



# 36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018

Baltimore, Maryland | July 30 – August 3, 2018

*The State of the Art and Science of Coastal Engineering*

## Design and Performance of a Mixed Sediment Nourishment Project along an Urban Sediment-Starved Shoreline

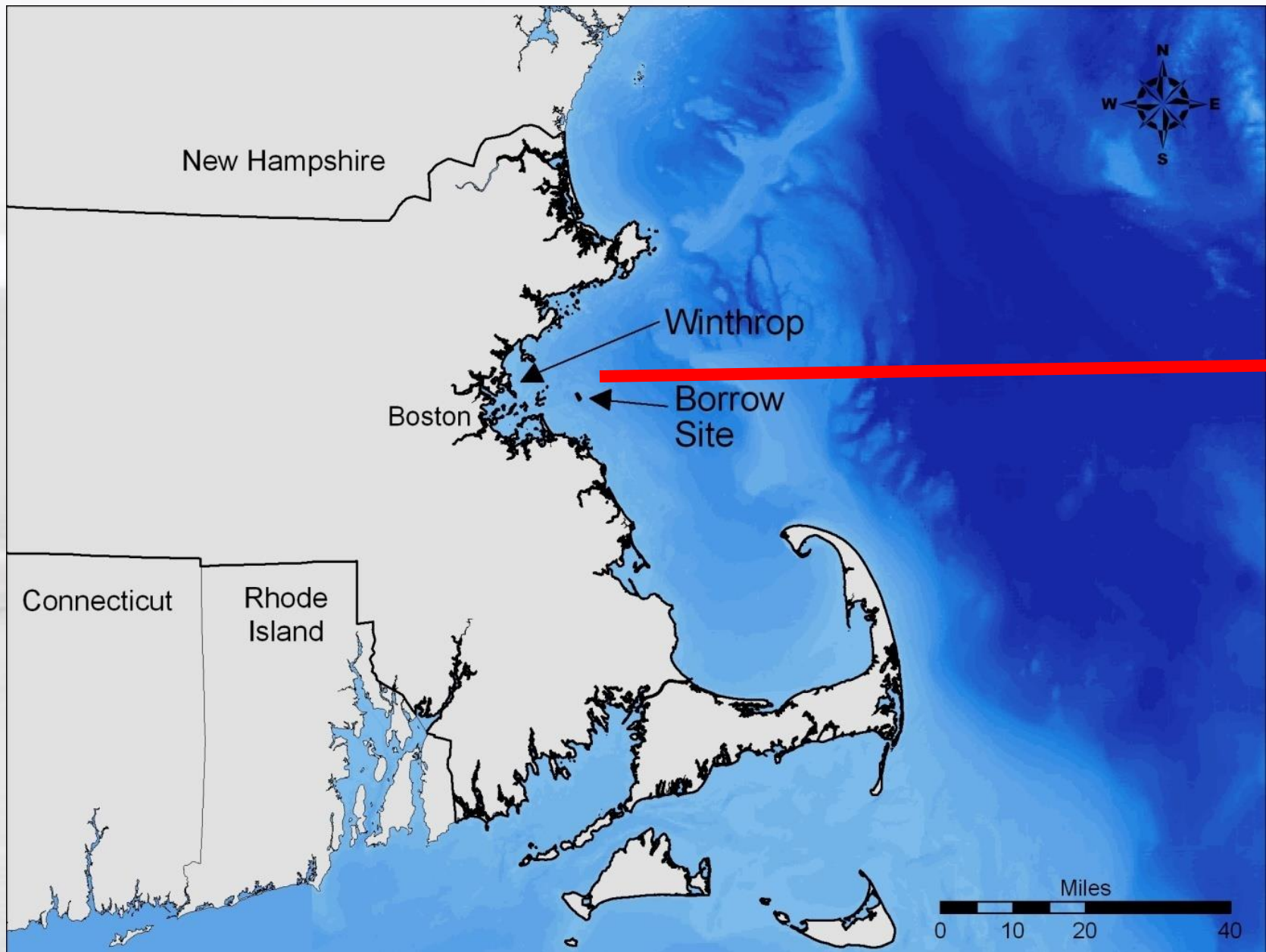
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*W.F. Baird & Associates*





Portugal





# The New York Times

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SUNDAY, FEBRUARY 10, 2013

## STORM LEAVES NORTHEAST REELING AND



The ocean overflowed a sea wall on Saturday in Wierthrop, Mass. Coastal flooding forced evacuations in some areas of the state.





*urban shoreline*

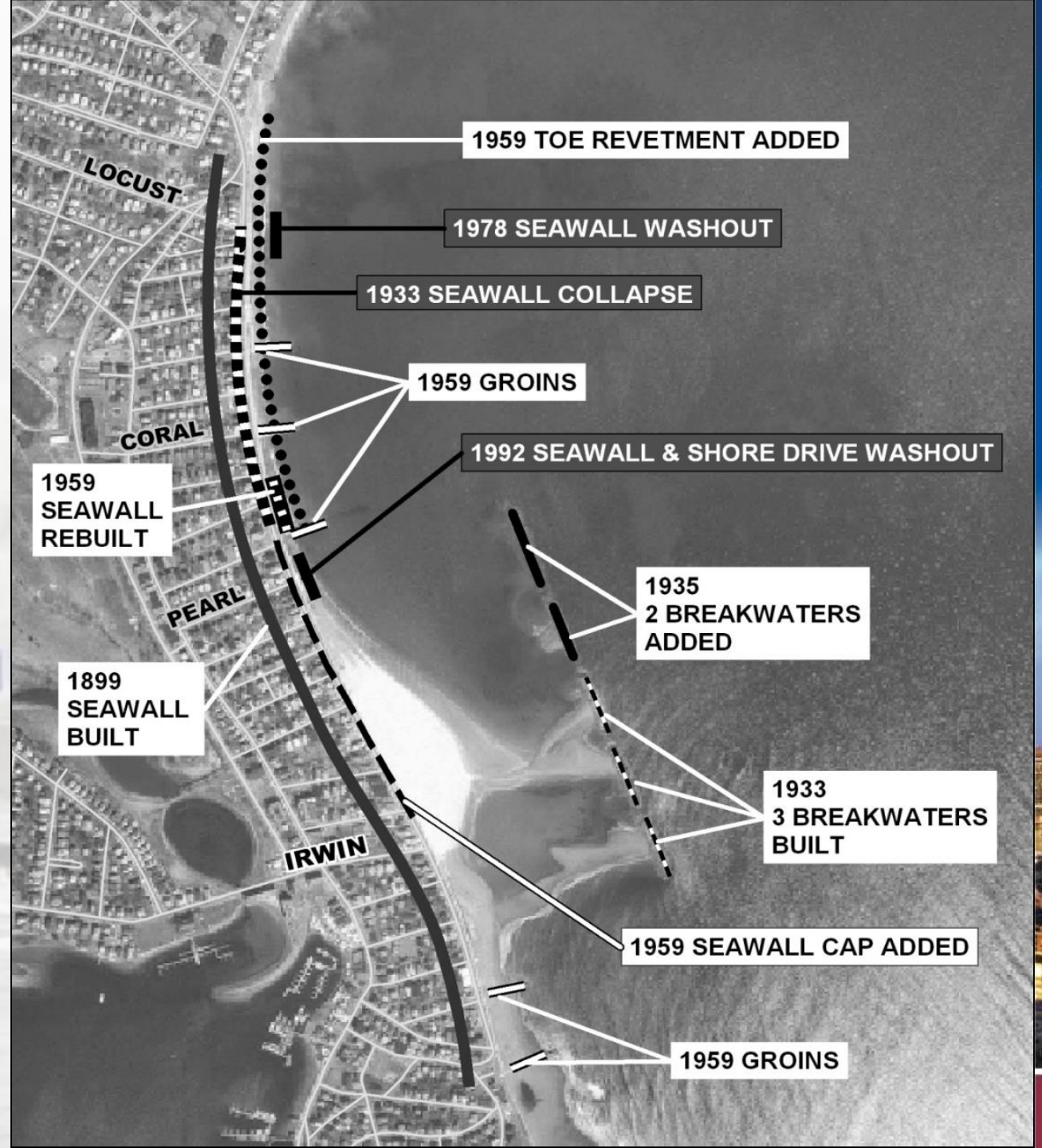
**~5,000 residents protected by seawall**





# A Brief History

- 1898: Portland Gale
- 1899: Seawall Constructed
- 1933: Seawall Collapse
- 1933 & 1935:  
The Five Sisters
- 1959: Groin, Toe Revetment  
& Seawall Cap
- 1978: Seawall Washout
- 1992: Shore Drive Sinkhole
- 2007: Shore Drive Sinkhole





# The Seawall Remains the Highest Elevation for the Winthrop Barrier Beach System



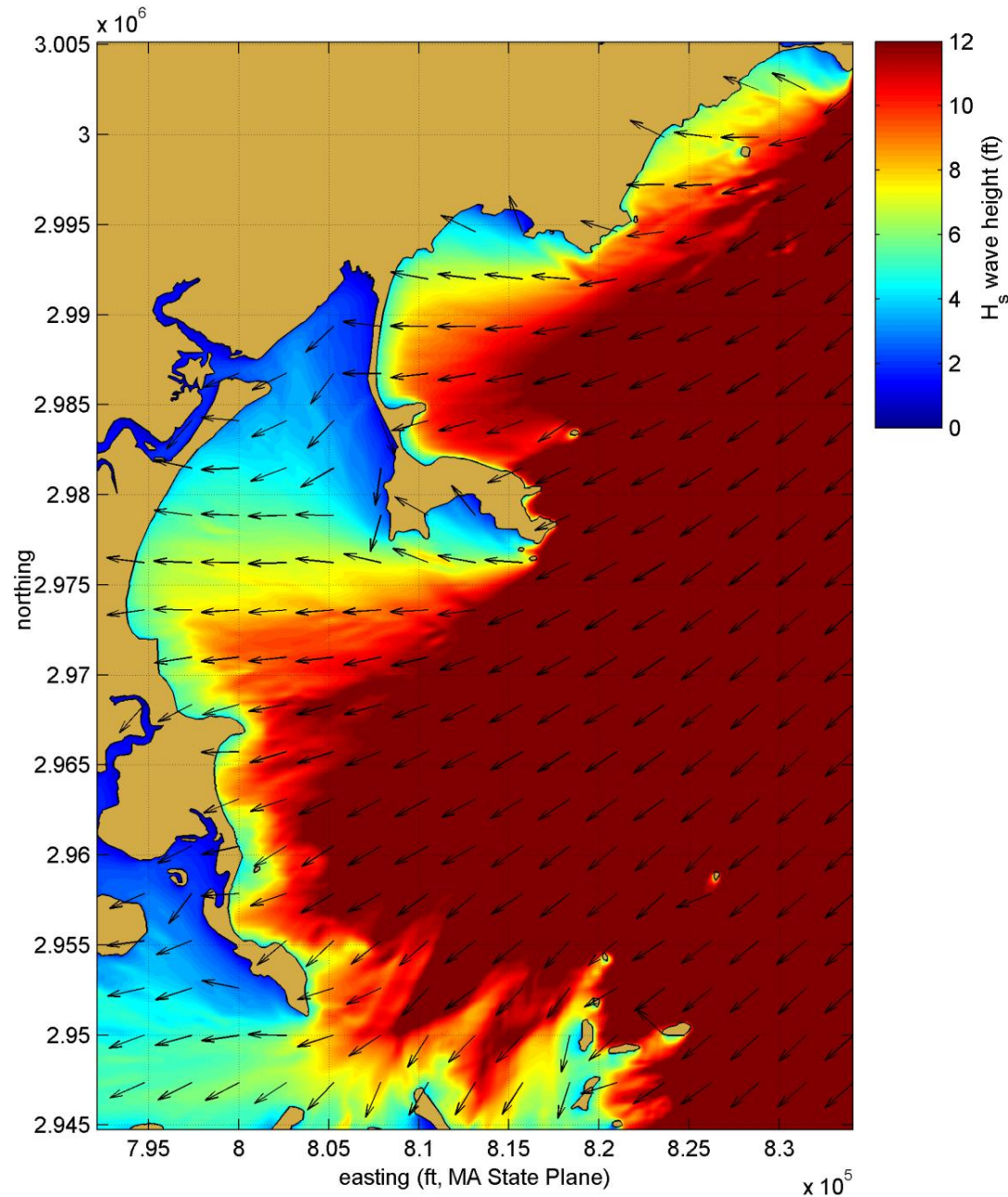


# Local Wave Climate

**Dominant winds from the west, but dominant waves from the east**

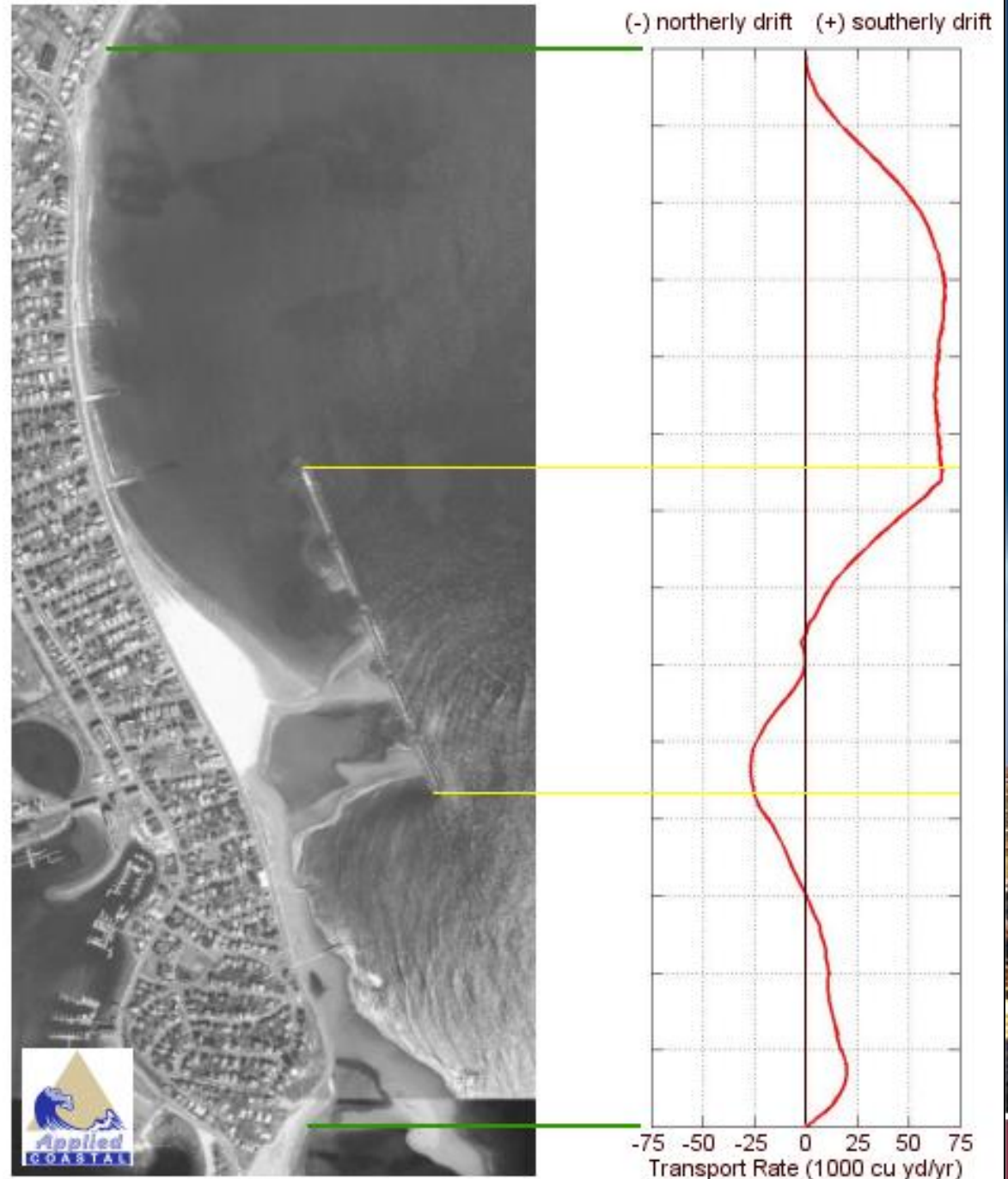
**Governed by regional glacial geology**

**Also influenced by large-scale coastal engineering structures (e.g. “the Five Sisters”)**



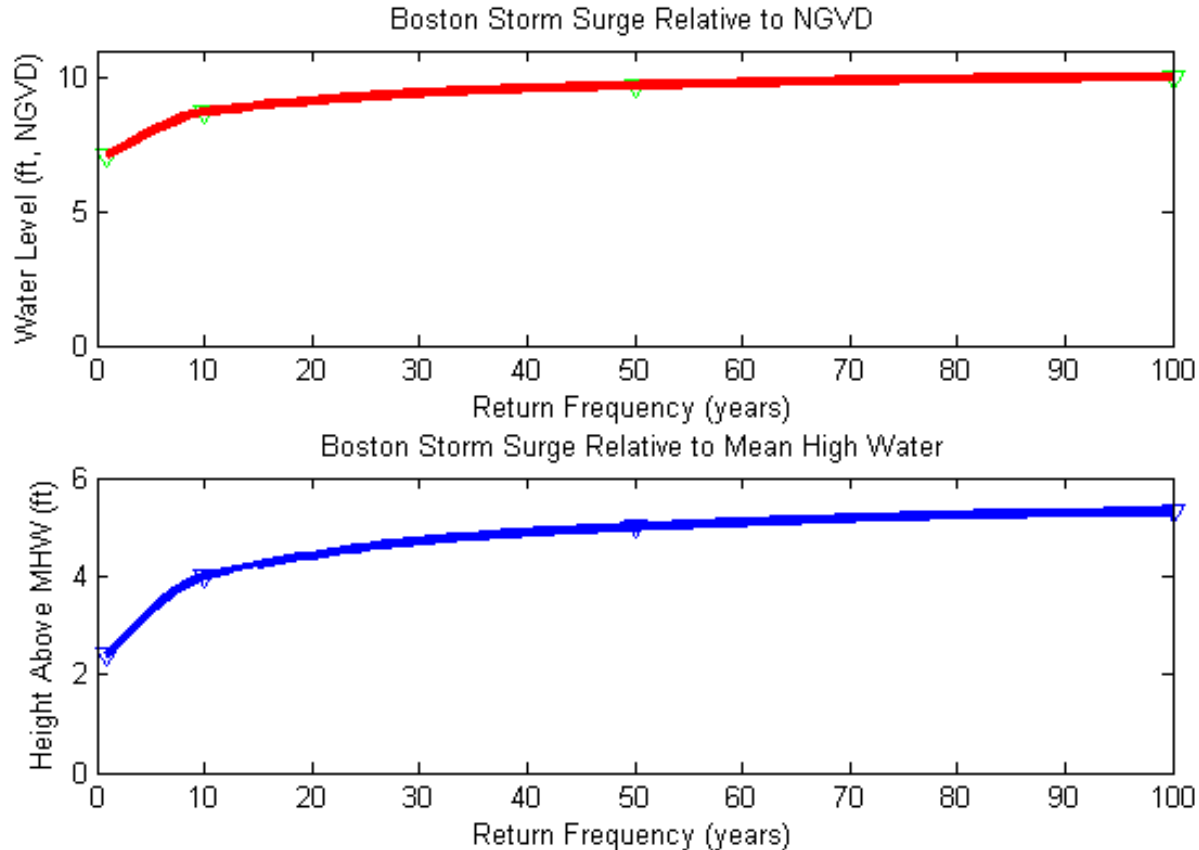
# Longshore Sediment Transport

Transport potential rates were computed from wave modeling  
Generally, littoral drift is to the south  
The “Five Sisters” cause the local reversal (diffraction)  
Sediment transport is greatest north of the “Five Sisters”





# Beach Nourishment Design Considerations

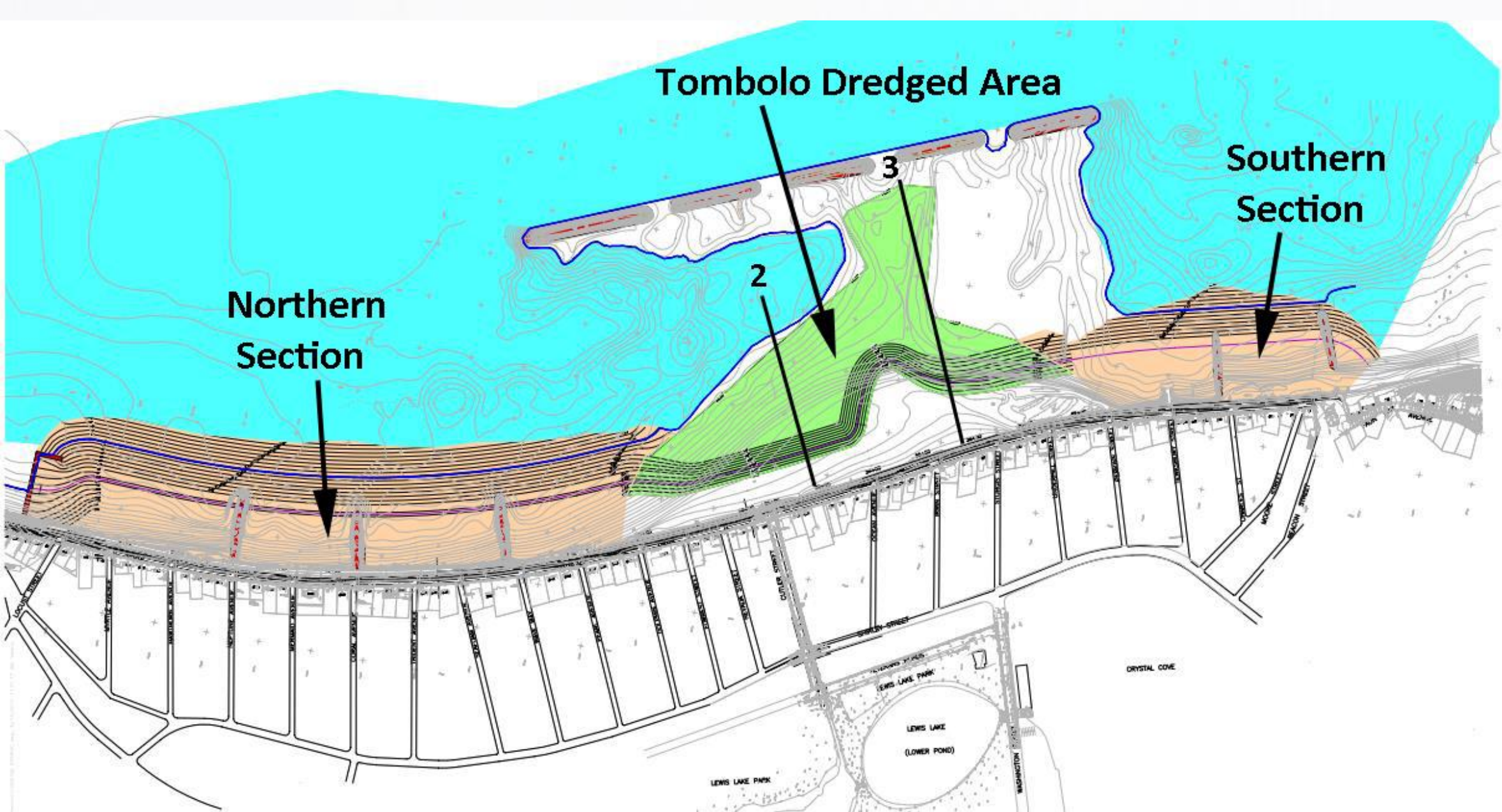


**Eliminate storm wave overtopping of the seawall**

**Provide a design life in excess of 10 years**

**Preserve and/or enhance endangered species habitat**









# Beach Compatible Sediment

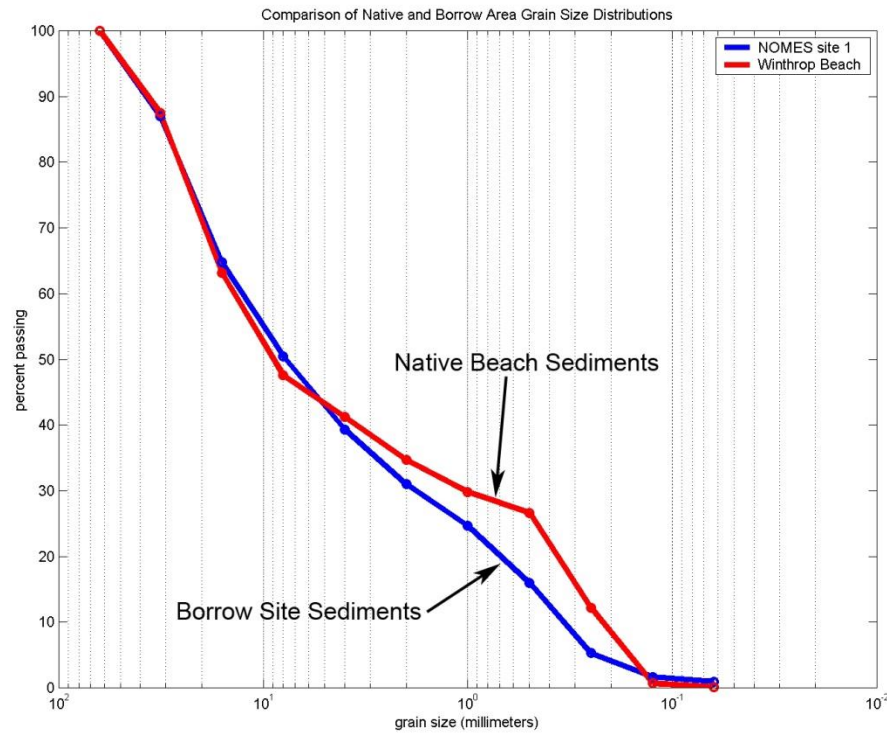
**Mixed shingle (cobble/gravel) and sand**

**Natural alongshore sediment supply lost, due to armoring of adjacent shorelines**





# Beach Compatible Sediment

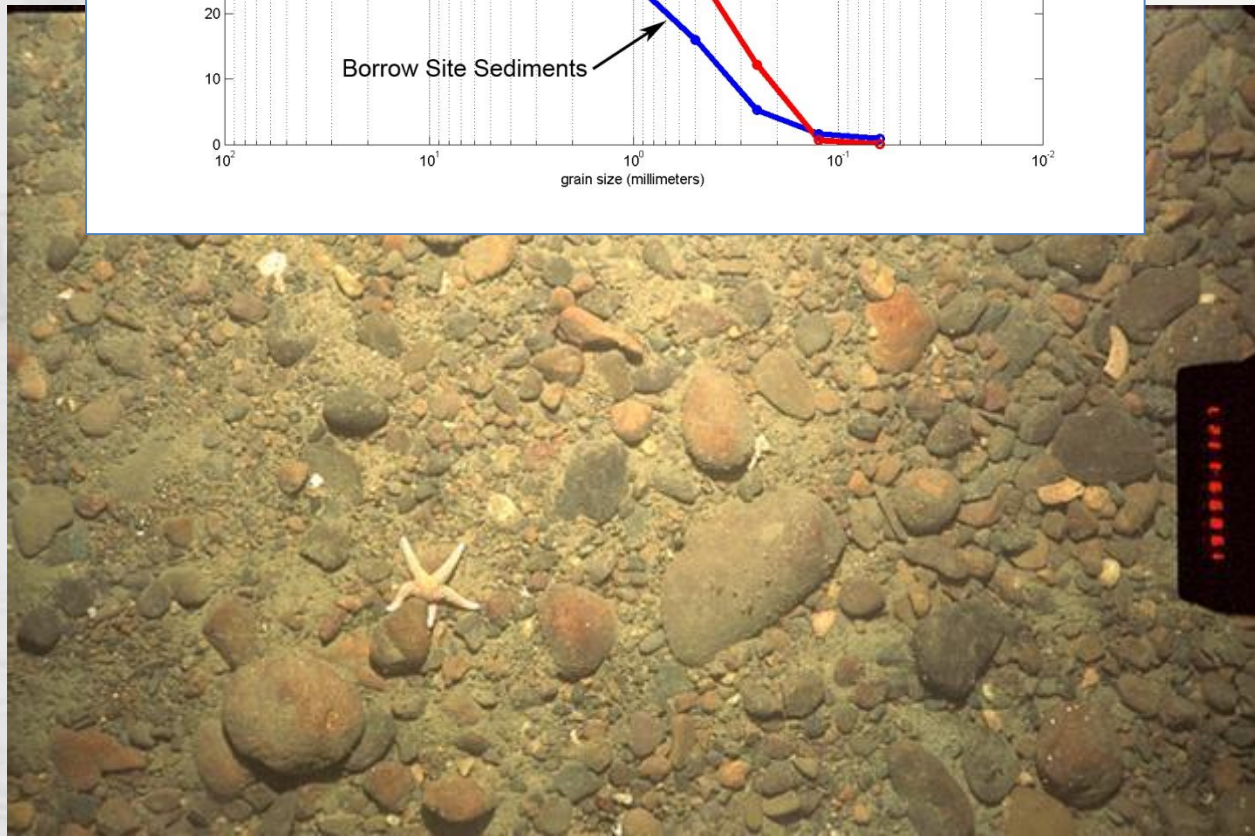


## What we wanted...

- Offshore source of nearly identical material

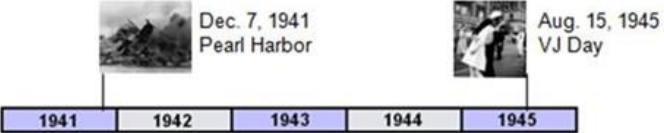
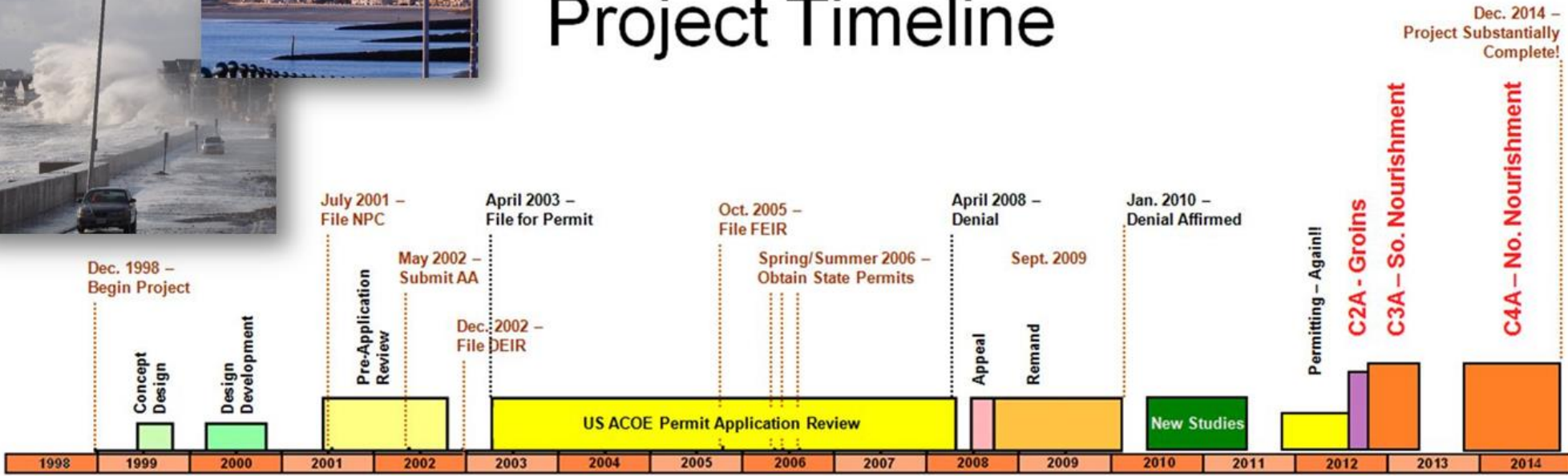
## What we got...

- Gap-graded “manufactured” sediment
- 75%-80% sand with a median grain size of 0.9 mm
- 20%-25% natural gravel and cobble with median grain size of 76 mm



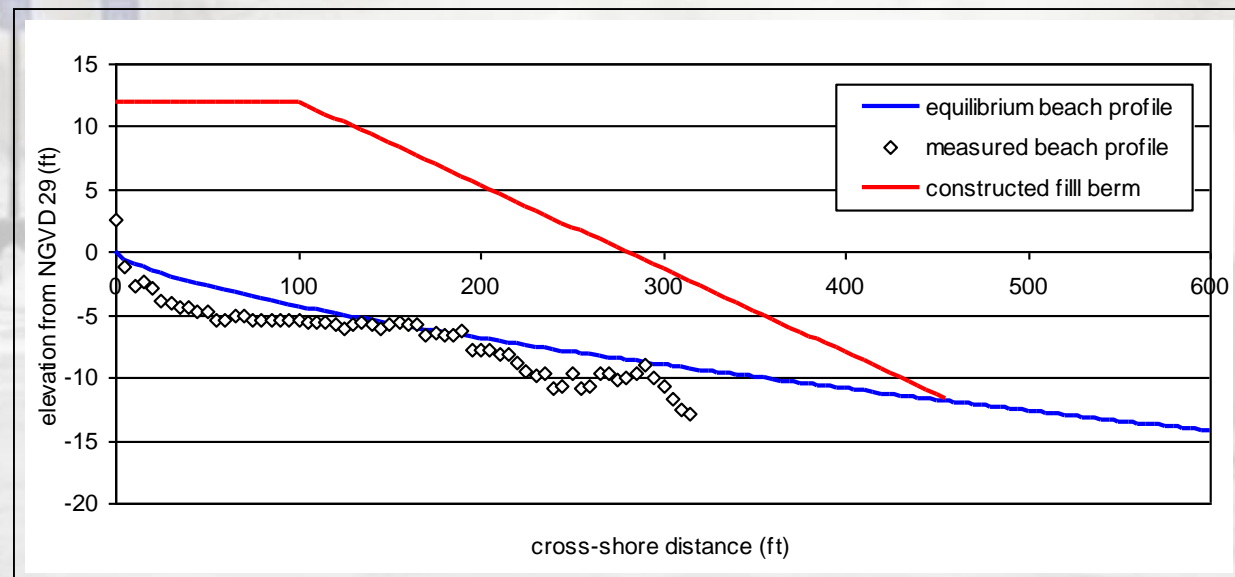


# Project Timeline





|  | Northern Nourishment Segment | Southern Nourishment Segment | Total      |
|--|------------------------------|------------------------------|------------|
| Required "in-place" Volume                                       | 350,000 cy                   | 90,000 cy                    | 440,000 cy |
| Anticipated Borrow Volume (after placement and transport losses) | 420,000 cy                   | 100,000 cy                   | 520,000 cy |



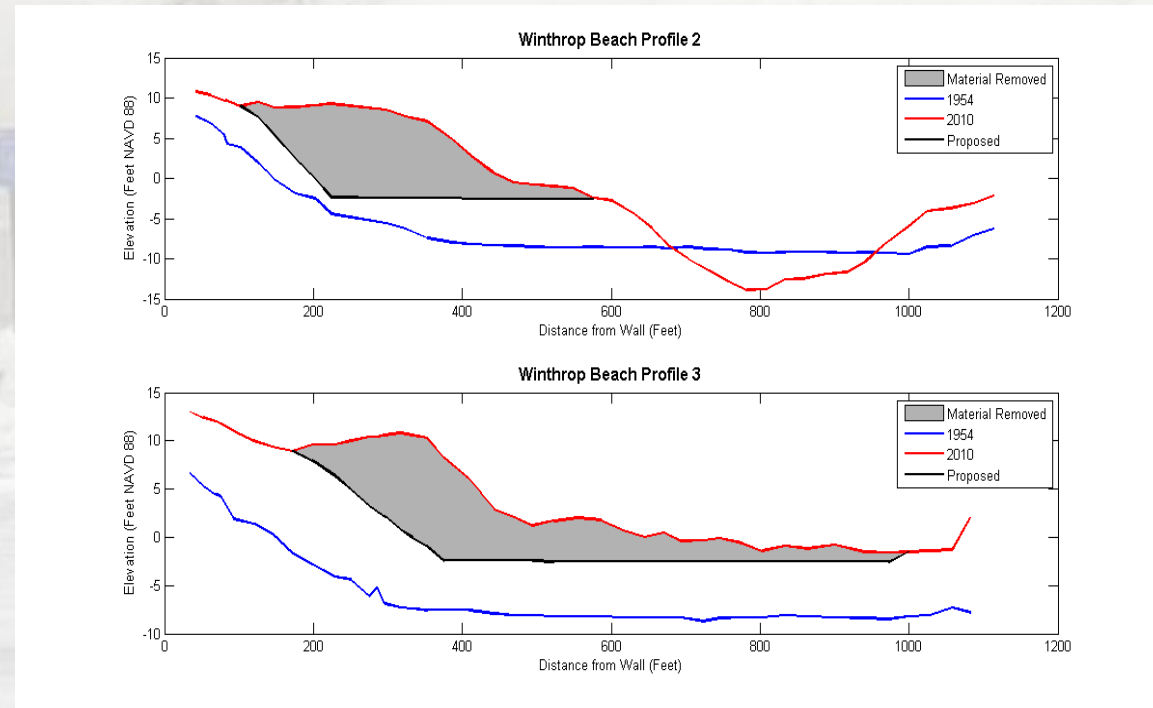
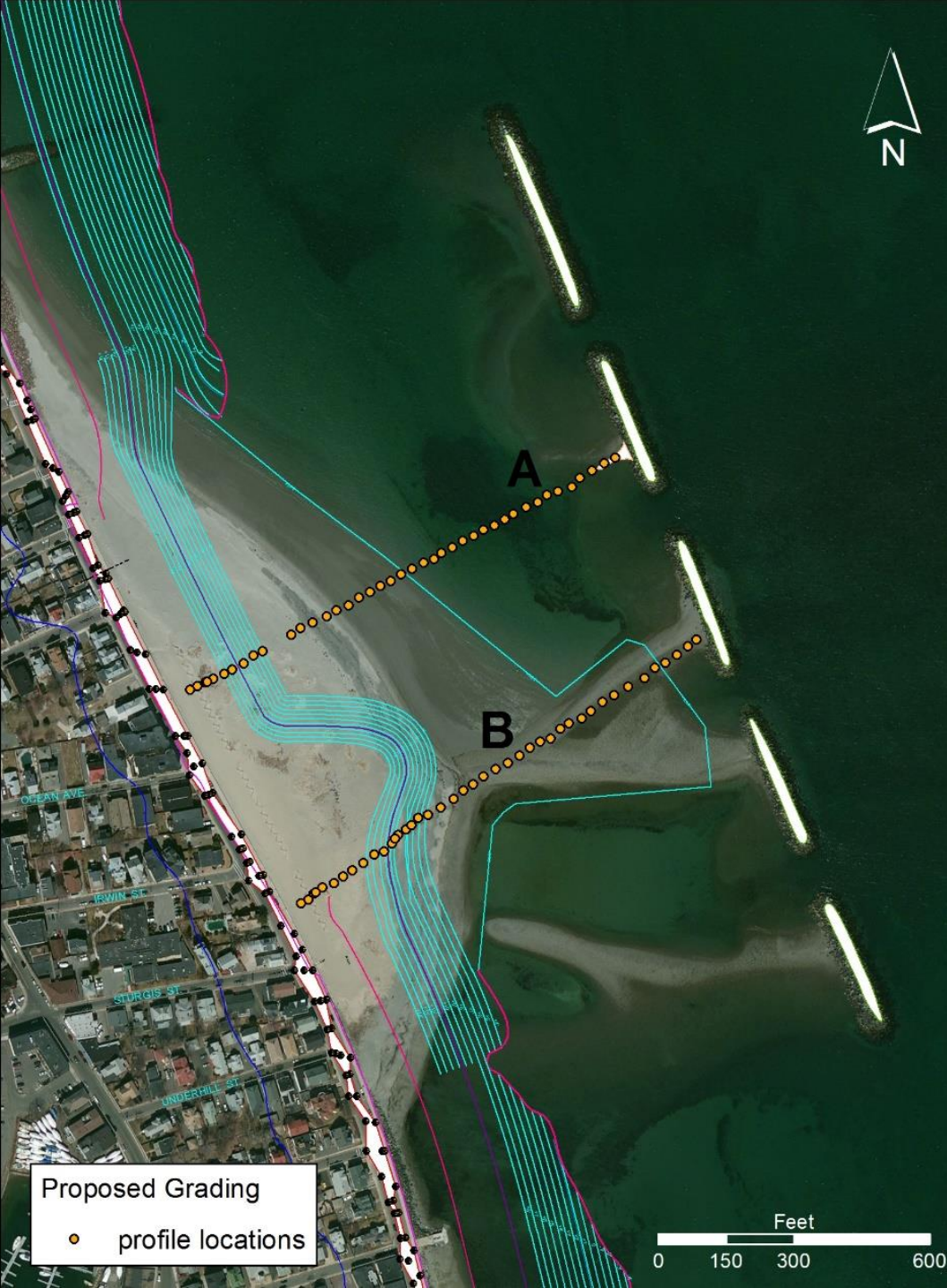


# Pilot Project

## Dredging Tombolo to Provide Southern Nourishment Material

“Value Engineering” to Reduce Project Costs

## Potential Future Borrow Source for Renourishment











**Before Nourishment**



**After Nourishment  
Photo taken after Winter Storm Juno**







April 2008



August 2013

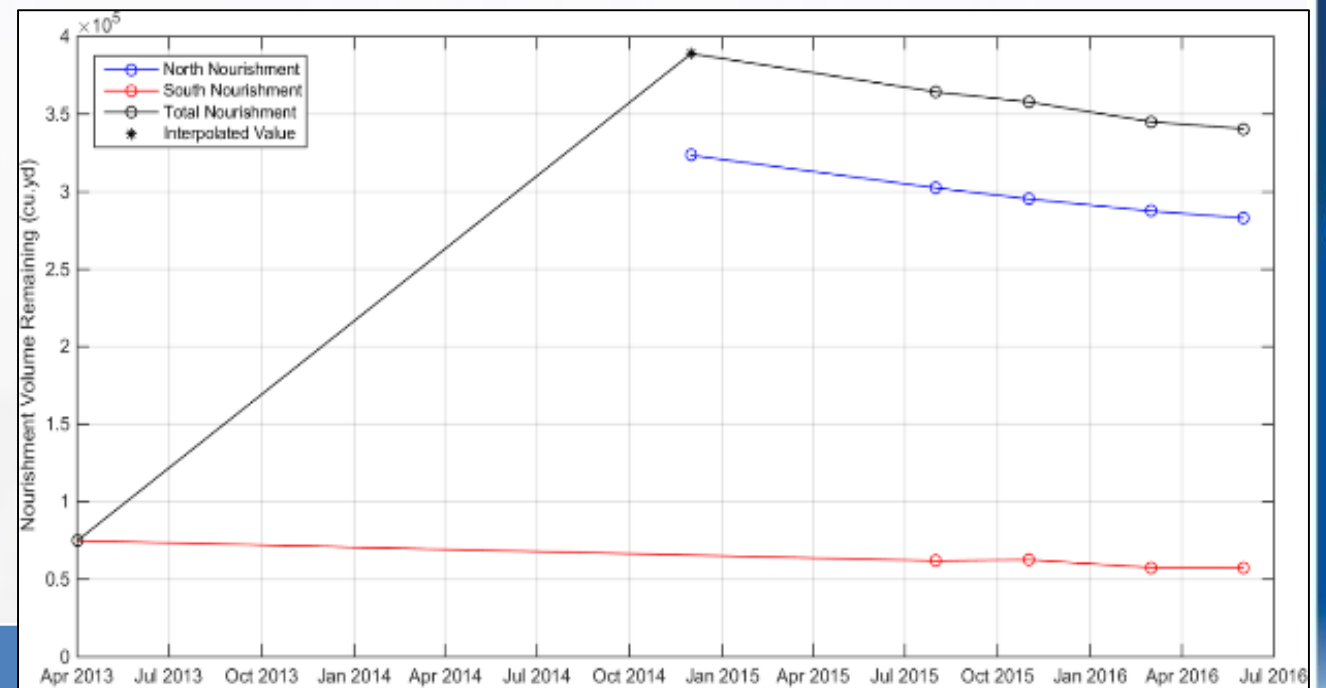


March 2015





# Beach Nourishment Performance

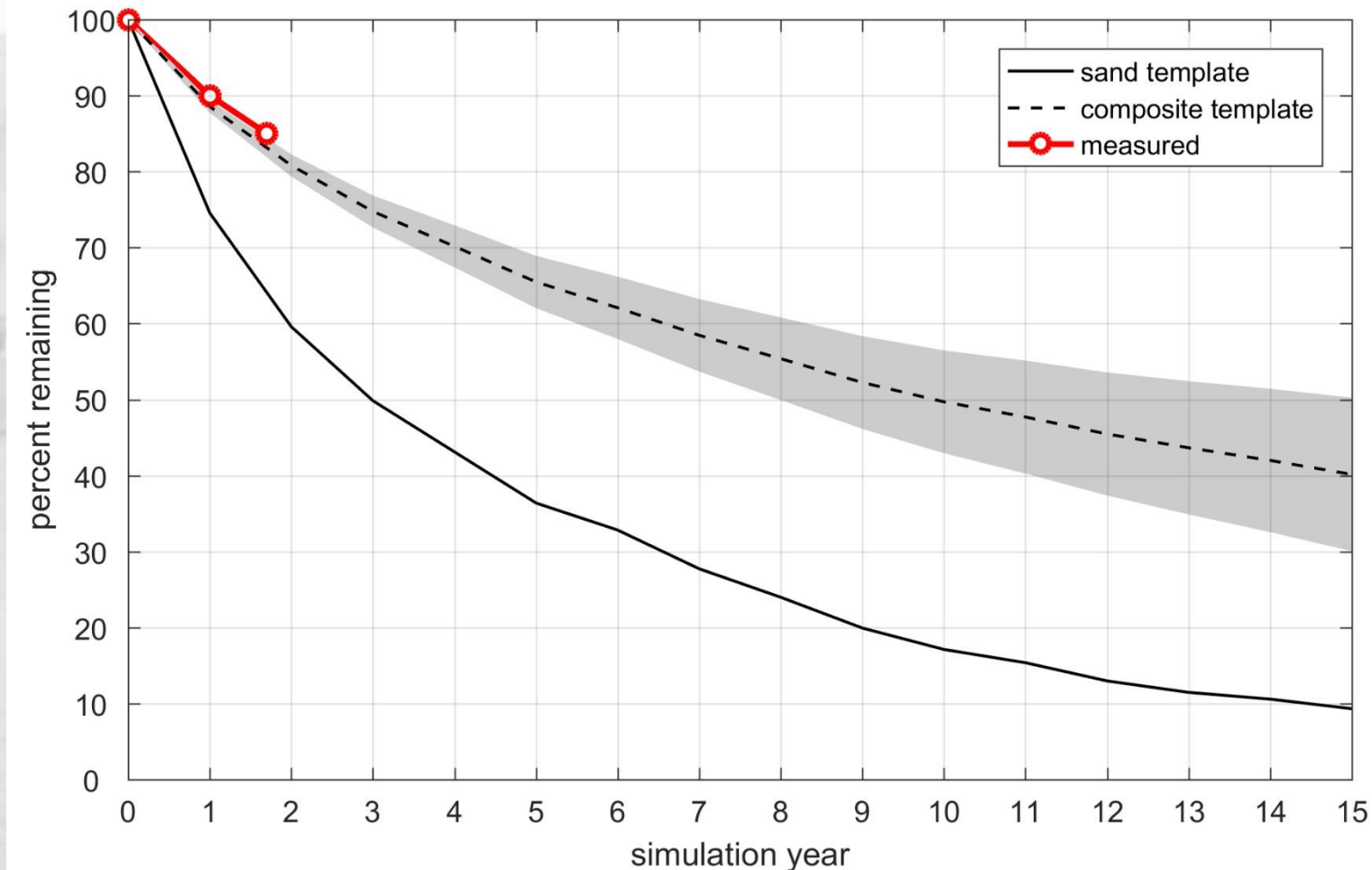


Nourishment volume remaining at Winthrop Beach

| Survey Date | Nourishment Volume Remaining (%) |               |       |
|-------------|----------------------------------|---------------|-------|
|             | North Section                    | South Section | Total |
| Apr 2013    | --                               | 100%          | 100%  |
| Dec 2014    | 100%                             | 88%           | 98%   |
| Aug 2015    | 93%                              | 83%           | 91%   |
| Nov 2015    | 91%                              | 84%           | 90%   |
| Mar 2016    | 89%                              | 77%           | 87%   |
| Jun 2016    | 87%                              | 77%           | 85%   |



# Predicting Beach Nourishment Performance



## Comparisons Using Different Sediment Transport Formulations

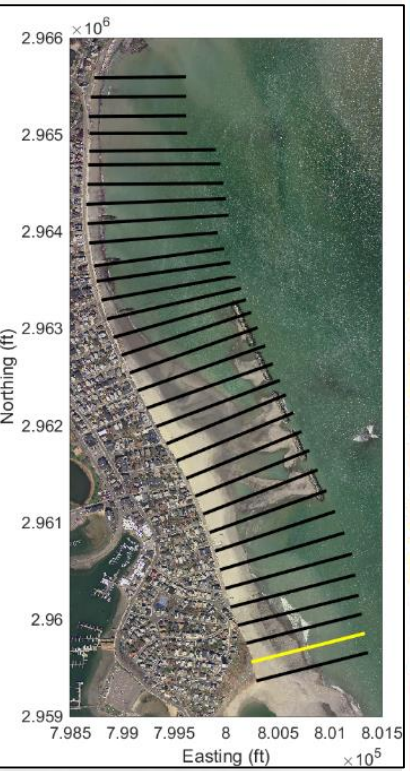
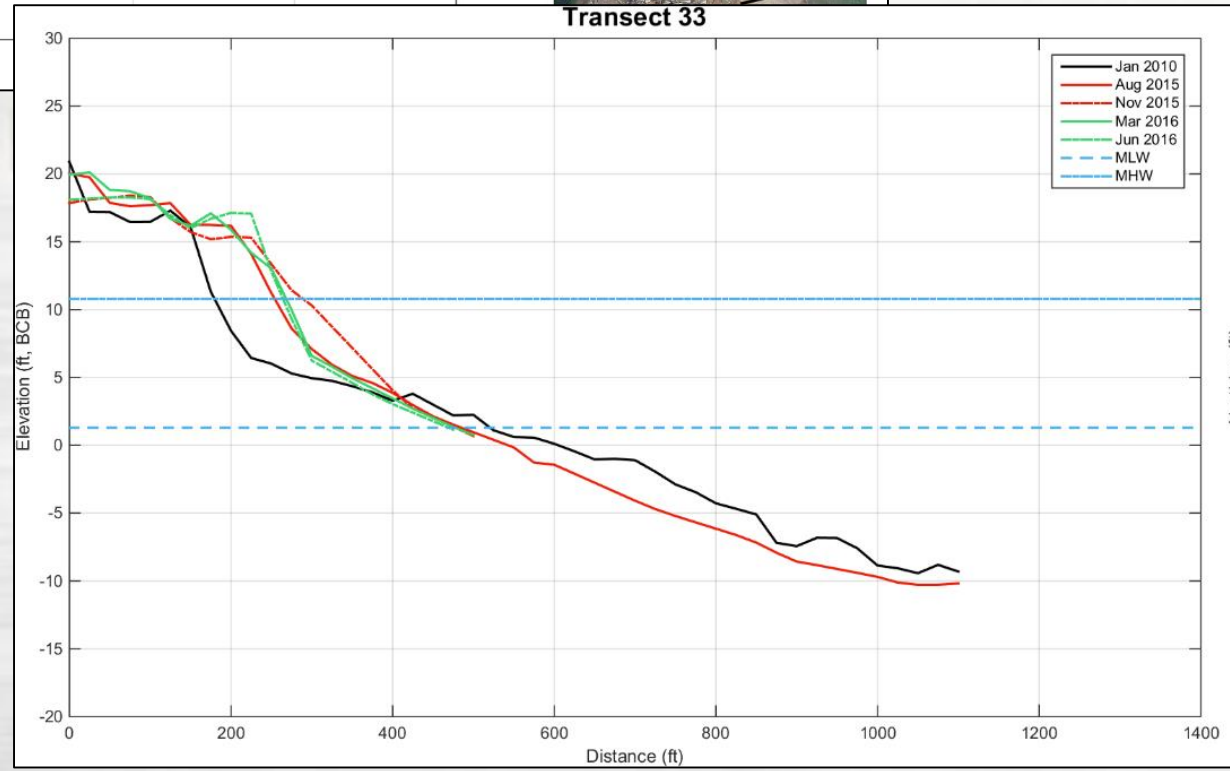
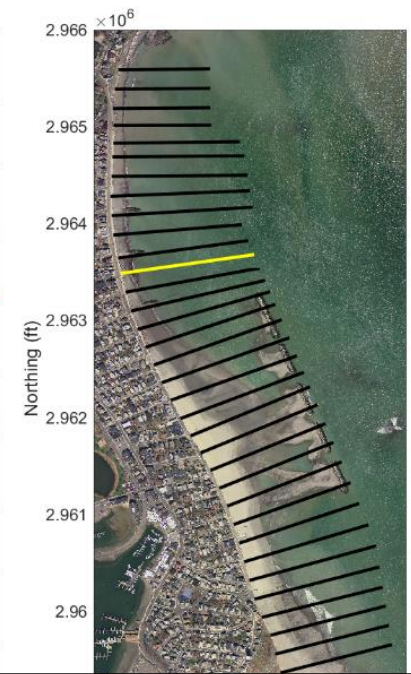
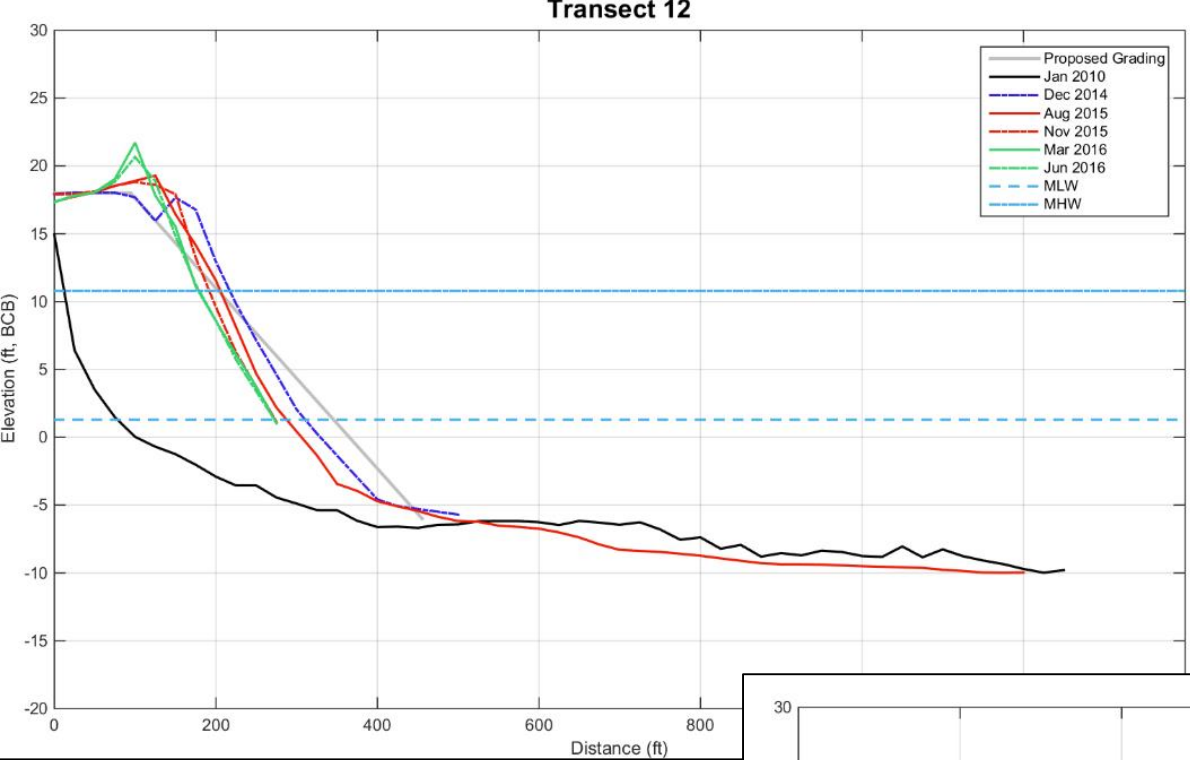
**Sand Only:**  
**Kamphuis (1990)**

**Composite:**  
**Kamphuis (1990) for sand**

**van Wellen, et al. (2000) for gravel/cobble**



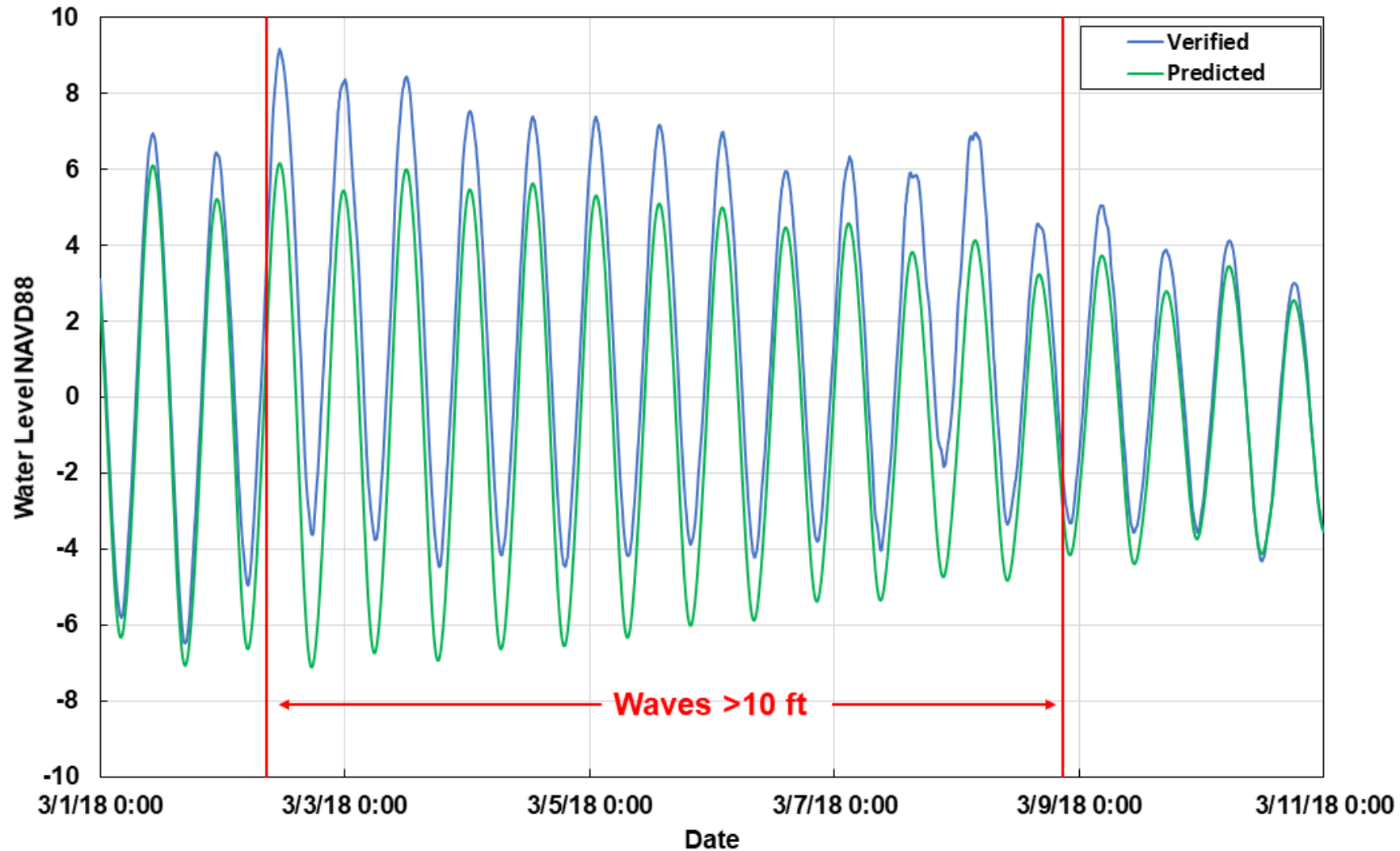




# Beach Nourishment Performance



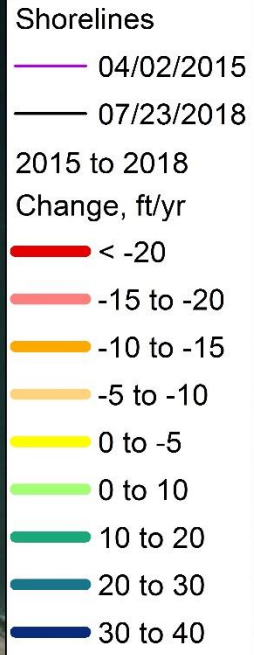
# Major Nor'easter – March 2018





# 2018 High Water Line Survey

## Winthrop, Massachusetts





# Questions

