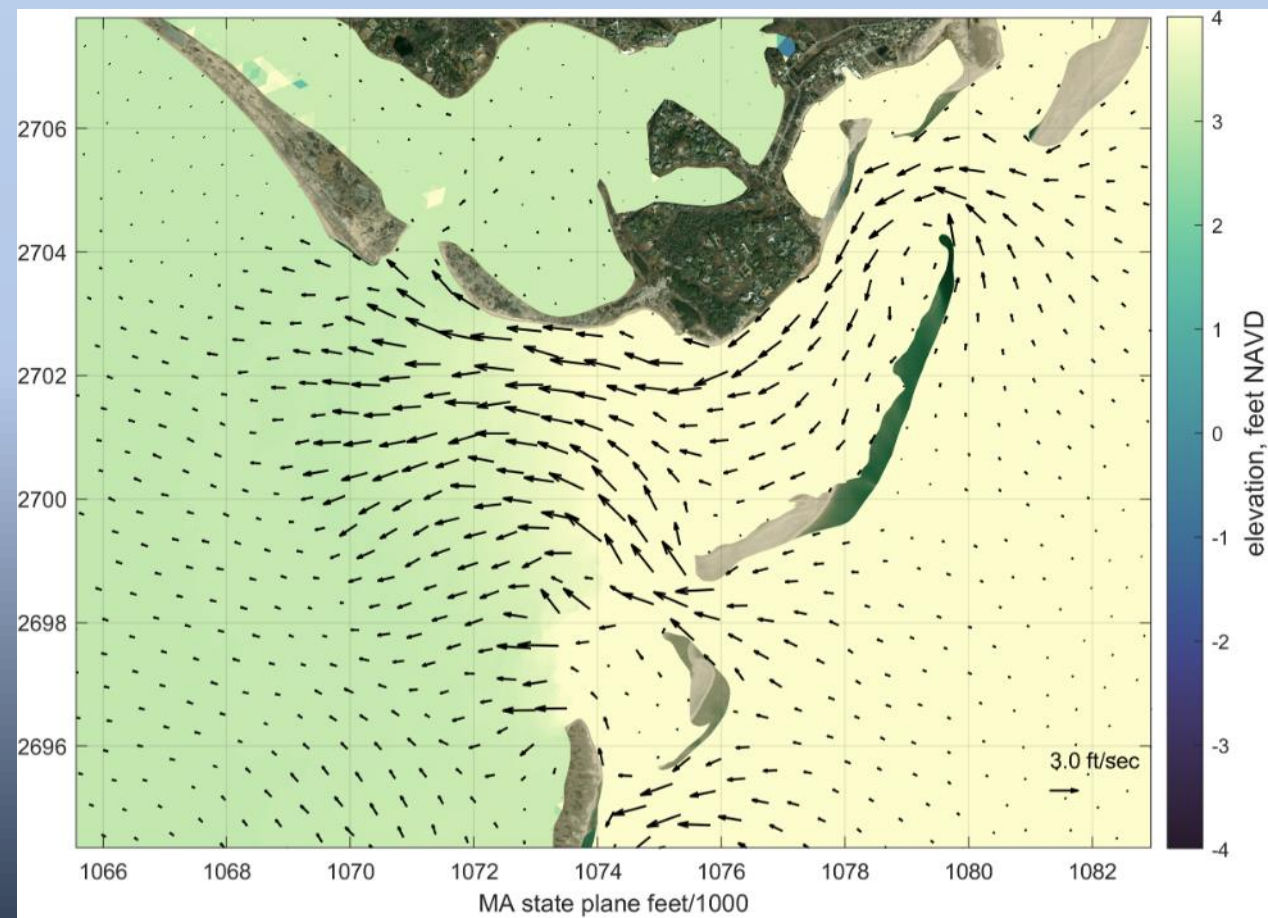
- Delft 3D Flow FM was used to simulate tidally driven sediment transport to assess alternatives
- Model Parameterization-
 - Tide data: June-July 2019
 - Bathymetry/topography: 2018 LiDAR
 - Sediment: USACE and Town dredge records ($d_{50} = 0.5$ mm)
- Grid Generation-
 - Nodes: 49,540
 - Triangular elements: 97,362
 - Minimum edge length: 45 feet





Maximum Ebb Currents

Maximum Flood Currents



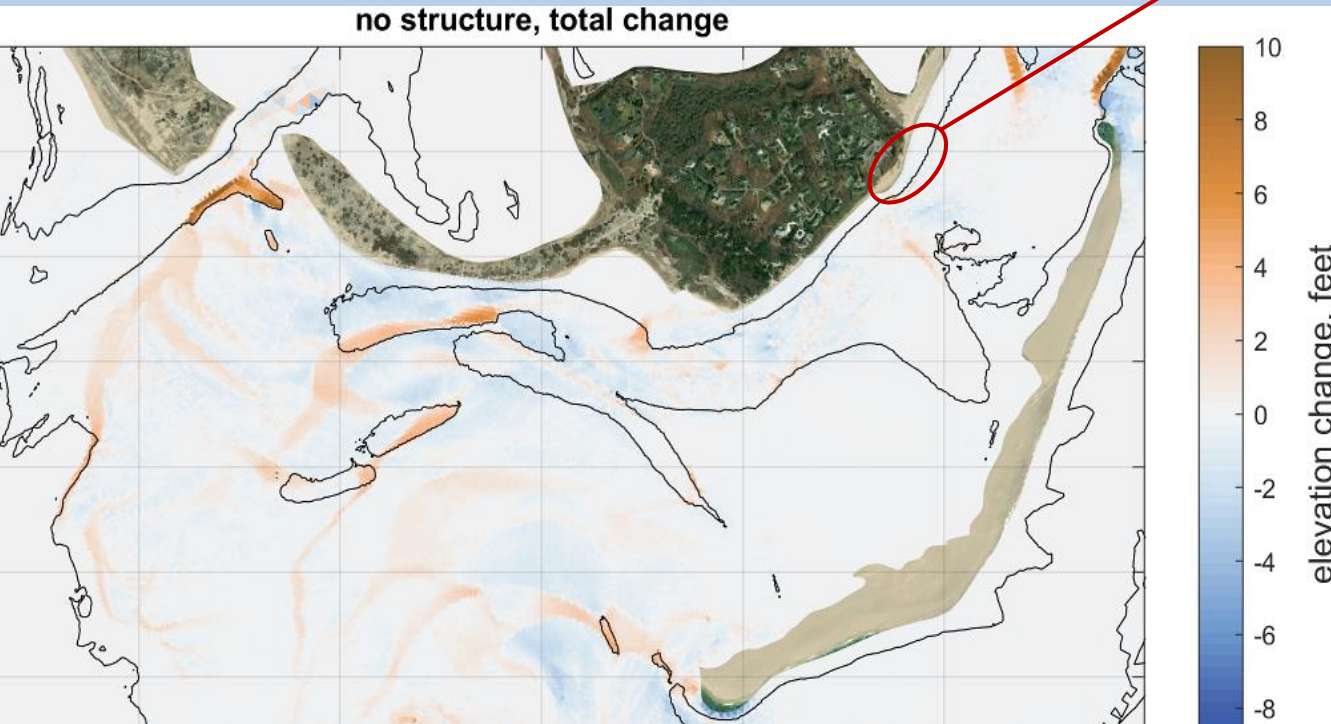
Alternatives

- Alternative 1 – No Action
- Alternative 2 – Reorientation of Entrance Channel
- Alternative 3 – Inlet Relocation
- Alternative 4 – Flow Control Structures
- Alternative 5 – Nourishment and Temporary Flow Control Structure



Alternative 1 - No Action

- No Human intervention – allow natural processes to continue



- Strong currents through Fools Cut will continue to erode Crescent Beach and Morris Island
 - Increasing exposure of infrastructure
 - Endangering ecological resources and habitat
- Navigational safety will continue to be maintained through Stage Harbor FNP and occasional emergency dredging
 - Approximately 50,000 to 80,000 cubic yards of dredging annually – although diminishing
- It is anticipated that Fools Cut will naturally infill over the next 15-to-20 years
 - Shoreline change rates indicate Crescent Beach may breach within the next decade

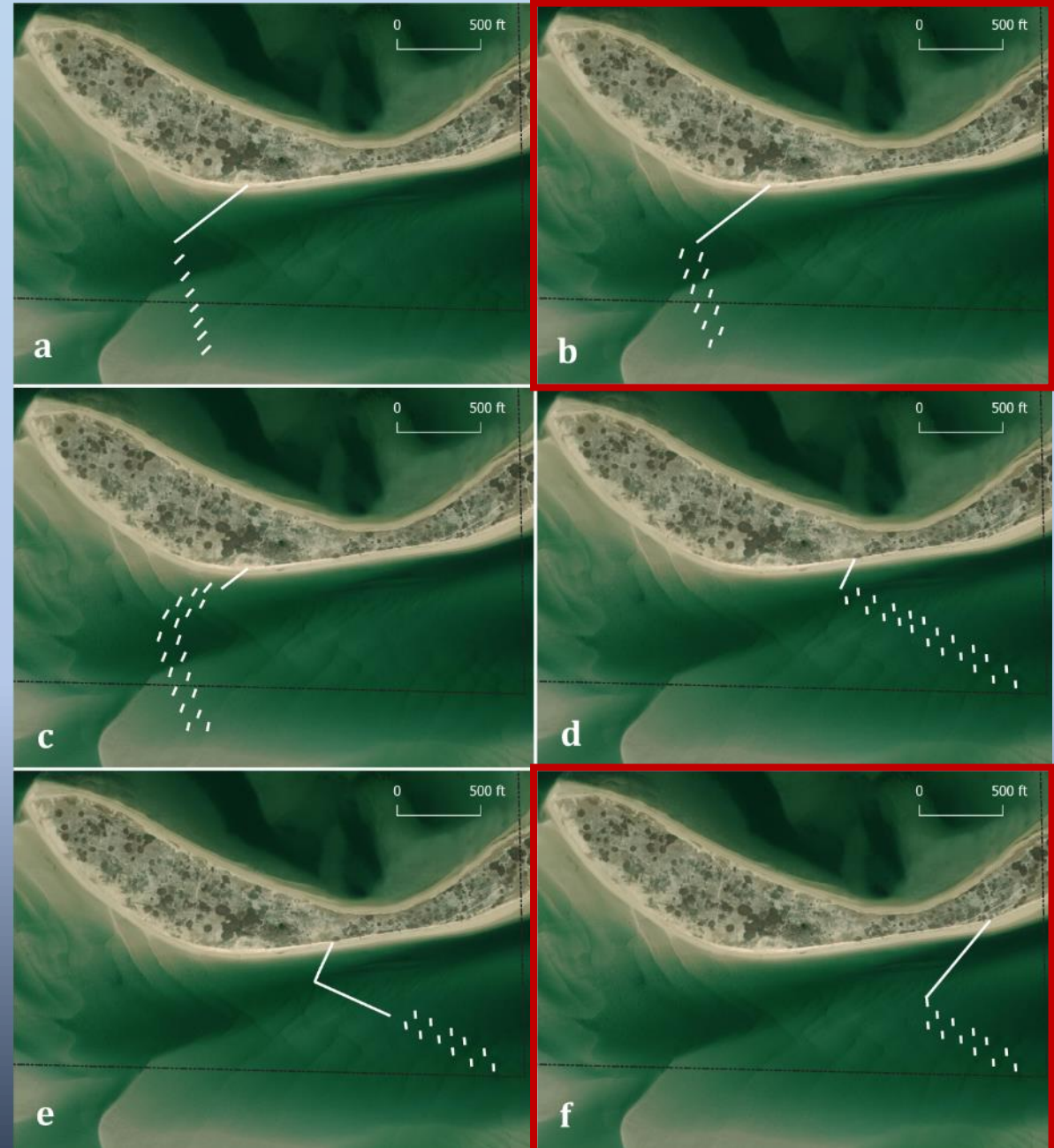
✓ Model produced comparable results to infilling rates at the Stage Harbor FNP

Alternative 4 – Temporary Flow Control Structures

- Structural – Address shoreline erosion and channel shoaling by altering nearshore hydrodynamics
 - Can be considered temporary and removed when no longer needed
 - Combinations of structural configurations were investigated to evaluate varying levels of effectiveness
 - Initial model results suggested design “b” and “f” showed the greatest reduction in flow velocities

Dimensions and particulars of modeled conceptual structure arrays.

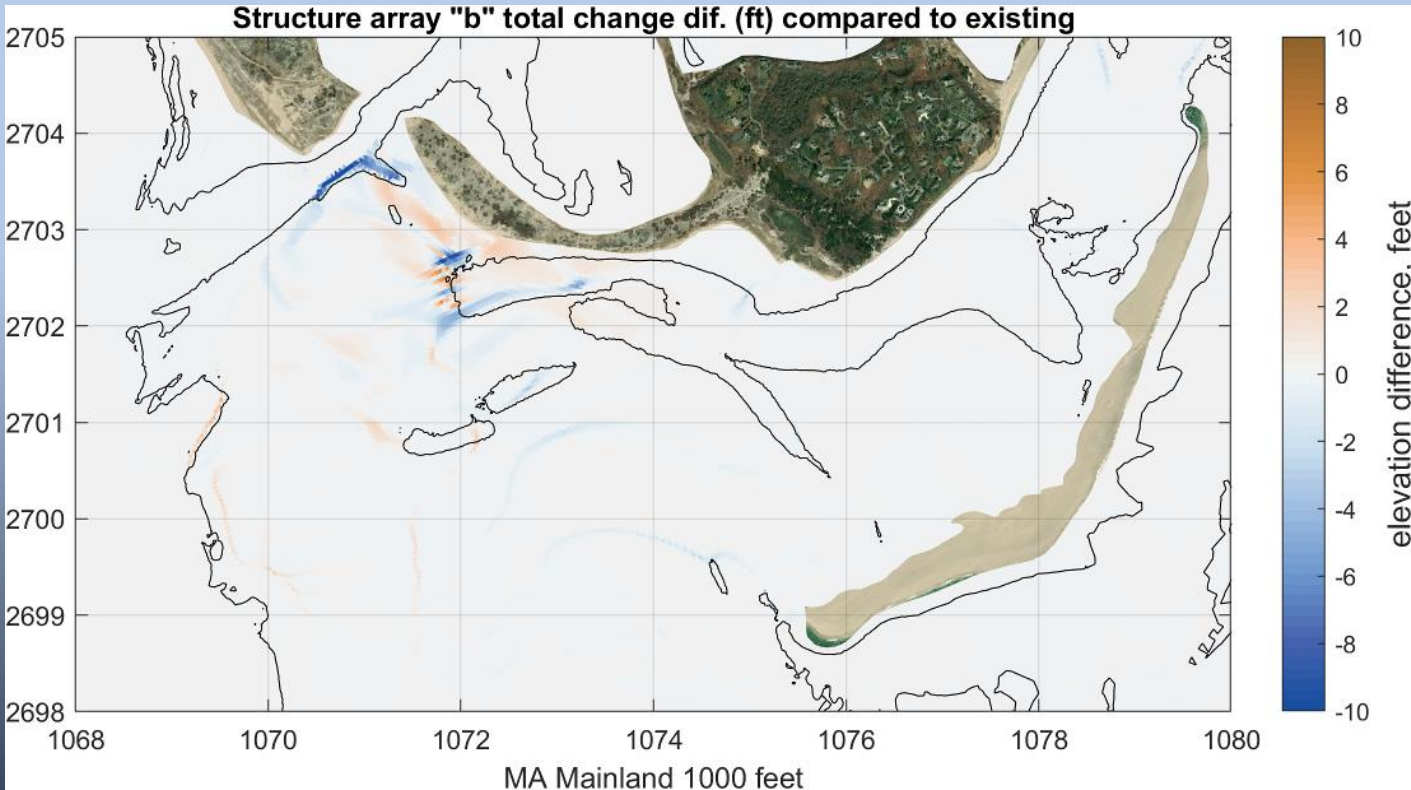
Alternative	Groin length	No. of vanes	Vane length	Total array length	Description
A.0	543	0	55	543	Groin alone
A.1	543	7	40	931	Groin with flow-parallel vanes
B	543	11	42	988	Groin with flow-perpendicular vanes
C	185	19	31	981	Short groin with vanes
D	285	21	32	930	Short groin with vanes east
E	740	11	31	1088	Dogleg groin with vanes east
F	639	11	55	977	Groin with vanes at USACE dike



Alternative 4 – Flow Control Structures

Design “b”

- Reduced infilling of the Stage Harbor FNP
- Sand is deposited at the lee of the groin
 - Reduces the flux of sediment to Stage Harbor channel
 - Erosion near the structure indicates bathymetry adjusting to the structure

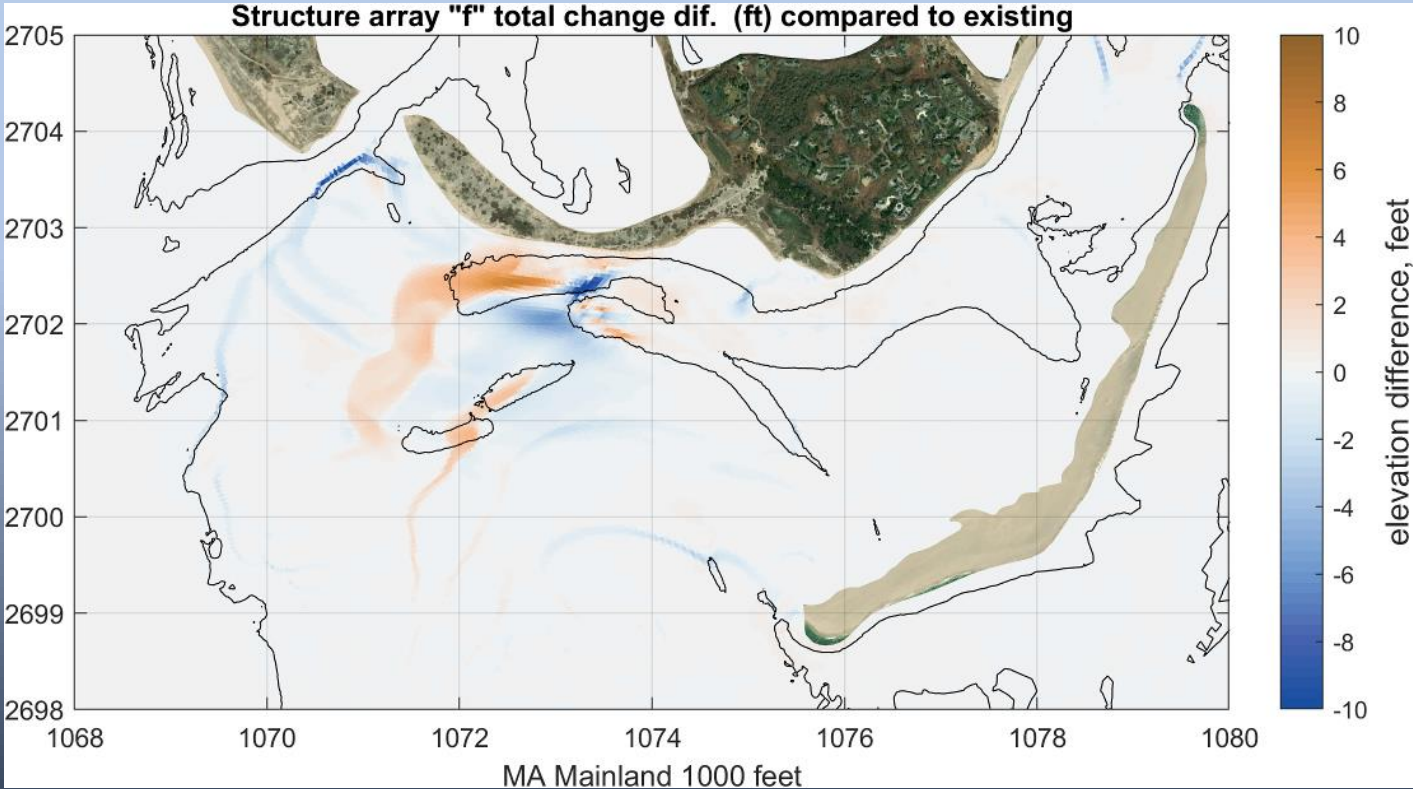


Dimensions and particulars of modeled conceptual structure arrays.					
Alternative	Groin length	No. of vanes	Vane length	Total array length	Description
B	543	11	42	988	Groin with flow-perpendicular vanes

Alternative 4 – Flow Control Structures

Design “f”

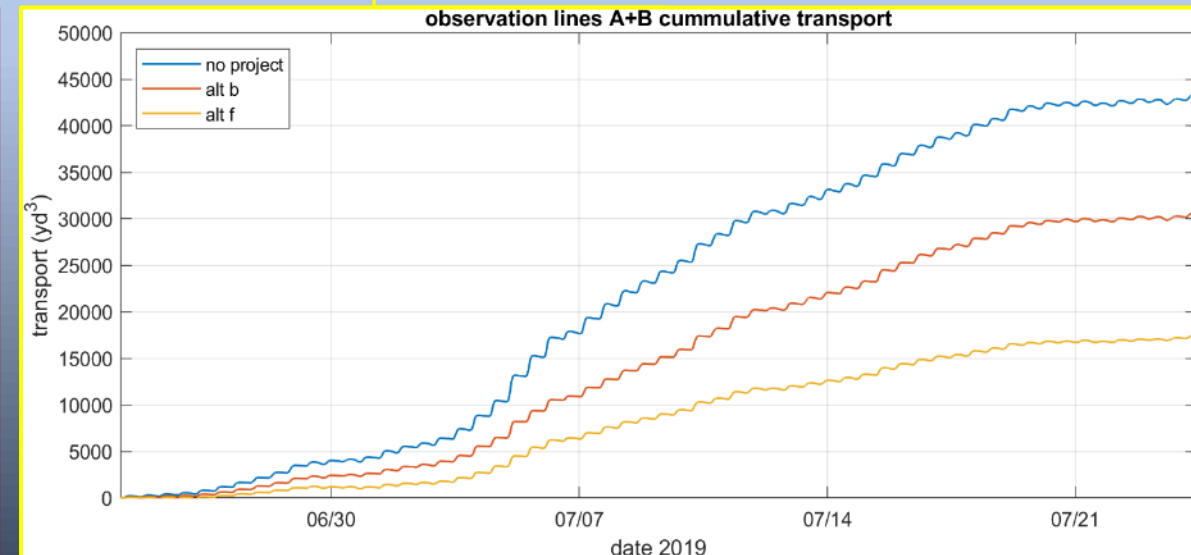
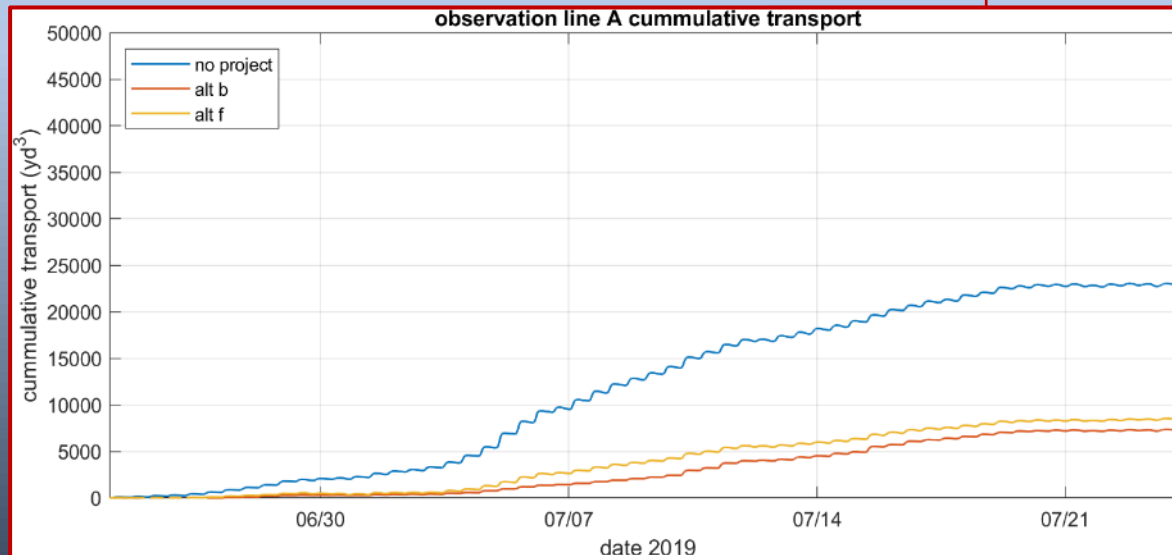
- Reduced infilling of the Stage Harbor FNP
- Much broader influence on shoaling and erosion patterns
 - Reduces sand deposition east of Stage Harbor FNP
 - Long-term accretion will likely redirect flow away from Stage Harbor inlet.



Dimensions and particulars of modeled conceptual structure arrays.					
Alternative	Groin length	No. of vanes	Vane length	Total array length	Description
F	639	11	55	977	Groin with vanes at USACE dike

Comparison of designs “b” and “f”

- Similar reduction in sediment movement toward Stage Harbor FNP
- Design “f” shows greater overall reduction in sediment flux toward channel (by 60%)
 - Design “f” is better positioned in the flow field of the existing conditions



Alternative 5 – Flow Control Structures and Nourishment

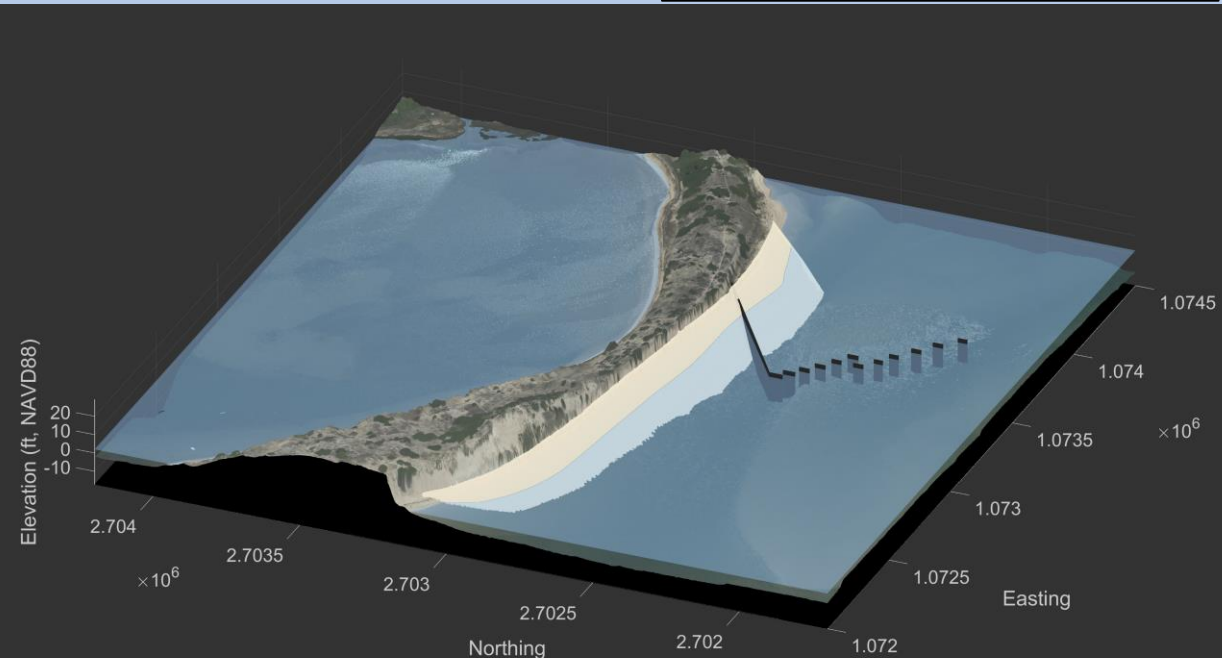
Preferred Alternative

➤ Flow control structures

- Design “f” was chosen and optimized to balance the distribution of tidal flows through the structure
 - Maximizes reduction in sediment flux towards Stage Harbor FNP
 - Reduces shoreline erosion along the narrowest stretch of Crescent Beach
 - Minimizes impacts to the Monomoy NWF
- Temporary
 - Can be removed when no longer needed
 - Likely constructed using steel sheeting

Specifications

- Groin Length: 640 feet
- Number of vanes: 11
- Length of vanes: 398 feet



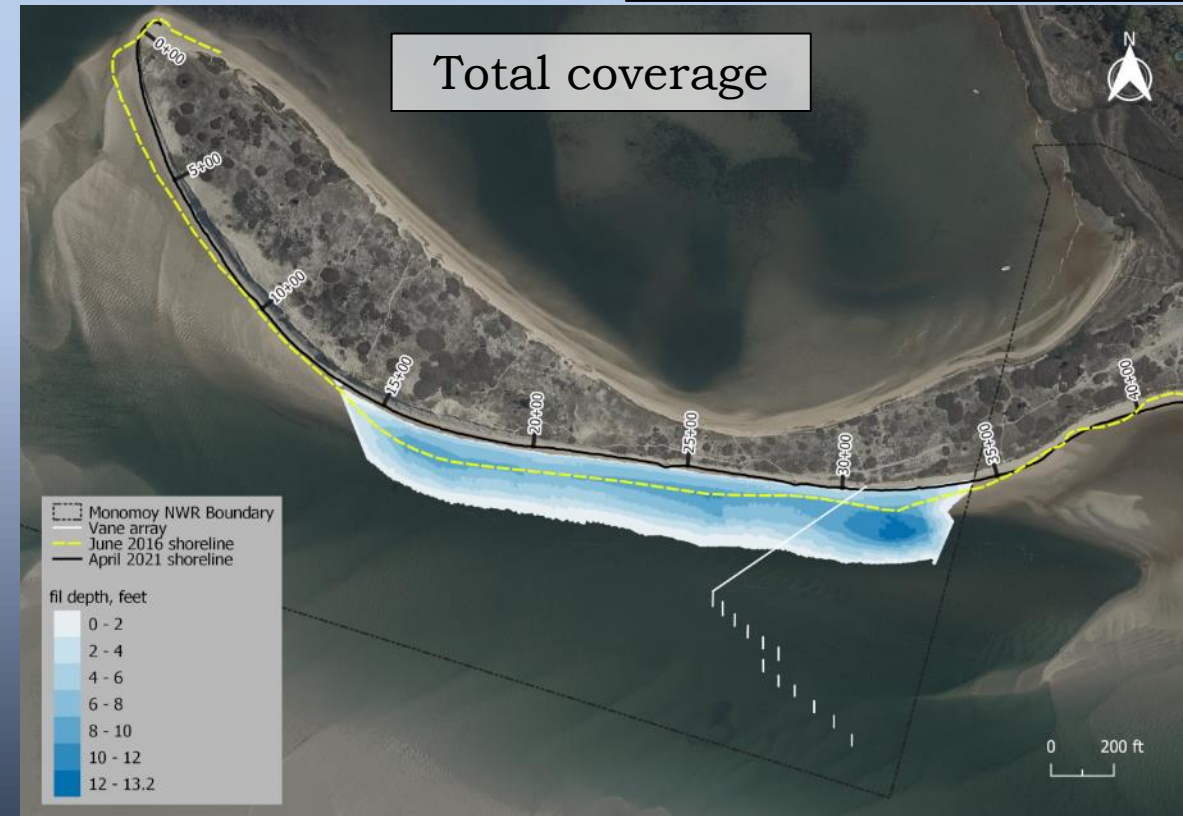
Alternative 5 – Flow Control Structures and Nourishment *Preferred Alternative*

➤ Nourishment

- Overall nourishment plan to return beach to pre-2017 conditions



Specifications

- Area: 9.1 acres
- Volume: 84,000 yd³
- Offshore Slope: 1:10 (v:h)





May 2022

 Monomoy NWR Boundary
 Vane array

0 500 ft


Alternative 5 – Flow Control Structures and Nourishment *Preferred Alternative*

- U.S. Army Corps of Engineers dike:
 - Any potential breach of Crescent Beach (likely in the vicinity of Station 25+00) will jeopardize the functionality of the existing dike
 - The proposed temporary structures and nourishment have been designed to enhance the performance of the USACE 1960s dike project
 - No detrimental impacts to the existing dike are expected



Alternative 5 – Flow Control Structures and Nourishment

Preferred Alternative

- Placement Zone:
 - Provides flexibility to relocate temporary structure to adjust to evolving bathymetry and hydrodynamic conditions
 - No increase in total structure length is anticipated
 - Continued optimization analysis will be preformed to justify any changes
 - Removal and reinstallation of the groin or vanes is straight-forward utilizing a barge and vibratory pile installation equipment



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Sustainable Coastal Solutions, Inc.

Nantucket Sound

Questions?