

# Delineation and Protection of Coastal Dunes and Barrier Beaches



Photo:  
[Wickedlocal.com](http://Wickedlocal.com)

Rebecca Haney, CFM, Coastal Geologist, Mass CZM

Andrew Poyant, Environmental Analyst and Circuit Rider, MassDEP

# Presentation Overview

- MA State Building Code standards for coastal dunes
  - Conservation Commission's role in coastal dune delineation
- Coastal dune and barrier beach protection under the WPA
  - Coastal Manual overview
  - Guidance for delineation coastal dunes
  - Assessing function of developed dunes and barrier beaches
  - Examples of coastal dune function
  - Lessons learned from coastal storm events
  - Activities that adversely affect the storm damage prevention and flood control functions of coastal dunes

# 7<sup>th</sup> Edition MA State Building Code Changes: Purpose



- Codify Existing Practice under the Wetlands Protection Act
- Improve Public Safety
- Reduce Property Damage
- Assist Natural Storm Damage Prevention & Flood Control Capacity of Coastal Dunes

# Purpose

- Conform Building Code to National Flood Insurance Program (NFIP):
  - No adverse impacts to coastal dunes
- Formalize the requirements in ASCE and FEMA guidance documents
  - ASCE 24-14 Flood Resistant Design and Construction:  
“Foundations constructed on erodible soils shall be founded on piles” Coastal dunes are considered erodible soils.
  - FEMA Coastal Construction Manual highlights the importance of considering the effects of coastal erosion in dunes, even landward of the mapped floodplain and recommends construction of a deep foundations (pilings).



Photo: DCR

- These Houses are located in the Primary Frontal Dune, but mapped as landward of the 1% chance floodplain on the FEMA FIRM
- This picture was taken just after a 5 year return frequency storm
- The dune eroded significantly, endangering these houses.



# FEMA Fact Sheet: Erosion, Scour and Foundation Design

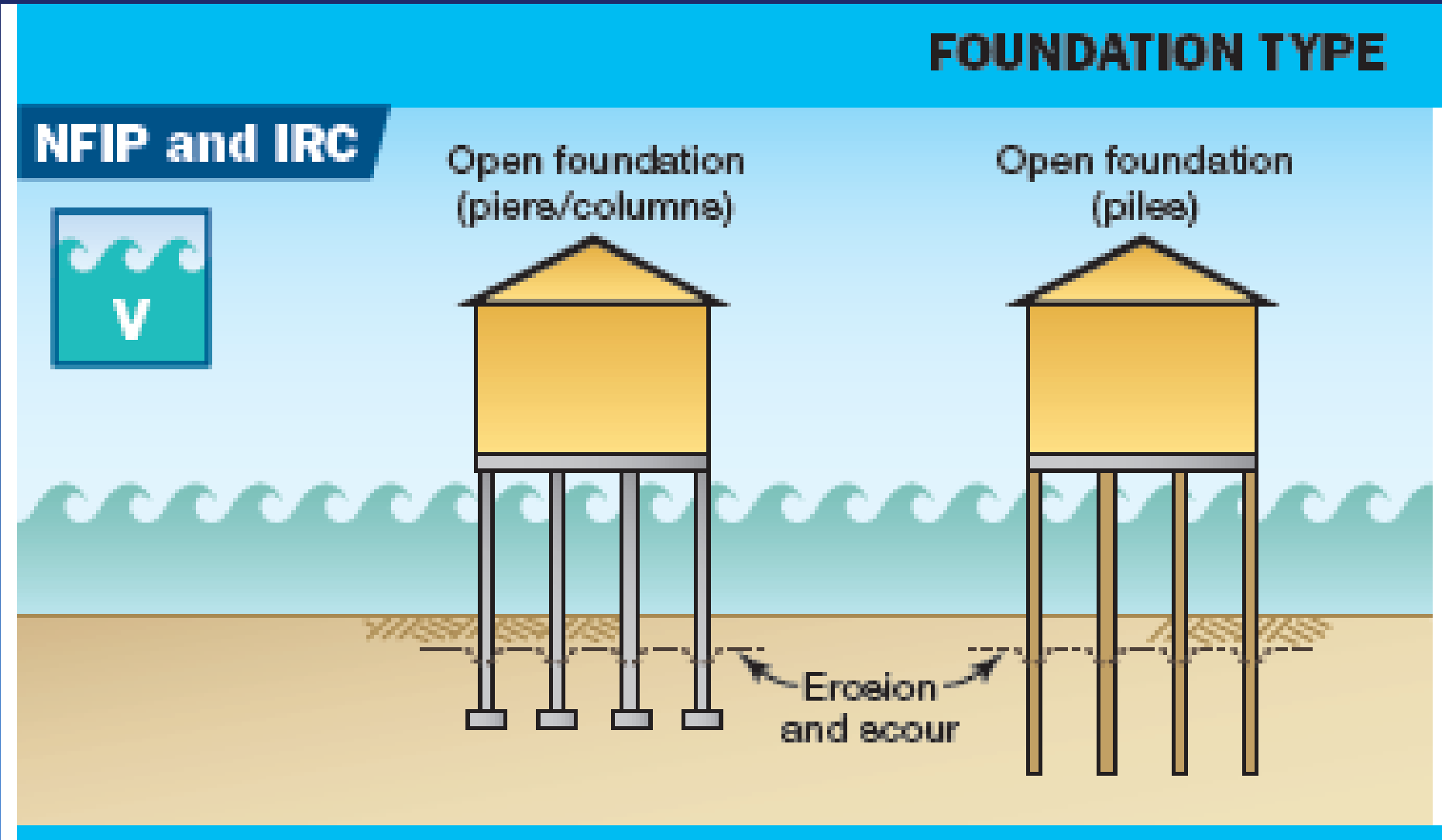


Photos: FEMA

# MA State Building Code

- To assist Building Officials with implementing the new requirements, DEP and CZM developed maps for Building Officials to determine if a project may be in a coastal dune: “*Map of Coastal Wetland Resources For Building Officials*”
- These maps are based on the DEP gis wetland resource area maps, which were developed primarily through interpretation of aerial photographs. They are NOT intended for site specific resource delineation.
- The maps for Building Officials were intended to help them identify when they need to work with the Conservation Commission regarding a detailed resource delineation.
- Whether the site is a coastal dune and whether it functions to provide storm damage prevention and flood control interests per the WPA is up to the Commission (and/or DEP).

# Foundation Types

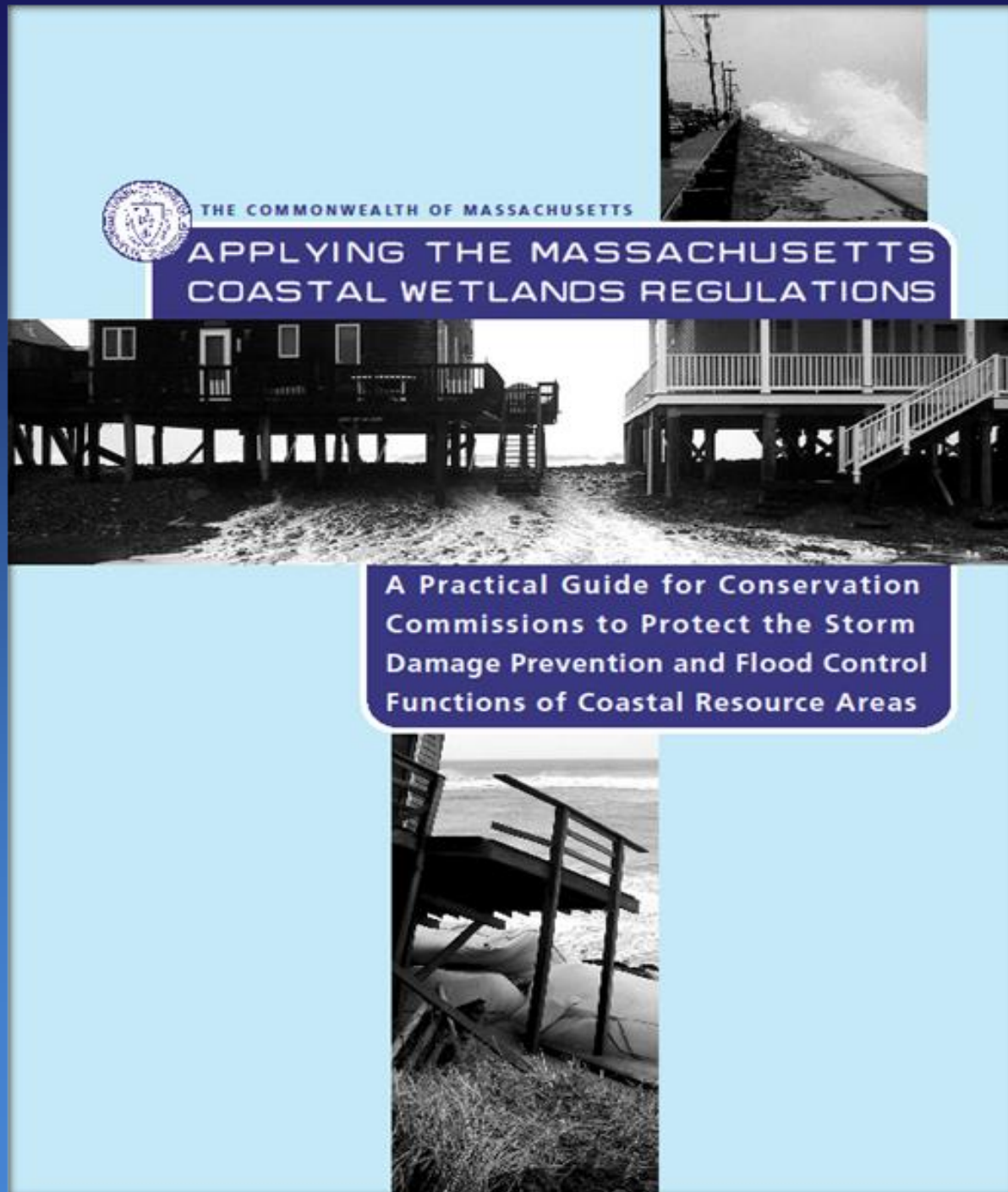


From: FEMA 2018 Quick Reference Guide: Comparison of Select NFIP and 2018 I-Code Requirements for Special Flood Hazard Areas



# Coastal Manual

- Guidance document developed by CZM and DEP
- Issued in 2017
- Updated urls in 2020
- Available on CZM and DEP's websites



# Contents – Chapters 1 & 2

- Chapter 1: Resource Area Delineations
  - WPA definition of resource areas
  - Special considerations and complexities unique to certain resource areas
  - What to look for on applications and plans
  - How to delineate resource areas in the field
- Chapter 2: Resource Area Functions
  - Does the resource area serve the public interest of flood control and storm damage prevention
  - Each coastal resource area is presumed significant

# Contents – Chapters 3 & 4

- Chapter 3: Performance Standards for Project Review
  - Provides detailed requirements for each performance standard
  - Lists examples of typical project activities
  - Provides methodology to determine if a proposed project meets the performance standards
- Chapter 4: Selected Scenarios: From Principle to Practice

# Contents – Appendix

- Appendices:
  - Glossary
  - Useful data sources
  - Technical specifications for delineating primary frontal dunes
  - Policy 92-1 for Coastal Banks, Measuring slope on a coastal bank
  - Using an engineer's scale, references



# Delineation of Coastal Dunes



Rexhame Beach



# Delineation of Coastal Dunes



Figure 1.4

## Beach/Dune Profile Plot

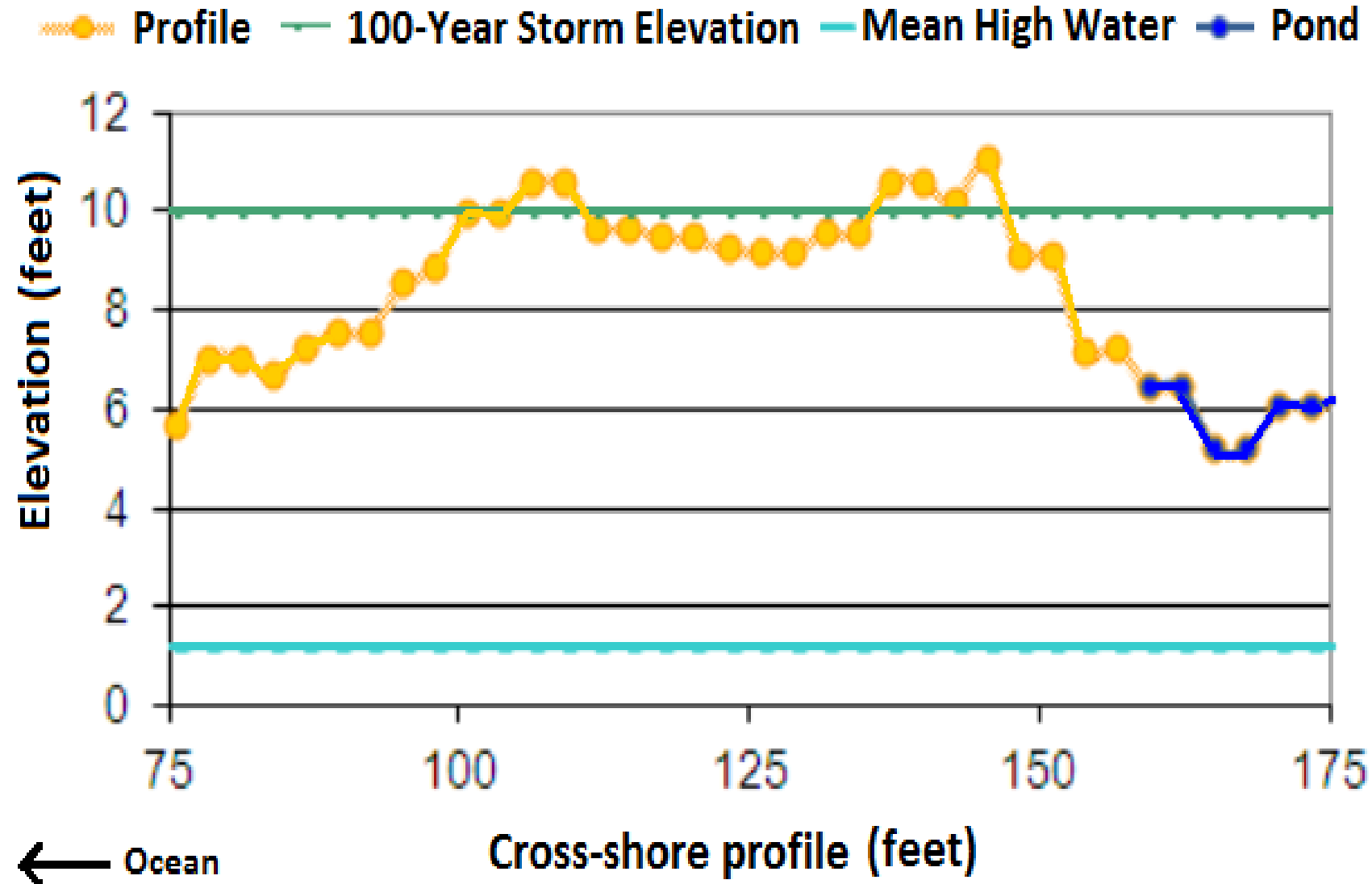


Figure 1.4



# Coastal Dune Secondary Dunes



Salisbury Beach



# Coastal Dune?



Photo: CZM

Scituate



# Delineation of Coastal Dunes

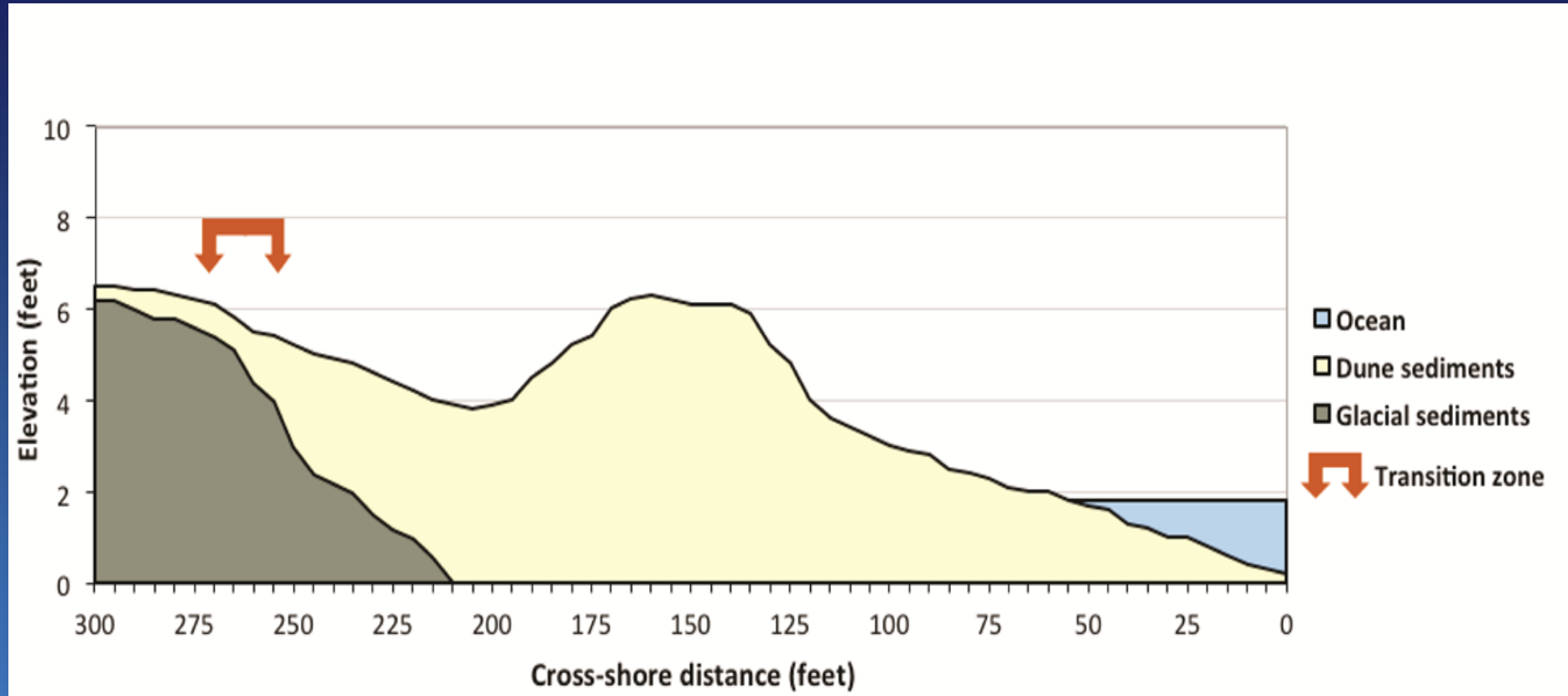
- Information to consider in delineation of coastal dunes
  - Barrier Beach Inventory Maps and DEP Wetlands gis layers – a place to start.
  - For site specific delineation, you need to identify the thickness and characteristics of the subsurface sediments at the site (p. 1-24).
    - Wind or wave deposited sediments, artificial fill or glacial sediments?
    - Do the thicknesses vary across the site?  
Multiple data points may be needed to characterize the landform.



# Coastal Dune Delineation

- Tapering coastal dunes – where do they end?
- “Veneers” – are they coastal dunes?
- To be considered a coastal dune under the Regulations, the landform must meet the definition:
  - located landward of a coastal beach,
  - consisting of sediments that were deposited by wind action or storm overwash, and
  - exhibiting a hill, mound, or ridge topography.

# Coastal Dune Delineation

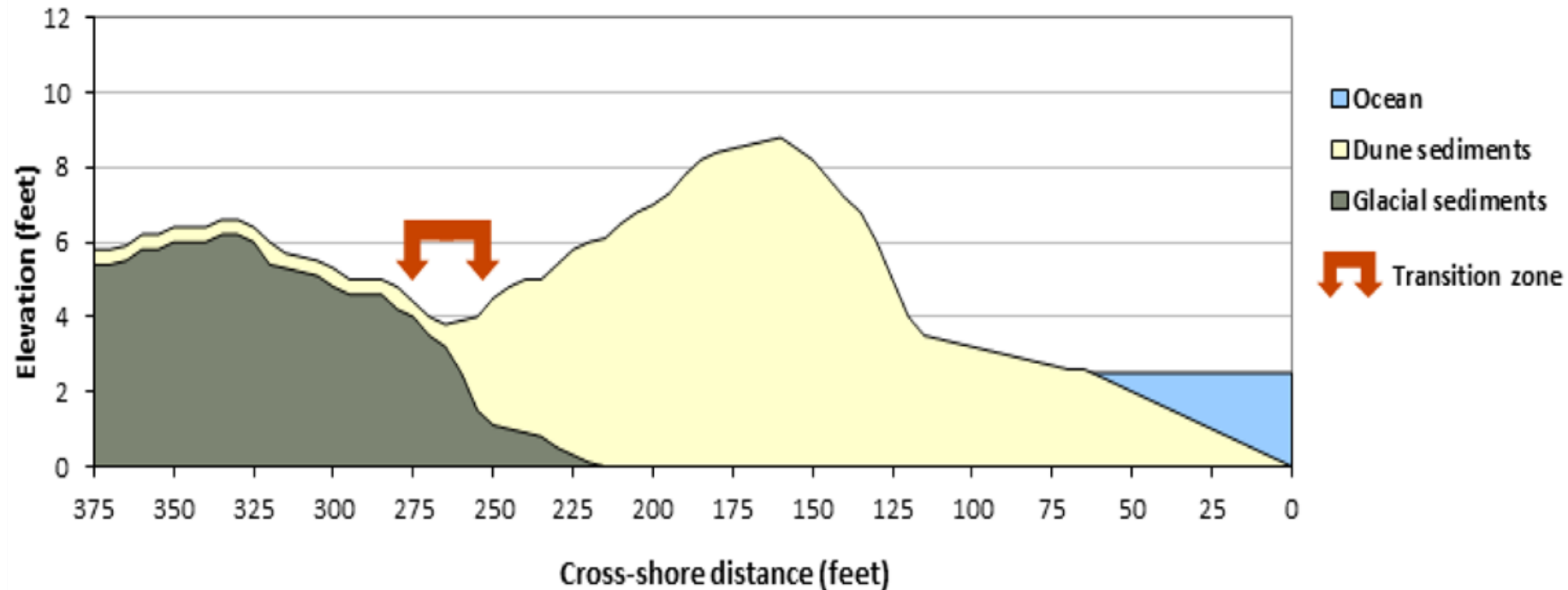


Viewing a subsurface profile illustrates more clearly where dune sediments that overlie glacial material are part of the overall landform and where they are not part of the hill, mound or ridge of sand.

Figure 1.5 Profile B



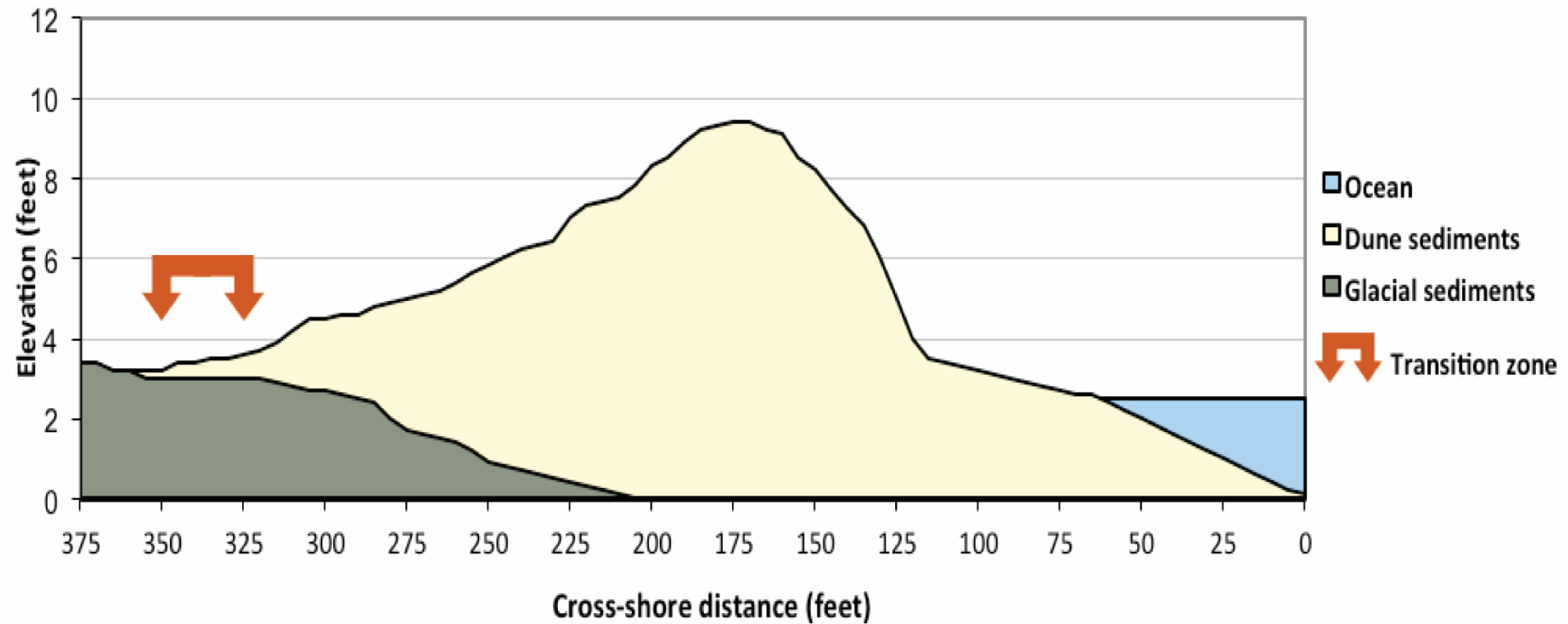
# Coastal Dune Delineation



The windblown sediments landward of the coastal dune in this example are a constant thickness, not part of the hill, mound or ridge. They are a veneer.

Figure 1.5 Profile A

# Coastal Dune Delineation



Though fairly thin, the landward layer of sand is still part of the overall dune landform.

Figure 1.5 Profile C

# Coastal Dune Delineation

## Methodology:

Define the thickness and characteristics of the surface and subsurface sediment layers and the method of deposition (windblown, wave deposited, glacial or artificial fill)

- Take multiple transects from the coastal beach landward across the site.
- Use auger, shovel, corer or machine to determine the characteristics and thickness of the surface and subsurface sediment layers.
- The depth of analysis needed will depend on the height of the dune and the depth to underlying materials.

# Coastal Dune Delineation

- Dune sediments are typically rounded and well sorted. Dunes often have obvious layers.
- It is helpful to look at the range of sediments on the fronting beach to put the subsurface sediments landward of the beach in context.
- South shore beaches and dunes are often a mix of sand, gravel and cobble size sediments.



Photo: 1.11



# Coastal Dune Delineation



Photo: 3.2, DEP

- In contrast to dunes, glacial sediments are relatively unsorted and unstratified.
- In some cases, there may be a clear difference in color of the dune sediments vs. glacial. It is not unusual to see development of a soil profile in coastal dunes.



# Coastal Dune Delineation



Source: Google

Ipswich

# Coastal Dune Delineation

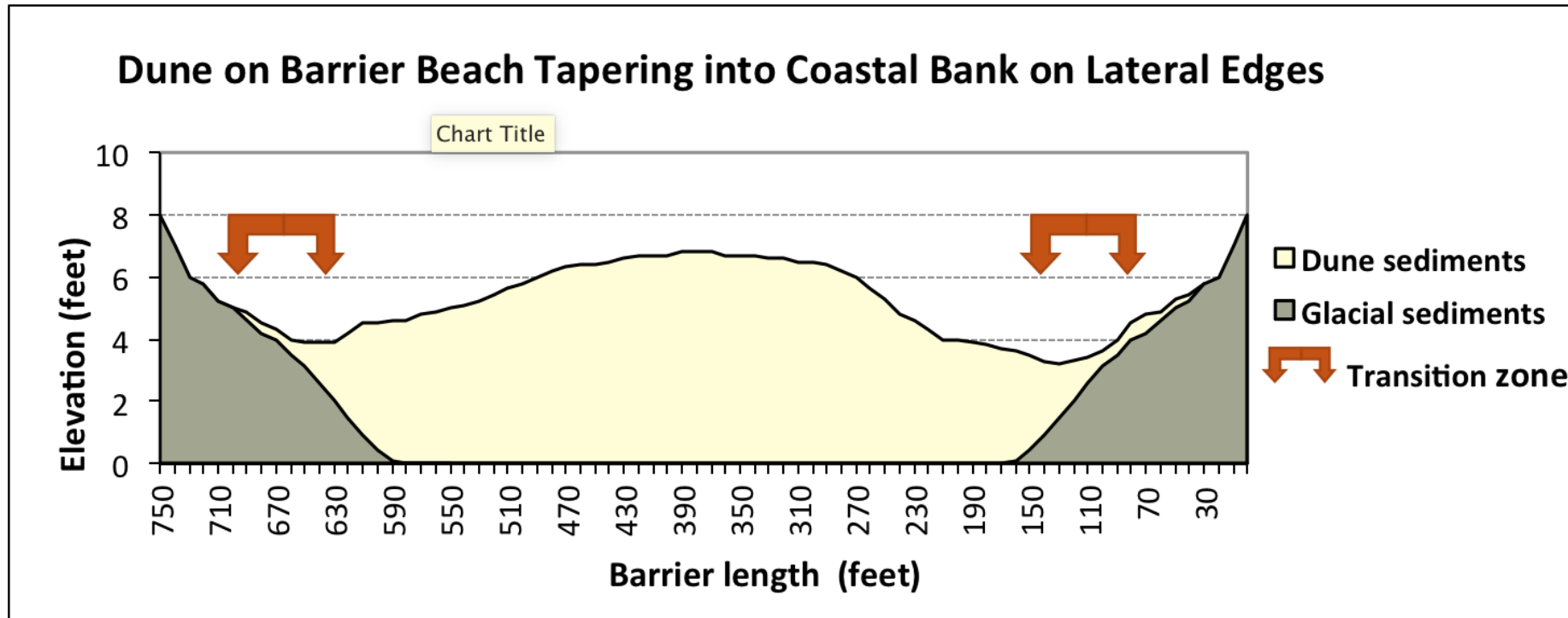


Figure 1.10



# Coastal Dune Delineation



Source: Google.

Ipswich



# Coastal Dune Delineation



Photo: CZM

Ipswich



Bottom of the core

Top of the core





**Area of Interest (AOI)**

[Soil Map](#)

[Soil Data Explorer](#)

[Download Soils Data](#)

[Shopping Cart \(Free\)](#)

**Search**

**Area of Interest**

**Quick Navigation**

Address

State and County

**Soil Survey Area**

[Set AOI](#)

[Select Map Units](#)

[View](#)



State

County (optional)

Soil Survey Area

Name	Area Symbol	Data Availability	Version
<input type="radio"/> Essex County, Massachusetts, Northern Part	MA605	Tabular and Spatial, complete	Survey Area: Version 12, Sep 14, 2016 Tabular: Version 11, Sep 14, 2016 Spatial: Version 3, Dec 17, 2013
<input checked="" type="radio"/> Essex County, Massachusetts, Southern Part	MA606	Tabular and Spatial, complete	Survey Area: Version 13, Sep 14, 2016 Tabular: Version 11, Sep 14, 2016 Spatial: Version 4, Sep 14, 2016

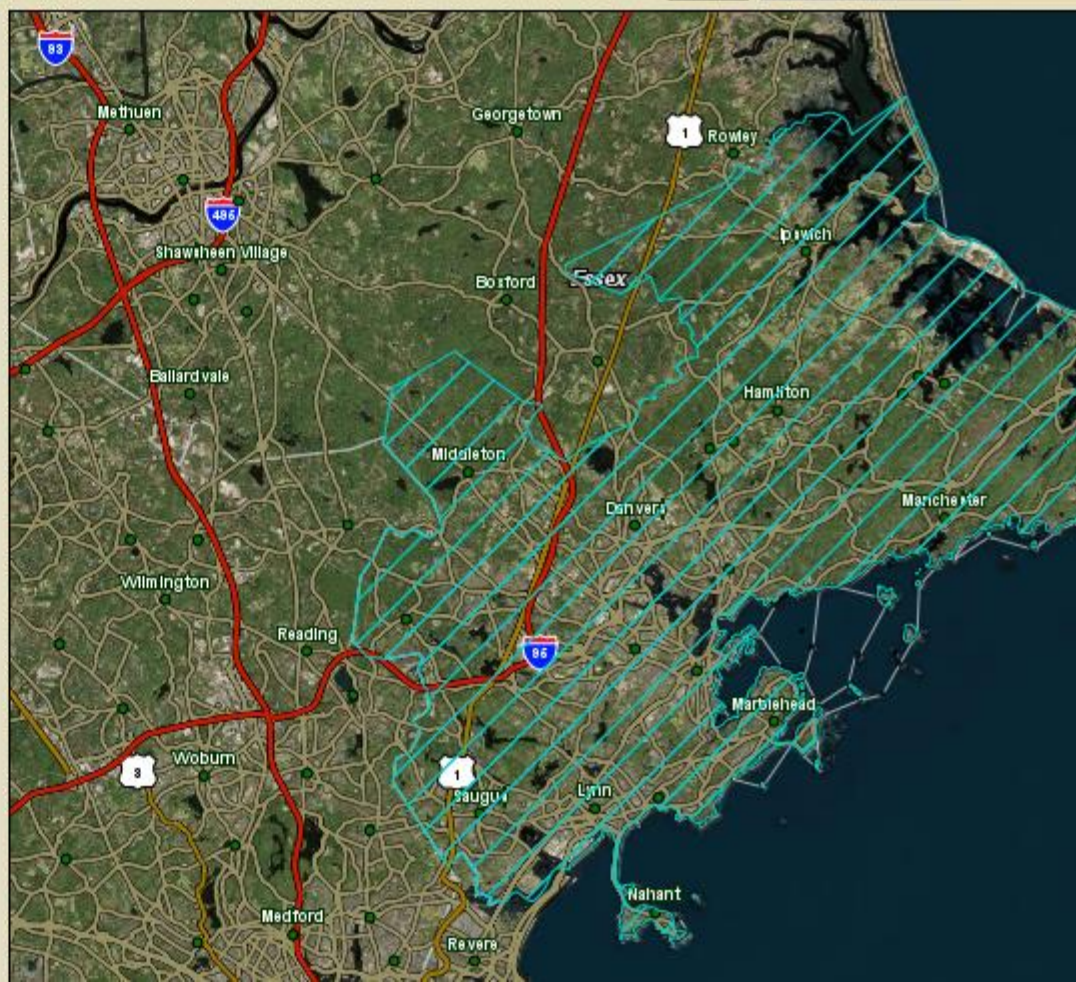
Show **Soil Survey Areas** Layer in Map ☒

**Area of Interest Interactive Map**



View Extent

Scale





# Coastal Dune?



Photo: CZM

Scituate



# Delineation of Coastal Dunes

## Artificial Fill?

- Is the site in a flood zone on the FEMA Flood Insurance Rate Map? If so, how high is the flood elevation above grade?
- Has there been overwash of the site observed during coastal storms?
- If it is in a mapped flood zone or has been overtopped in storms, it would serve the function of storm damage prevention and flood control, and therefore is a coastal dune.



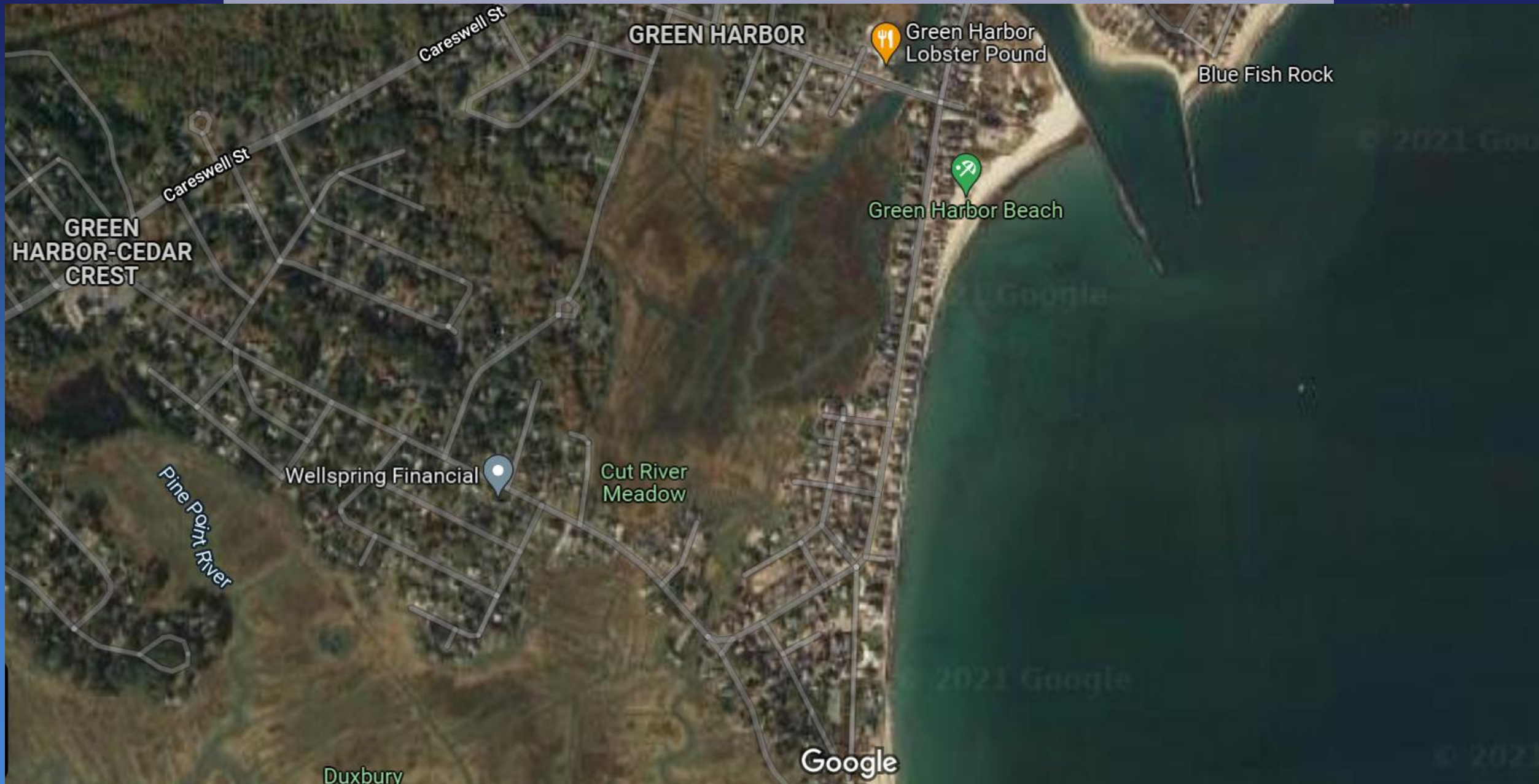


# Developed Coastal Dune





# Developed Coastal Dune/Barrier Beach





# Coastal Dune Delineation

- If the soils are wind or wave deposited sediments or artificial fill in a flood zone, it is a coastal dune.
  - Even if a site has pavement, concrete, a house with a solid foundation it is still a coastal dune.
  - If the site is behind a seawall, revetment, bulkhead or other coastal engineering structure, it is still a coastal dune.
  - If the site has a paved roadway, it is still a coastal dune.

# Coastal Dune Function

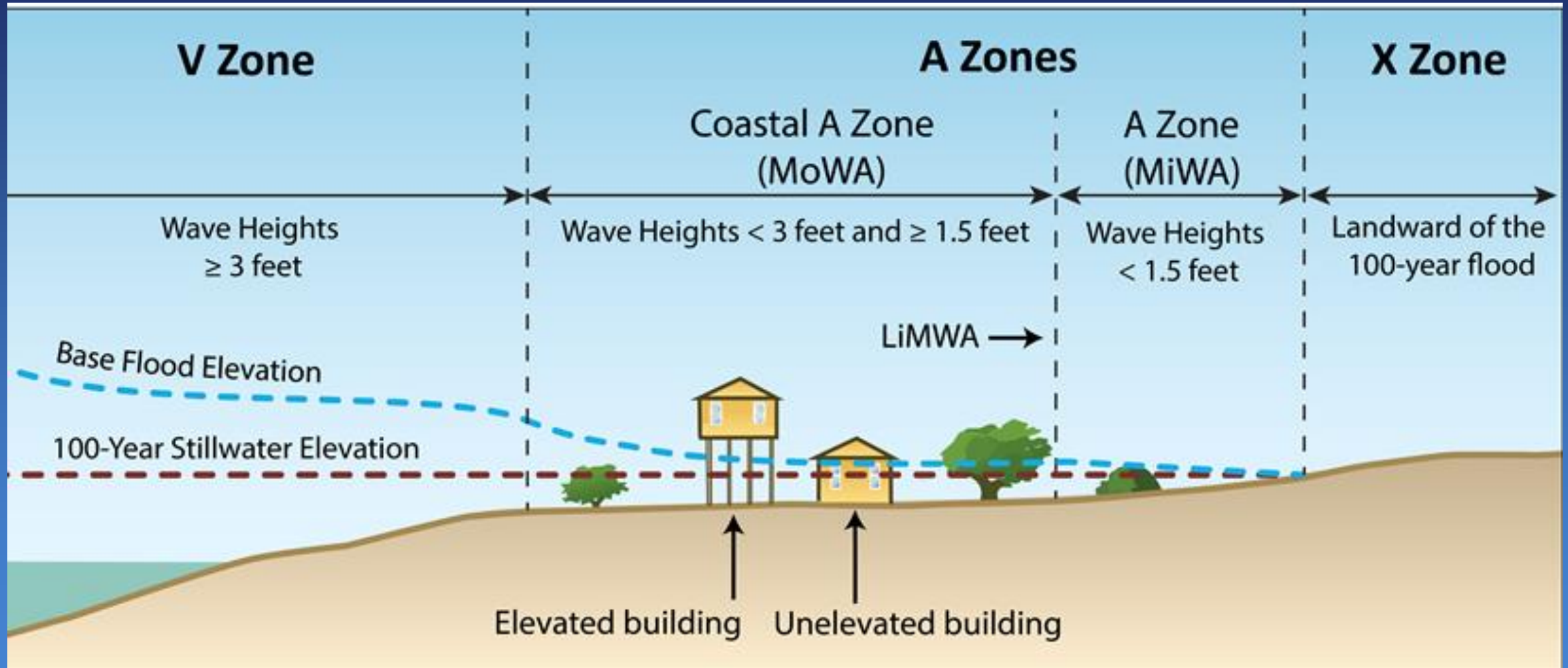
- WPA defines primary dunes and all dunes on barrier beaches to be per se significant to storm damage prevention and flood control.
- They are significant because their volume determines the capacity of a barrier beach system to protect landward areas from storm damage and flooding.
- These functions include dissipating waves, slowing down overwash, and some serve as a reservoir of sand for the beach.
- Altered or developed dunes may not exchange sediment with the beach, but they can still erode and dissipate the energy associated with moving water and waves in a moderate to major coastal storm event.

# FEMA Flood Zones

- **Zone VE – Areas of 100-year coastal flood with velocity waves**
  - Wave height 3 feet or greater
  - Wave runup depth 3 feet or greater
- **Zone AE – Areas of 100-year flood;**
  - **Moderate Wave Action Area (MoWA):** Portion of the A Zone with 1.5 – 3.0' waves.
  - **Minimal Wave Action Area (MiWA):** the area of the A Zone landward of the LiMWA where wave heights are less than 1.5'
  - MoWA and MiWA separated by the Limite of Moderate Wave Action (LiMWA) on the FIRMs
- **Zone AO – “Overwash” areas with flow depths of 1 to 3 feet**
  - Generally coastal with sloping ground
  - Flow velocities can vary greatly



# FEMA Flood Zones



# FEMA Flood Insurance Rate Map



# Information to Consider in Assessing Coastal Dune Function

- FEMA flood zones as shown on the FEMA Map Service Center: <https://msc.fema.gov/portal>
  - What is the flood zone? (V, Coastal A, AE, AO)
  - How high is the base flood elevation above the ground?
  - How much water will flow over the site?
  - If it is an AE zone, how close is it to the V or Coastal A Zone?
  - Is there likely to be moving water flowing across the site in a storm?
- Field observation regarding the extent of storms, including the MyCoast online database can be informative: see the StormReporter or King Tides tools on [MyCoast.org/ma](http://MyCoast.org/ma)



# Developed Coastal Dune Function



Photo: CZM

Salisbury Beach



# Developed Coastal Dune Function



Gun Rock

Atlantic Ocean

Seal Rock



Atlantic Ave

Gunrock Ave

Atlantic Ave

Straits Pond

Hull



# Reduced Floodplain Function





# Altered Coastal Dune Function

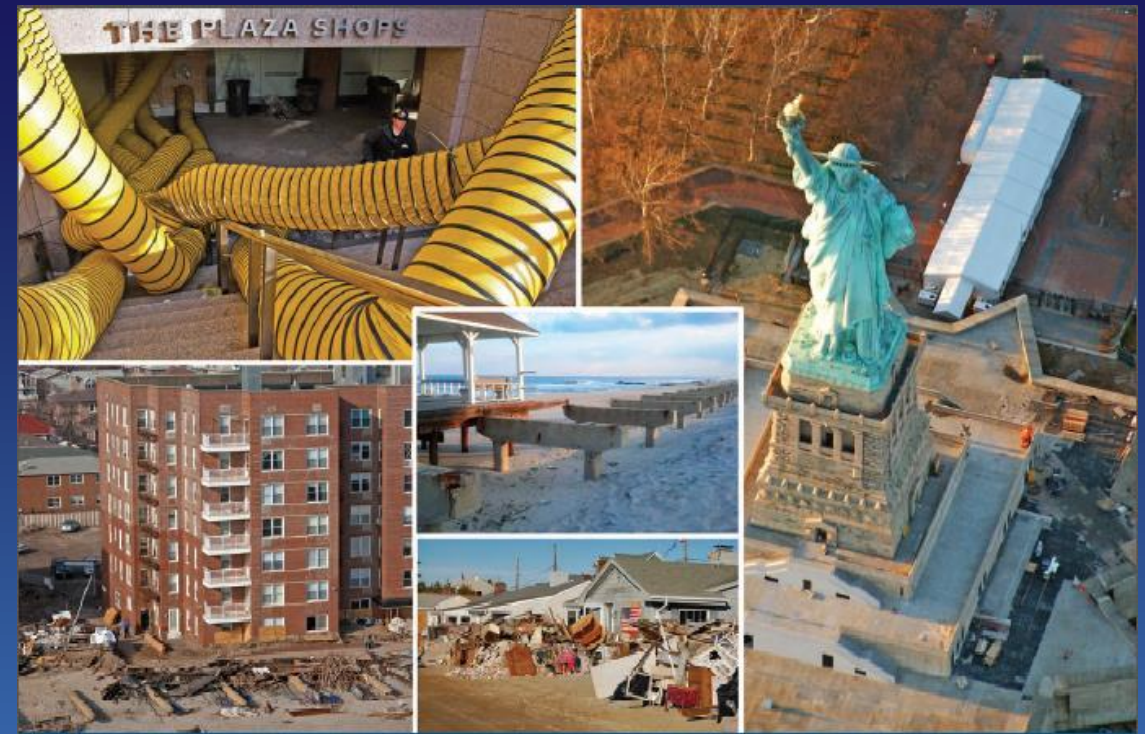
January 17, 2017



Video: Christian Krahforst, Hull

# Lessons learned

- FEMA sends out teams of building science experts and engineers after major coastal storm events to determine why buildings were damaged.
- The Mitigation Assessment Team (MAT) reports make recommendations for reducing future damages.
- Some recommendations apply to building codes while others apply to landform function.



Mitigation Assessment Team Report

## Hurricane Sandy in New Jersey and New York

Building Performance Observations, Recommendations,  
and Technical Guidance

FEMA P-942 / November 2013



FEMA



# Features and Structures That Focus Flow

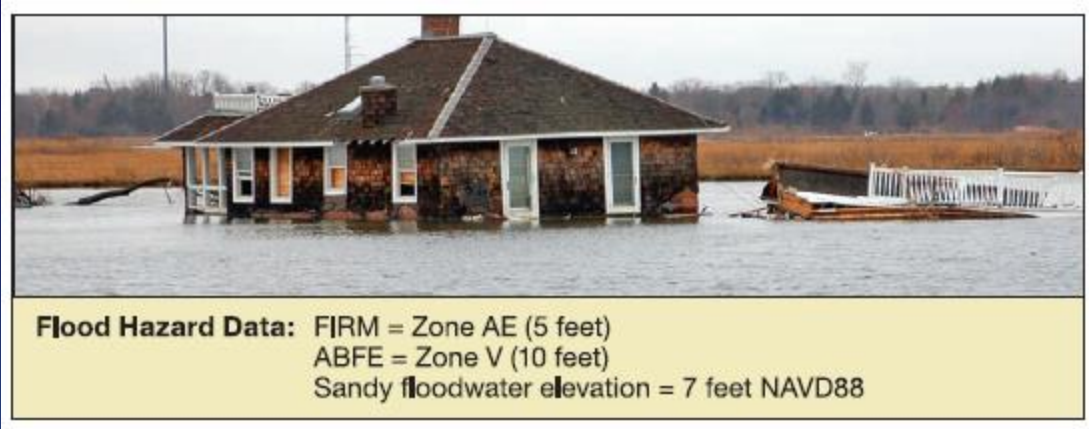
Figure 3-10:  
Flow channels A–D (dashed lines) formed between buildings on the bayward side of the barrier island at Mantoloking, NJ, and washed sand into the bay at their ends

SOURCE: NASA

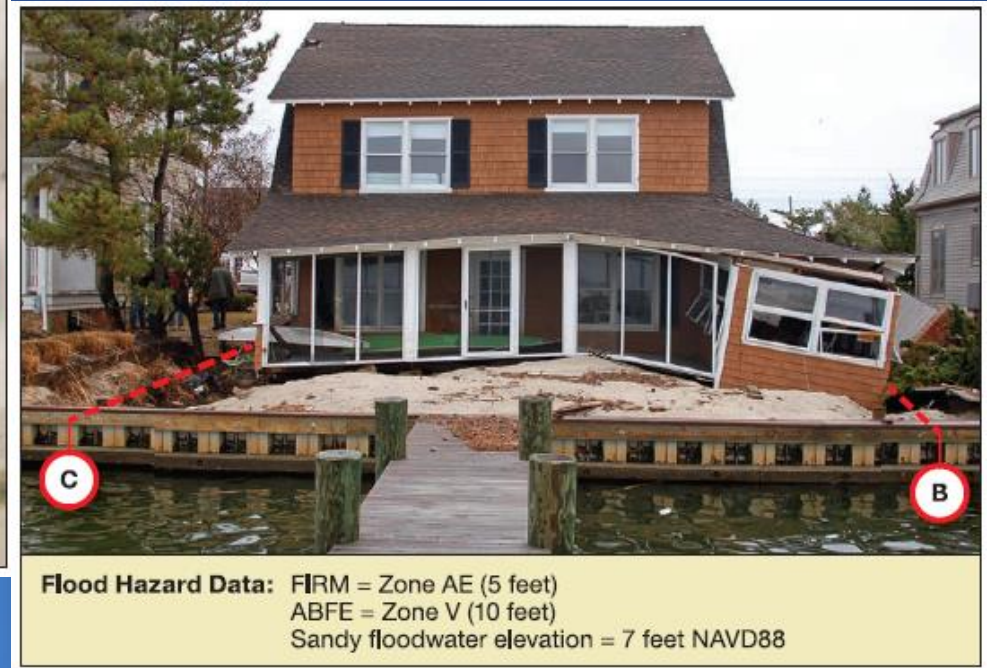


Gaps in dunes, streets, and areas between buildings or other structures often channel floodwater flow. This process tends to be highly localized, and seemingly small obstructions or changes in elevation can facilitate flow channelization.

# Flow Channels



House washed into the bay at the site of flow channel A

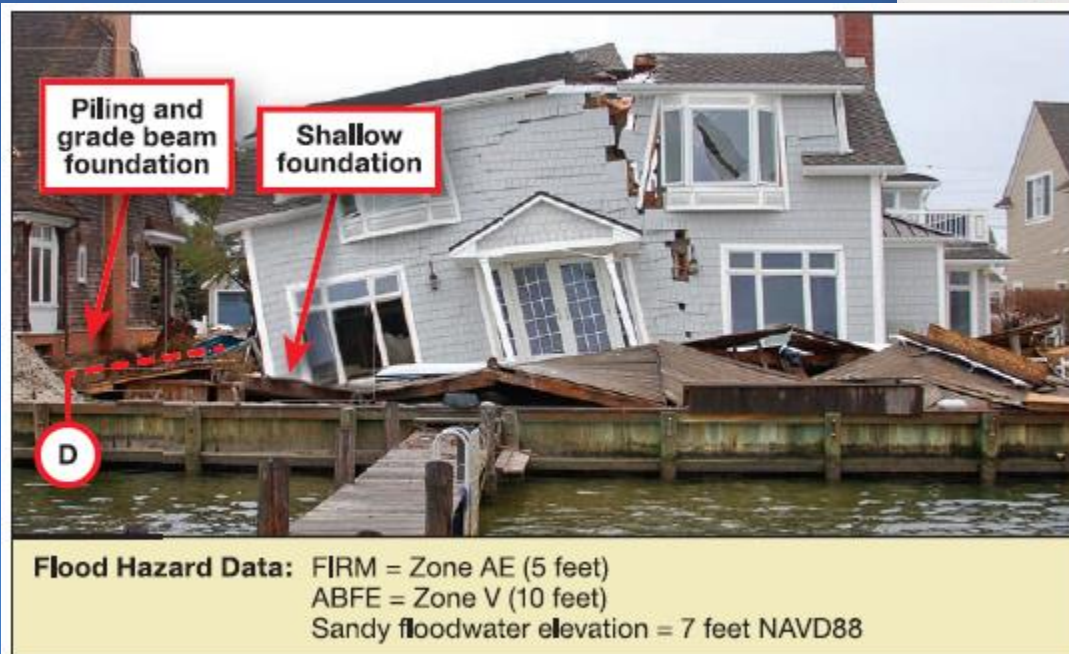


Undermined house with damaged foundation between flow channels B and C.



# Flow Channels

Figure 3-13 Undermined house south of flow channel D.



# Activities that Adversely Affect Storm Damage and Flood Control Functions in Coastal Dunes

- Solid foundations
- Retaining/landscape walls
- Some fencing (e.g. “sturdy drift fencing”)
- Decks where the lowest horizontal structural member isn’t at least two feet above grade.
- Stairs with risers
- New or enlarged solid concrete/paved slabs



- Pavement, slabs or other solid surfaces will adversely affect the ability of the dune to slow down flood waters. Flood water speeds up across a solid surface.
- Pavers may be pervious, but they can become projectiles in storms and are discouraged where waves or overwash will occur in major coastal storms.
- Pea stone, gravel or shell are recommended for driveways and walkways on individual properties. Pile supported walkways or ramps are an option for accessibility while allowing water to flow underneath and some vegetation to help stabilize the dune.

# Coastal Dune Project



Photo: CZM

Brewster



## Impacts of Sturdy Drift Fencing:

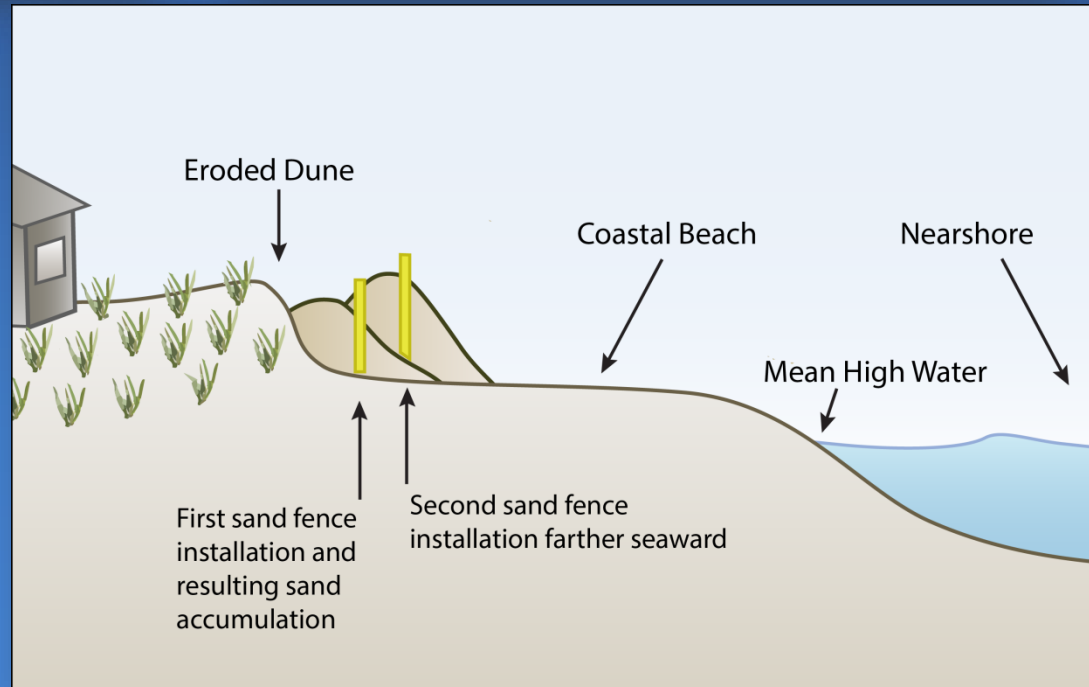
- Larger posts = increased scour around them
- Fence interferes with sediment flow along shoreline
- Fence can cause a wind tunnel effect, increasing erosion
- More metal marine debris when damaged.



# Sand Fencing



- Thin wood slats and twisted wire preferred
- Site landward of reach of waves
- Avoid plastic and metal





# Coastal Dune Project

## Solid structures

- Interfere with the ability of the dune to move landward or laterally
- Change the form of the dune



# Alternatives to Fencing





# Altered Dune Function





# Altered Dune Function





# Activities that Adversely Affect Dunes

- Construction of solid structures, such as building foundations, walls, fences and pavement can adversely impact the dune's ability to dissipate waves and flood waters and redirect it to adjacent properties.





# Activities that Adversely Affect Dune Function





# Damage Adjacent to Seawalls



# General Review Guidelines

- The performance standard for primary dunes and all coastal dunes on barrier beaches is no adverse impact. This applies to all of the critical characteristics and functions of dunes.
- Virtually all coastal dunes in the floodplain provide storm damage prevention and flood control functions.
- All projects should be reviewed relative to the exposure, wave and flooding activity at a site, and what role it serves in providing storm damage protection and flood control to landward areas.



# QUESTIONS?

- [HTTPS://WWW.MASS.GOV/FILES/DOCUMENTS/2020/10/14/CZM-COASTAL-MAUNUAL-2020-UPDATE.PDF](https://www.mass.gov/files/documents/2020/10/14/CZM-Coastal-Mannual-2020-Update.pdf)
- Rebecca Haney, CFM, Coastal Geologist, MA CZM, [rebecca.haney@mass.gov](mailto:rebecca.haney@mass.gov)
- Andrew Poyant, Environmental Analyst and Circuit Rider, MassDEP, [andrew.poyant@mass.gov](mailto:andrew.poyant@mass.gov)