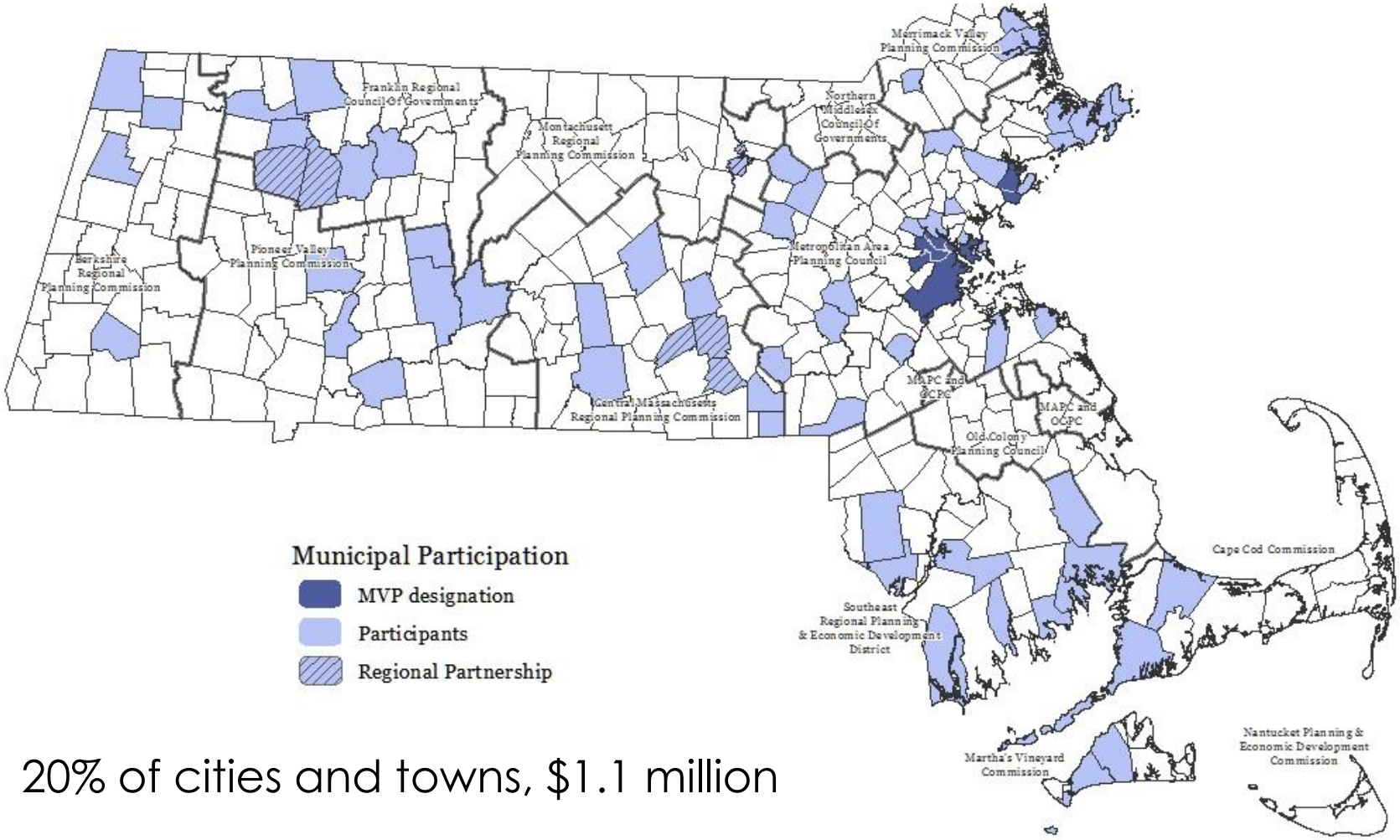
Municipal Vulnerability Preparedness (MVP)



State and local partnership grant to build resiliency to climate change

1. Engage Community
2. Identify CC impacts and hazards
3. Complete assessment of vulnerabilities & strengths
4. Develop and prioritize actions
5. Take Action

MVP Program 2017-2018



20% of cities and towns, $1.1 million

MVP Program
Learn more

https://www.mass.gov/municipal-vulnerability-preparedness-program

Katie Theoharides – kathleen.theoharides@state.ma.us

Jenny Norwood – jennifer.norwood@state.ma.us

Characterizing Coastal Flood Hazards & Increasing Resilience

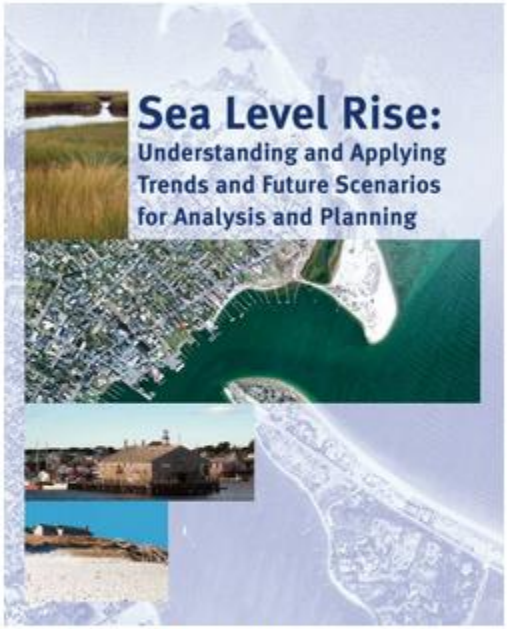
Executive Office of Energy and Environmental Affairs

Massachusetts Office of Coastal Zone Management

Julia Knisel, CZM Coastal Shoreline & Floodplain Manager

Massachusetts Sea Level Rise and Coastal Flooding Viewer

Margot Mansfield, CZM/EEA Climate Change & Coastal Hazards Analyst



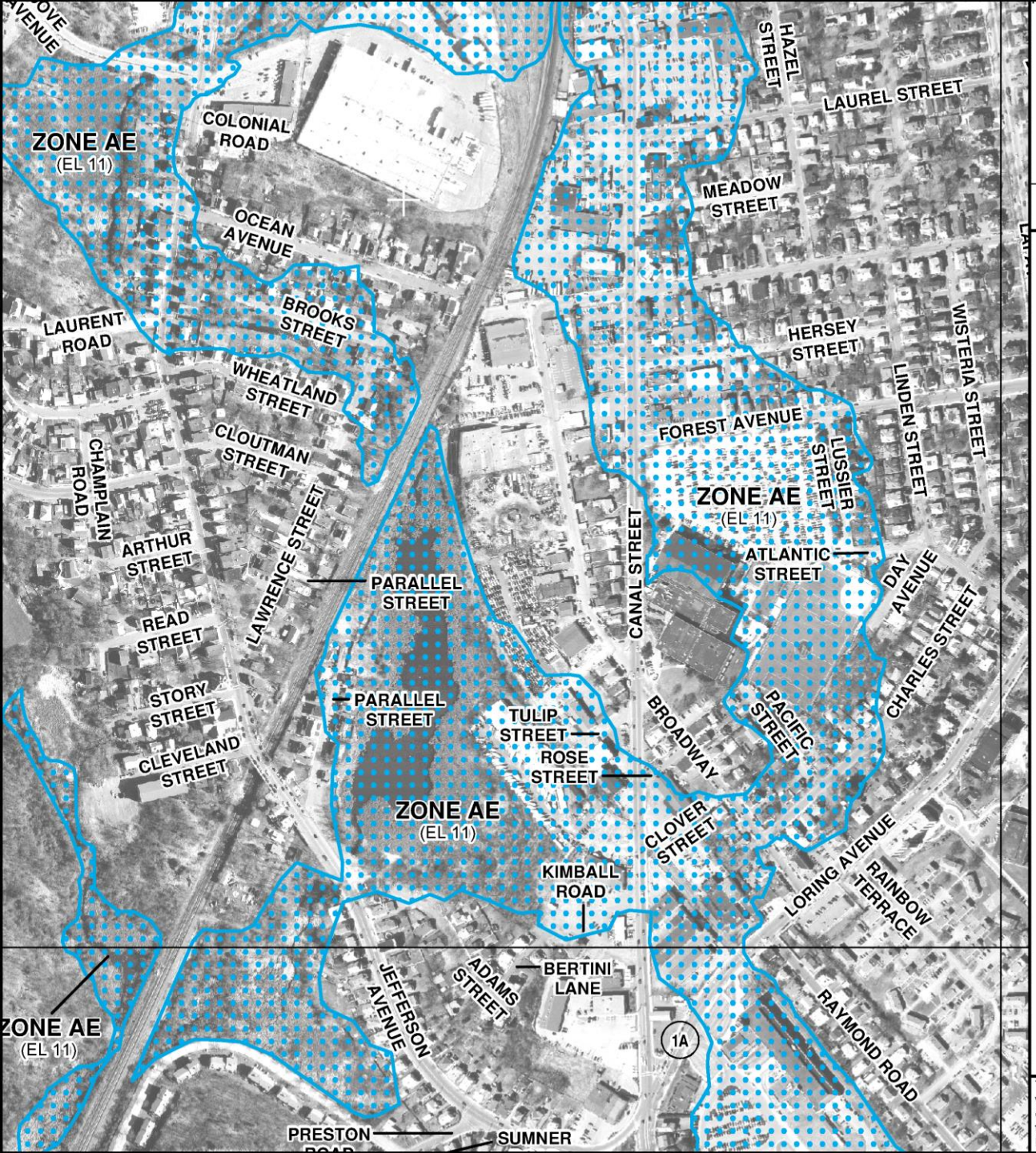
Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning

Tricia Bowie, CZM Coastal Resilience Specialist

Coastal Resilience Grant Program

Identify extent & magnitude of flooding from tides, storm surge, waves…

…*and erosion*



MAP SCALE 1" = 500'

250 0 500 1000 FEET

NFIP

PANEL 0419G

FIRM

FLOOD INSURANCE RATE MAP

ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 419 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARBLEHEAD, TOWN OF	250091	0419	G
SALEM, CITY OF	250102	0419	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25009C0419G

MAP REVISED
JULY 16, 2014

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

Massachusetts Sea Level Rise and Coastal Flooding Viewer

Interactive maps of coastal flooding areas and community facilities and infrastructure based on: sea level rise scenarios, Federal Emergency Management Agency coastal flood zones, and hurricane surge models.

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

Intro | Sea Level Rise | FEMA Coastal Flood Zones | Hurricane Surge

To support the assessment of coastal flooding vulnerability and risk for community facilities and infrastructure, the Massachusetts Office of Coastal Zone Management (CZM) developed the Sea Level Rise and Coastal Flooding Viewer. This viewer maps areas of potential inundation under various sea level rise and worst-case hurricane surge scenarios and located within the Federal Emergency Management Agency (FEMA) coastal flood zones. Examples of mapped facilities include: electrical generation facilities, fire stations, hospitals, police stations, town/city halls, and wastewater treatment plants. Facilities inland of mapped coastal flooding areas are not included in the viewer.

Community facilities and infrastructure are identified with an icon and facility outline. Users can zoom in to an area of interest on a map and then switch viewer tabs to compare coastal flood data.

Please see the technical report (PDF, 272 KB) for additional information, including how the maps were produced and a complete list of types of facilities included. The viewer and technical report are designed as a general planning tool to support broad-scale vulnerability and risk assessments and identification of adaptation strategies consistent with Governor Baker's Executive Order 569 and programs like CZM's StormSmart Coasts. This product should not be used for

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Interactive maps of coastal flooding areas and community facilities and infrastructure based on: sea level rise scenarios, Federal Emergency Management Agency coastal flood zones, and hurricane surge models.

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

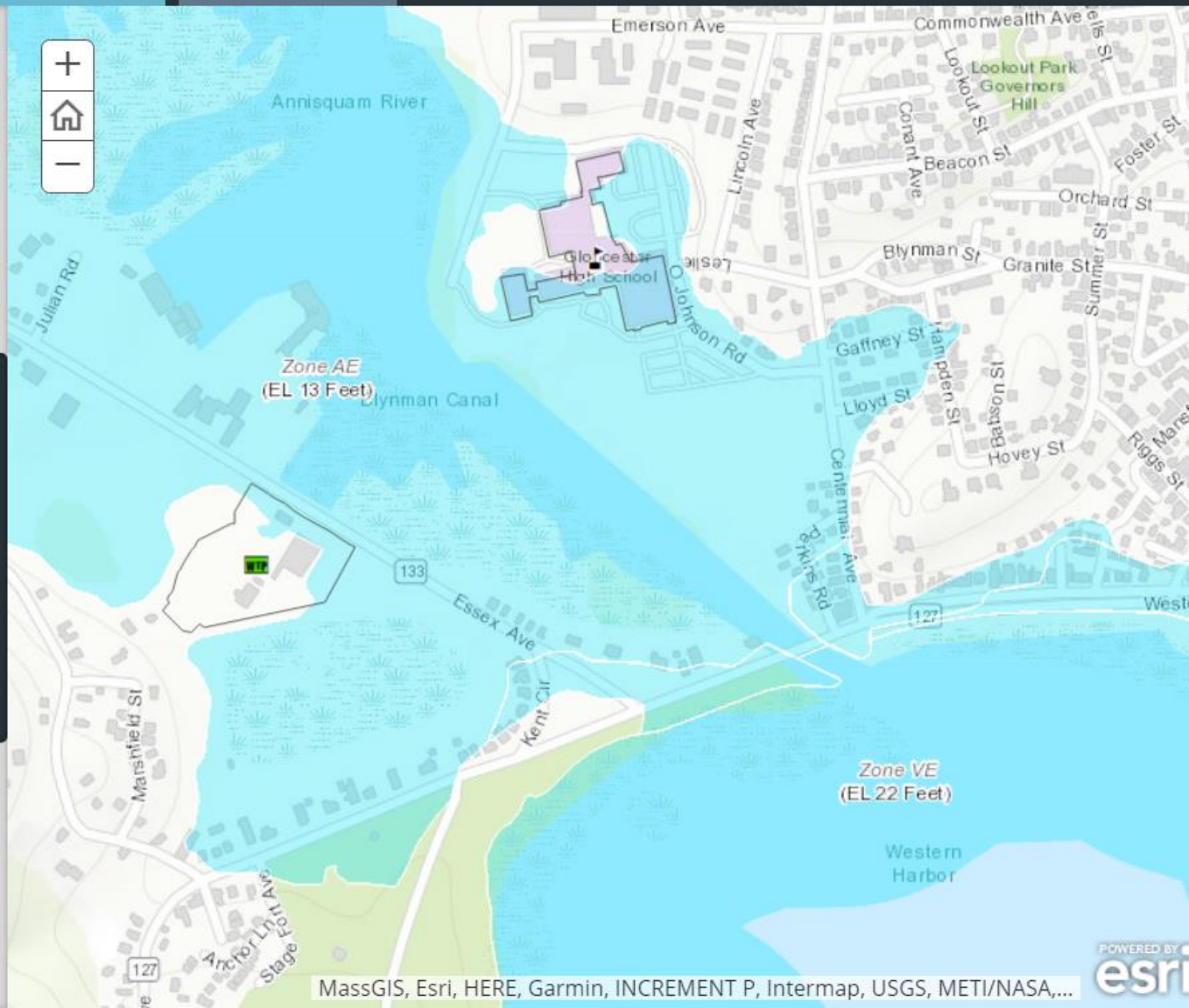
Intro | Sea Level Rise | FEMA Coastal Flood Zones | Hurricane Surge

FEMA Coastal Flood Zones

1% Annual Chance Flood Hazard (includes both A and V zones; zoom in to view zone labels)

Public Facilities and Infrastructure

- Airport
- Community Health Center
- Electrical Generation Facility
- Fire Station
- Harbormaster
- Hospital
- Landfill
- Library
- Long-Term Care Residence
- MBTA Commuter Rail Station
- MBTA Subway Station
- Police Station
- Port Facility
- Prison
- Public College/University
- Public Water Supply Source



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MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

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Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise

- MHHW
- MHHW + 1 ft Sea Level Rise
- MHHW + 2 ft Sea Level Rise
- MHHW + 3 ft Sea Level Rise
- MHHW + 4 ft Sea Level Rise
- MHHW + 5 ft Sea Level Rise
- MHHW + 6 ft Sea Level Rise

Public Facilities and Infrastructure

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- Hospital
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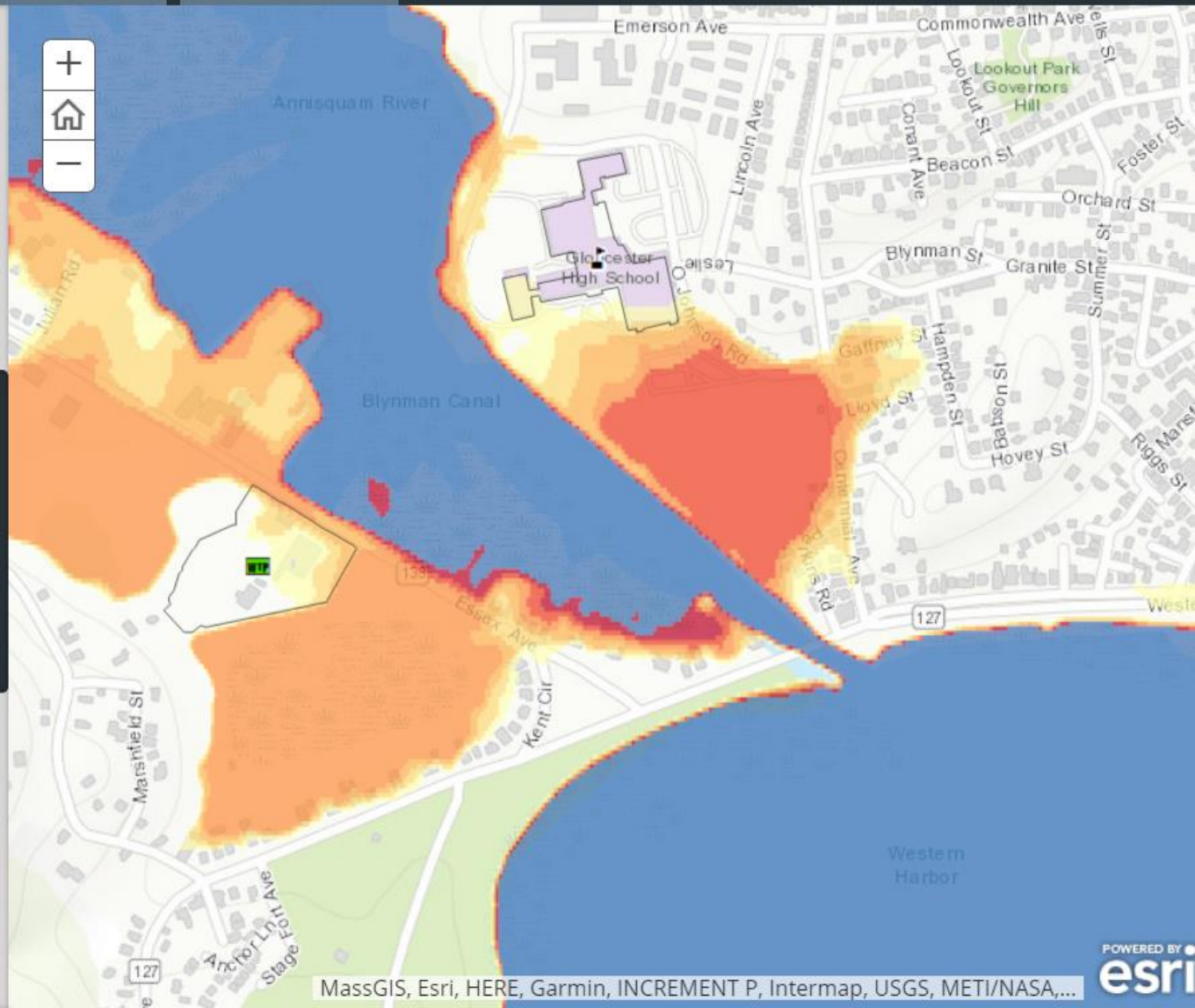

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MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

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Hurricane Surge Scenarios

- Category 1
- Category 2
- Category 3
- Category 4

Public Facilities and Infrastructure

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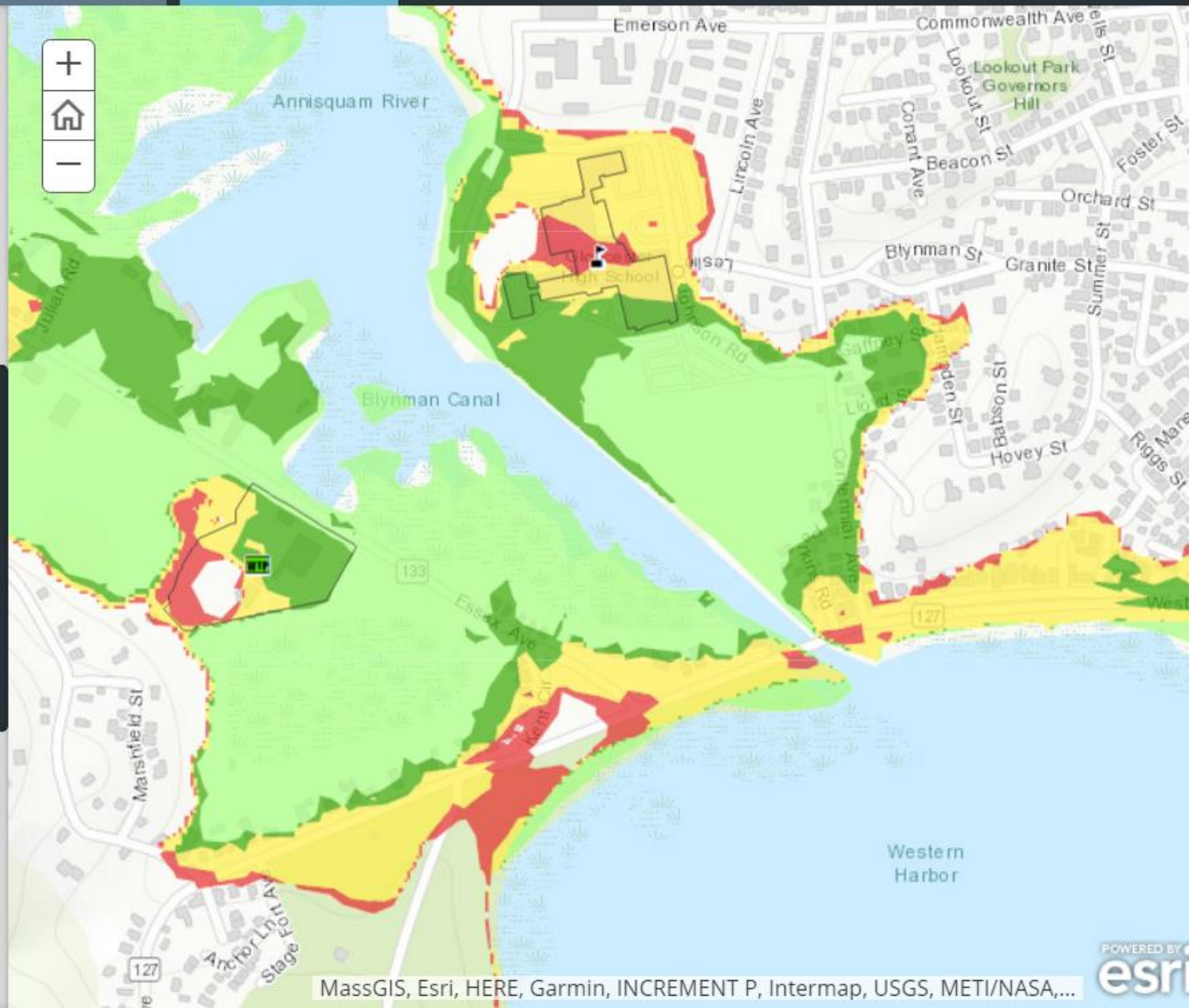

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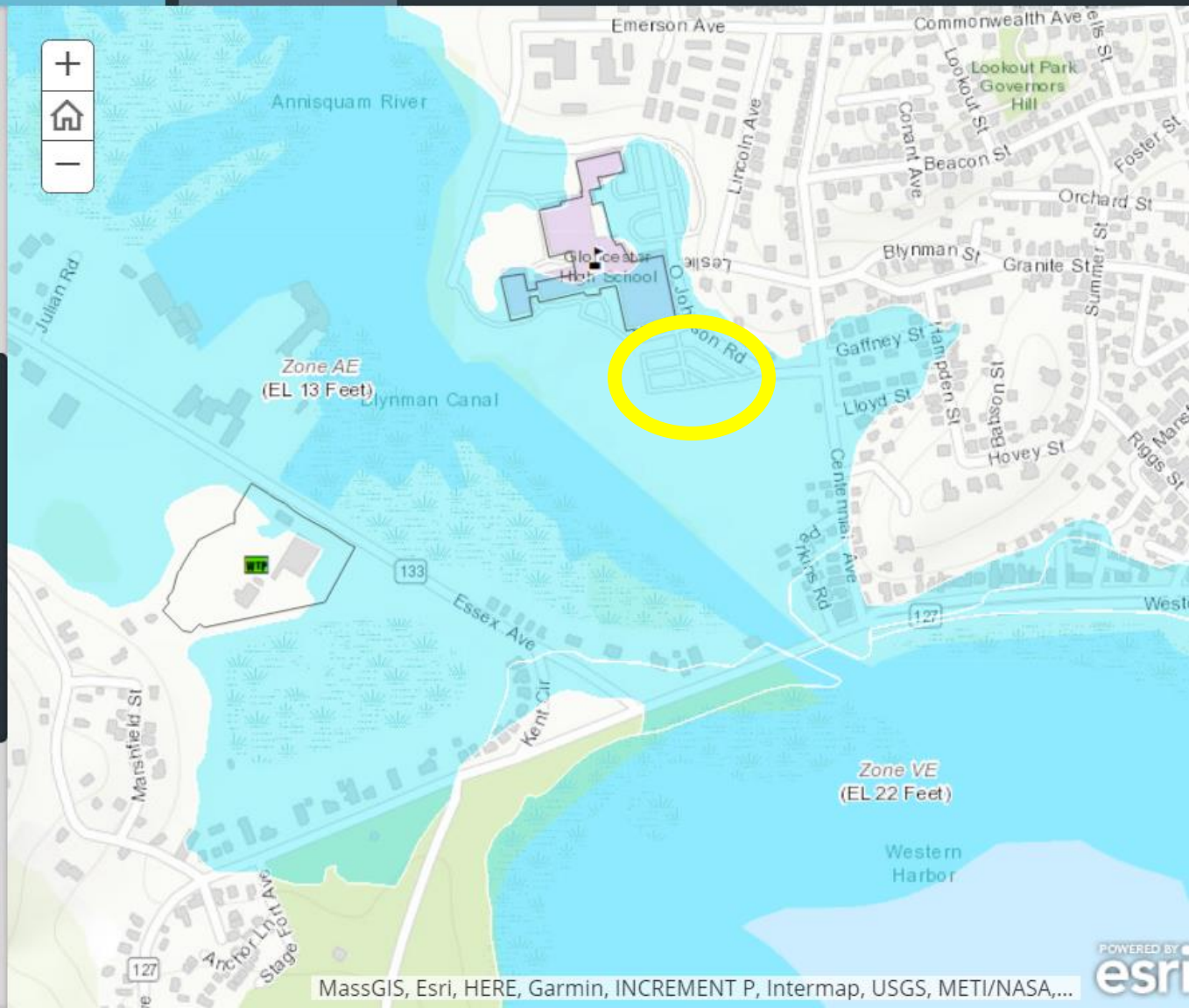


January 4th flooding at Gloucester High School

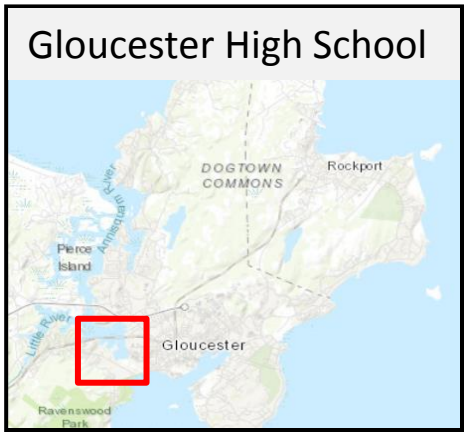


Photo courtesy of fire departments of New England on Facebook @firedepartmentsofnewengland

Conduct visual assessments during & after coastal flooding events

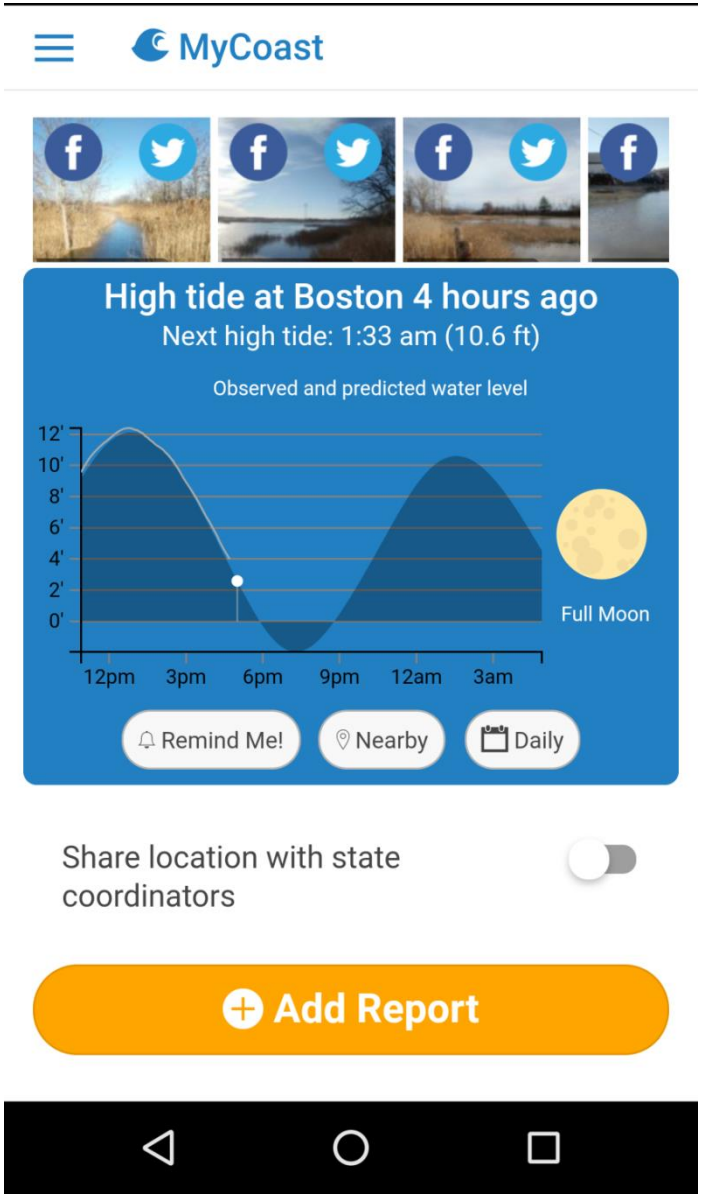


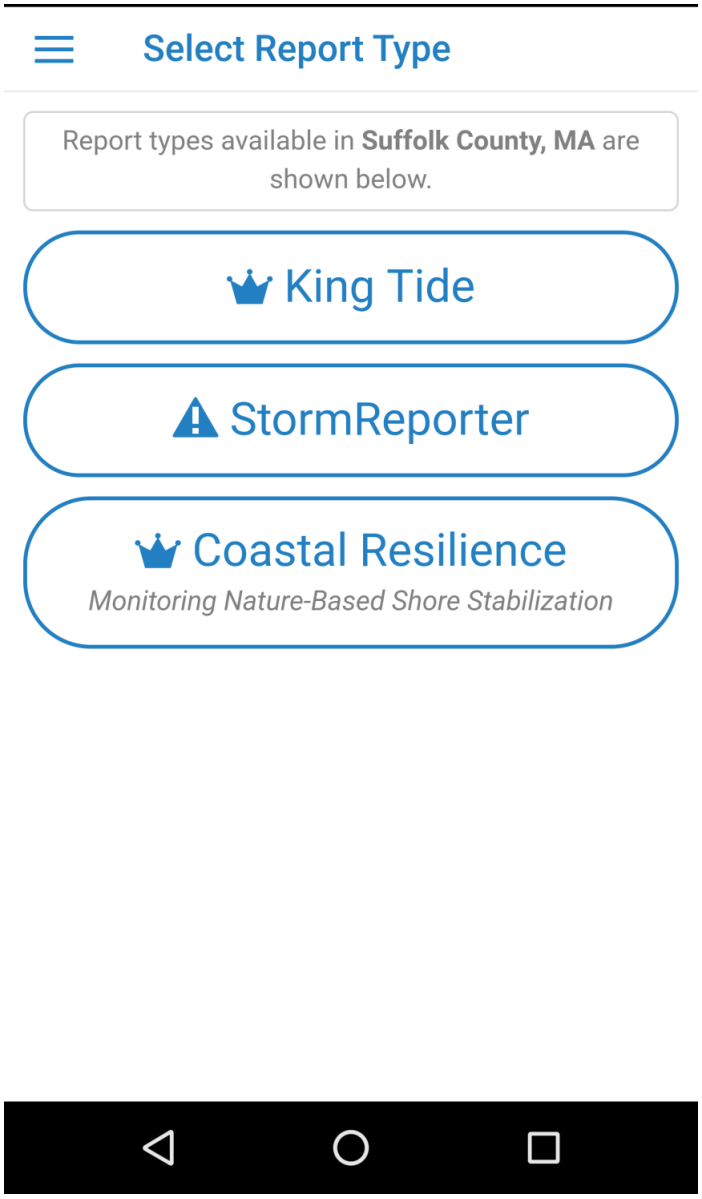







MyCoast Android & iOS apps



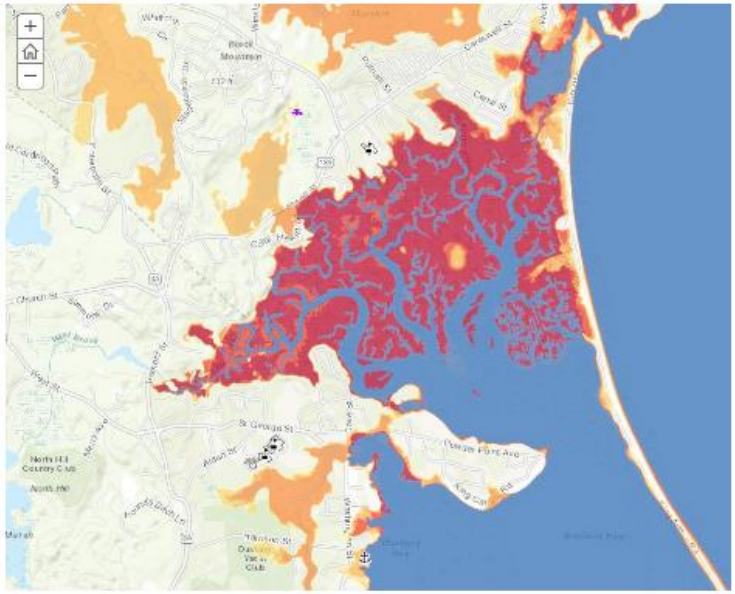


MyCoast: Massachusetts

66 communities

2,636 coastal storm reports

607 king tide photos



Massachusetts Sea Level Rise and Coastal Flooding Viewer

Questions?

resilient MA

Climate Change Clearinghouse for the Commonwealth

Explore Sectors → Identify Changes → Take Action

Maps Data Documents

Search for resources... Search

Providing the most up-to-date climate change science and decision-support tools for the Commonwealth. **More »**

Welcome

I am pleased to release the resilient MA Climate Clearinghouse. This website, and the Municipal Vulnerability Preparedness (MVP) program it supports, are cornerstones of our administration's efforts to further reduce greenhouse gas emissions, safeguard residents, municipalities and businesses from the impacts of climate change, and build a more resilient Commonwealth. While a changing climate knows no geographical boundaries, cities and towns across Massachusetts are on the front lines of climate change. Launched in 2017, the MVP program grew out of a strong desire to work with cities and towns to prepare for the impacts of climate change and build more resilient communities. We are proud that in our first year 71 communities have joined the program and are taking a leadership role using their local knowledge and community strengths to partner with the Commonwealth on this issue.

As first announced when we hosted a Municipal Climate Change Summit, our administration has produced the resilient MA Climate Clearinghouse to ensure continued access to information and enable communities to access the best science and data on expected climate changes, information on planning and actions to support community resiliency for climate change, and links to important grant programs and technical assistance. The site also catalogs specific vulnerabilities, risks and strategies for different sectors including agriculture, forestry, local government, education, energy, recreation, and transportation. All of the climate projections included on the website are specific to Massachusetts and were produced by the Northeast Climate Science Center at UMass-Amherst. We've also included an interactive map so that users can understand how climate change will affect their specific location and the resources they manage.

From the Berkshires to the Cape and Islands many communities are already working hard and leading the way to build resilience and we are excited to capture your ideas, strategies and best practices in future versions of this website. We hope you will find our Climate Clearinghouse to be useful tool, whether you are working on your MVP plan, applying for a grant to support a new capital project, or educating a local community group on the impacts of climate change.

We look forward to working together to build resilient and strong communities across our shared Commonwealth.

Continue

www.resilientma.org User Name: coming soon Password: c0mingS00n

resilient MA

Climate Change Clearinghouse for the Commonwealth

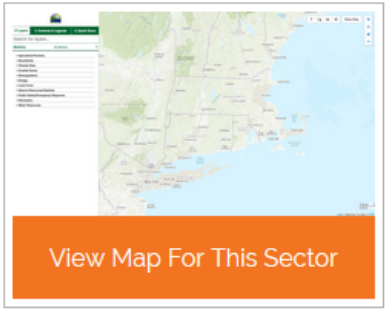
Explore Sectors → Identify Changes → Take Action

Maps Data Documents

Search for resources... Search

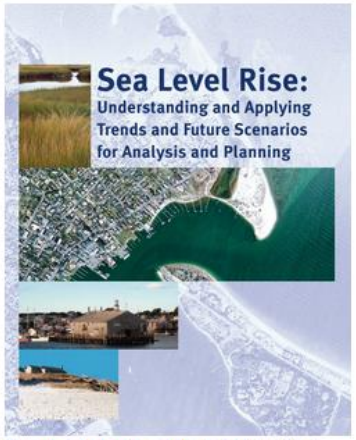
Coastal Zones

The Massachusetts coastal zone includes critical habitats for many important fish and wildlife species, property and infrastructure vulnerable to coastal flooding and storm damage, and an economy based in fisheries and recreation that represents over 88,000 jobs and nearly $6.5 billion in annual job earnings[1] . Climate change will impact both the built and natural environment in the coastal zone.



View Map For This Sector

Showcased Resources



Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning

Massachusetts Sea Level Rise and Coastal Flooding Viewer

Coastal Resilience Grant Program

www.resilientma.org User Name: coming soon Password: c0mingS00n

resilient MA

www.resilientma.org

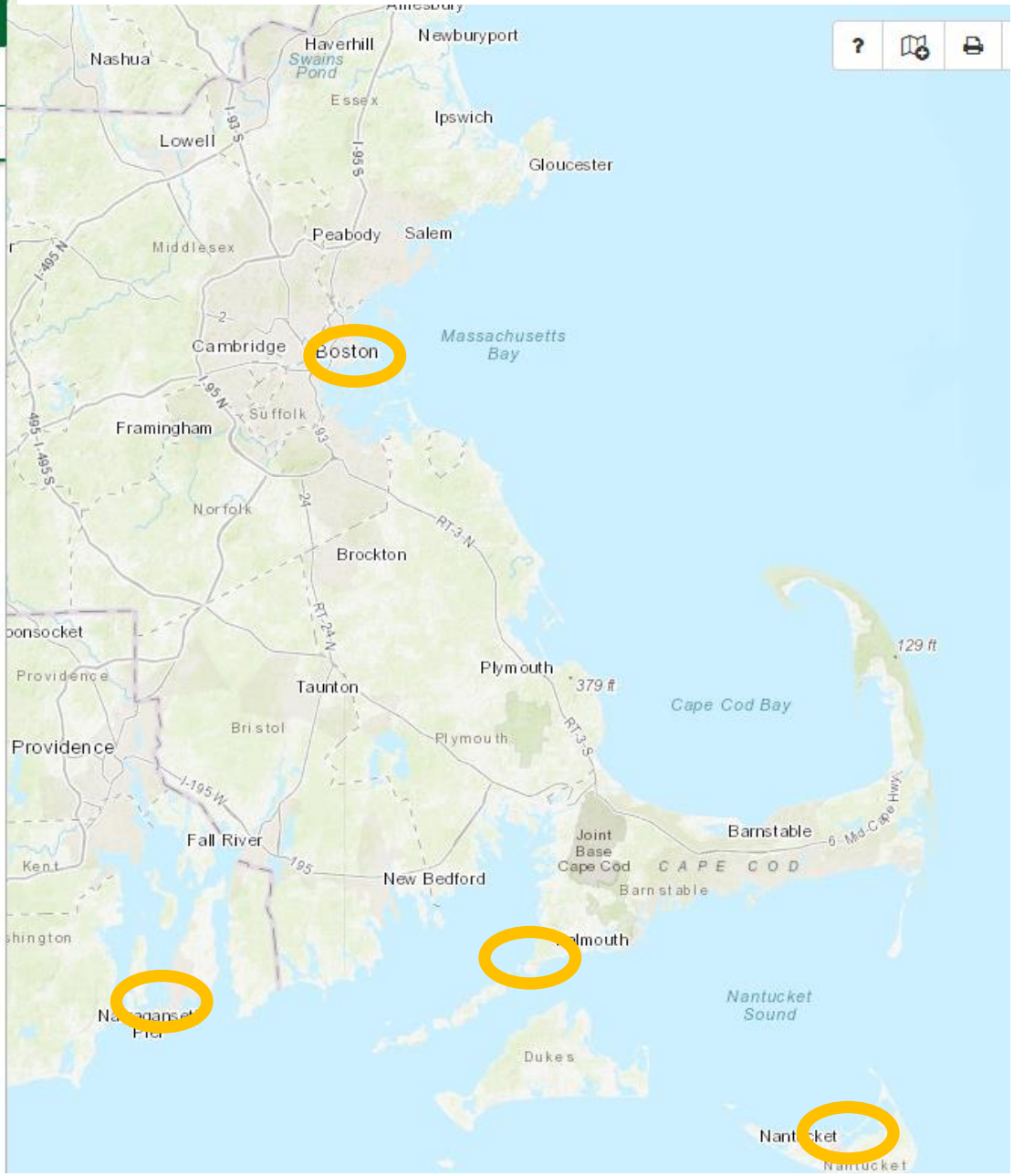
User Name: coming soon
Password: c0mingS00n

Layers | Controls & Legends | Quick Zoom

Search for layers...

Sectors: All Sectors

- Agriculture/Forestry
- Boundaries
- Climate Observations
- Climate Projections
  - Precipitation
  - Sea Level
    - ☐ Sea Level Rise
  - Temperature
- Coastal Vulnerability
- Demographics
- Energy
- Land Cover
- Natural Resources/Habitats
- Public Safety/Emergency Response
- Recreation
- Water Resources



Projections of mean sea level (NAVD88) at four tide stations:

- Boston, MA
- Nantucket, MA
- Woods Hole, MA
- Newport, RI

Relative mean sea level (feet NAVD88)	
Scenario	**Cross-walked probabilistic projections**
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway (RCP 8.5)
	• Extremely unlikely to exceed (95% probability) given a medium emissions pathway (RCP 4.5) • Unlikely to exceed (83% probability) given a medium emissions pathway (RCP 4.5) • About as likely as not to exceed (50% probability) given a medium emissions pathway (RCP 4.5) when accounting for possible ice sheet instabilities
Intermediate - High	Extremely unlikely to exceed (95% probability) given a high emissions pathway (RCP 8.5)
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High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway (RCP 8.5)
	• Unlikely to exceed (83% probability) given a high emissions pathway (RCP 8.5) when accounting for possible ice sheet instabilities • Extremely unlikely to exceed (95% probability) given a medium emissions pathway (RCP 4.5) when accounting for possible ice sheet instabilities
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway (RCP 8.5)
	• Extremely unlikely to exceed (95% probability) given a high emissions pathway (RCP 8.5) when accounting for possible ice sheet instabilities

NECSC Northeast Climate Science Center

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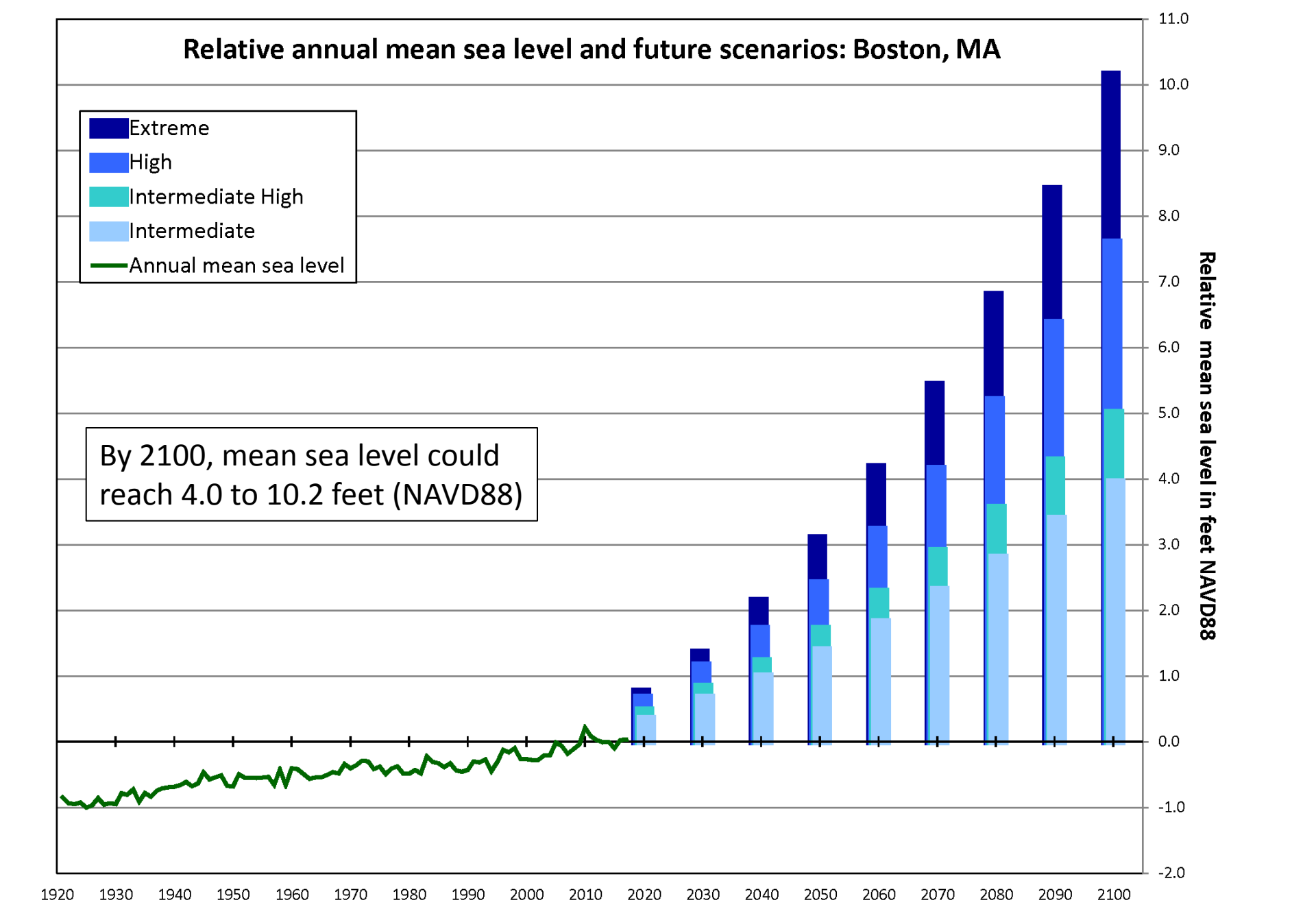
NE CSC Northeast Climate Science Center

Relative mean sea level (feet NAVD88) for Boston, MA					
Scenario	**Probabilistic projections**	**2030**	**2050**	**2070**	**2100**
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway (RCP 8.5)	0.7	1.4	2.3	4.0
Intermediate- High	Extremely unlikely to exceed (95% probability) given a high emissions pathway (RCP 8.5)	0.8	1.7	2.9	5.0
High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway (RCP 8.5)	1.2	2.4	4.2	7.6
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway (RCP 8.5)	1.4	3.1	5.4	10.2

Projections for the High scenario have been selected to update dynamic modeling for the entire coast of the Commonwealth.

NECSC Northeast Climate Science Center

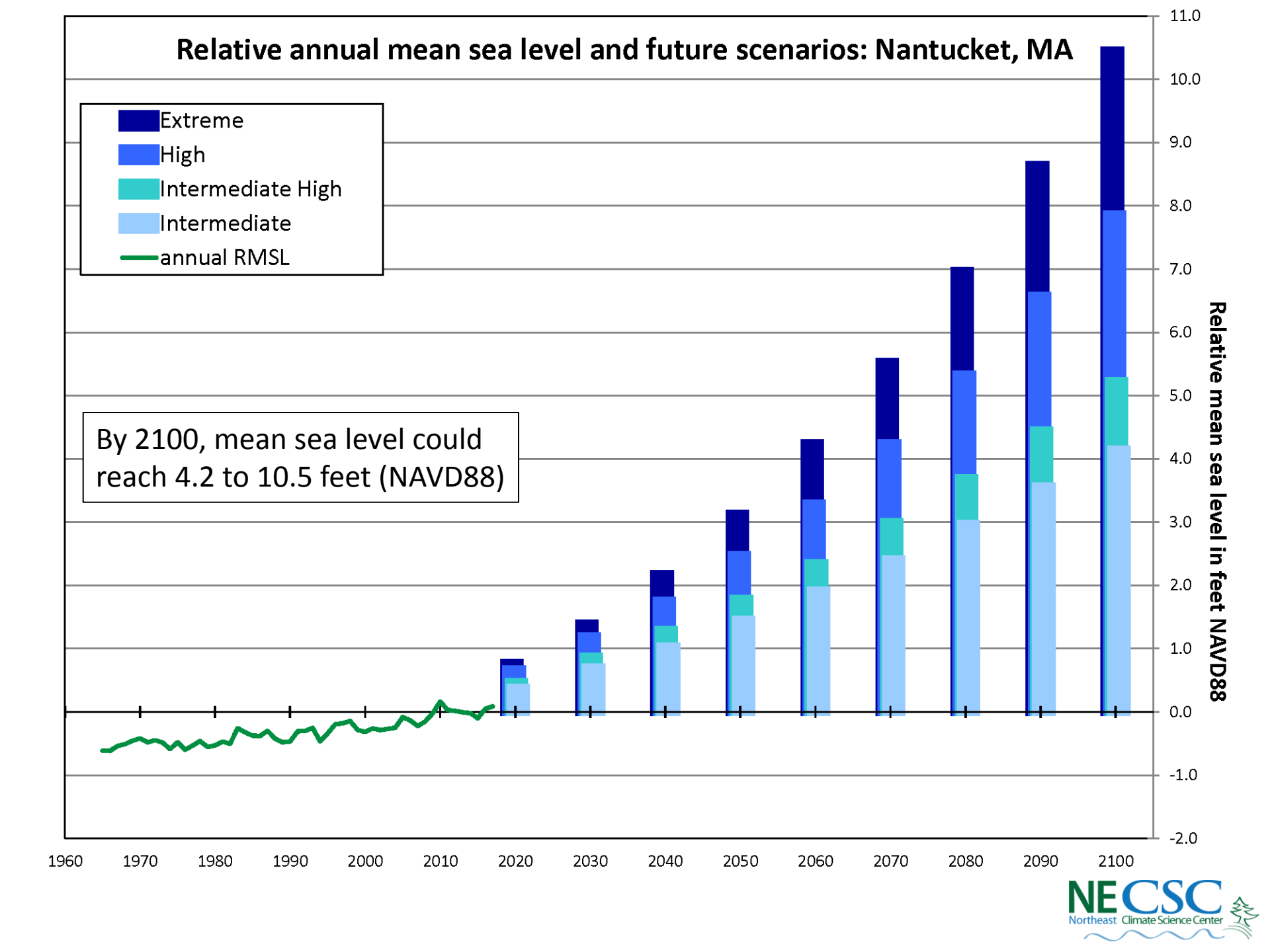


NECSC Northeast Climate Science Center

Relative mean sea level (feet NAVD88) for Nantucket, MA					
Scenario	**Probabilistic projections**	**2030**	**2050**	**2070**	**2100**
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway (RCP 8.5)	0.7	1.5	2.4	4.2
Intermediate- High	Extremely unlikely to exceed (95% probability) given a high emissions pathway (RCP 8.5)	0.9	1.8	3.0	5.2
High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway (RCP 8.5)	1.2	2.5	4.3	7.9
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway (RCP 8.5)	1.4	3.1	5.5	10.5

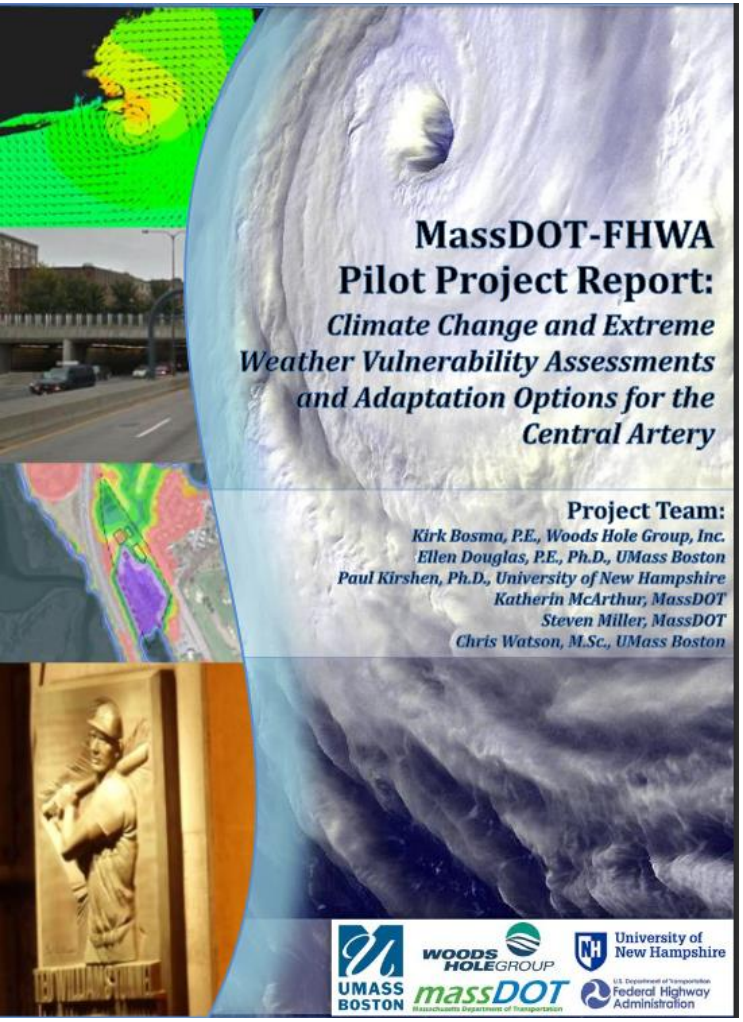
Projections for the High scenario have been selected to update dynamic modeling for the entire coast of the Commonwealth.

NECSC Northeast Climate Science Center



NECSC Northeast Climate Science Center

Climate Change Resiliency



The Unit supports MassDOT's goals of reducing transportation vulnerabilities and adapting infrastructure for current and future climate change impacts. Please see below for more information on our resiliency projects.

Central Artery and Tunnel Pilot Project

The Central Artery/ Tunnel (CA/T) Vulnerability and Adaptation Assessment, completed in June 2015, created the hydrodynamic Boston Harbor Flood Risk Model (BH-FRM) to identify risk and depth of water resulting from storm surge-induced coastal flooding in the City of Boston under current and future sea level rise and storm surge. Based on the CA/T system's high sensitivity to flooding and little redundancy built into it, the CA/T study recommended conceptual level adaptation strategies for current and future time horizons. Please see the Climate Change and Extreme Weather Vulnerability and Adaptation Options for the Central Artery/Tunnel System (Pilot Project Report) for more details on the study, and below for the CA/T Study Mapping Products.

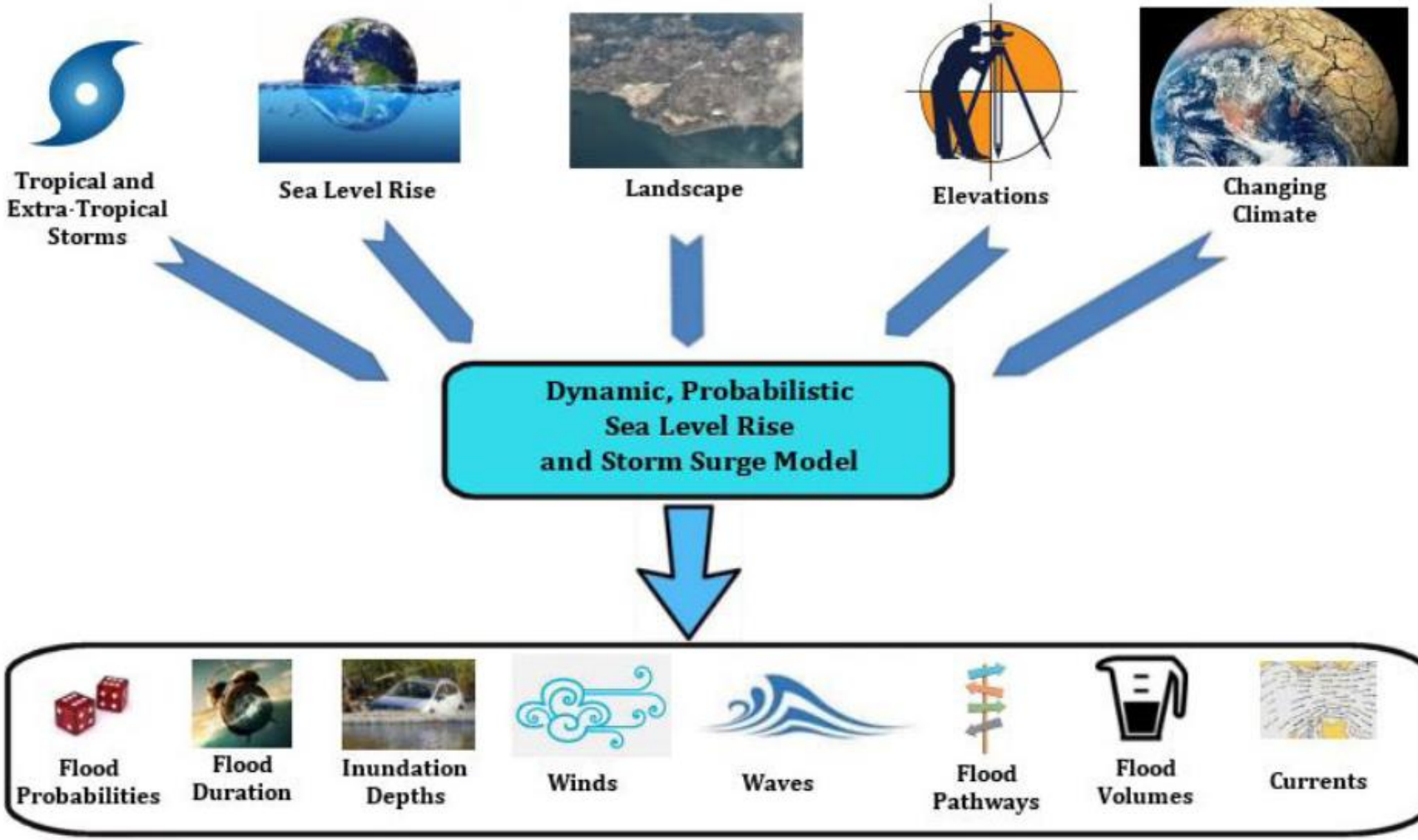
MassDOT is currently considering the recommendations presented in the report. However, in order to supply adaptation measures sooner, MassDOT is developing an alternate strategy to provide protection to 2030.

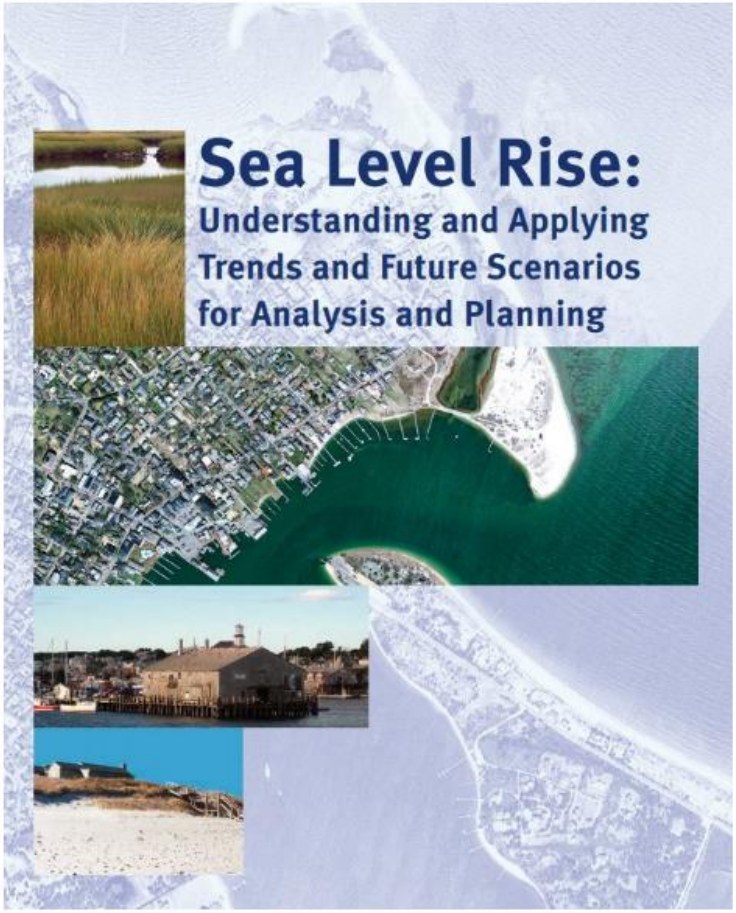
Figure 4-9. High resolution mesh grid in the vicinity of downtown Boston.

Figure 4-9. High resolution mesh grid in the vicinity of downtown Boston.

Coast-wide Hydrodynamic Modeling (*coming in 2018-2019*)

- Includes relevant physical processes (tides, storm surge, wind, waves, wave setup, river discharge, sea level rise, future climate scenarios)





Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning

Questions?

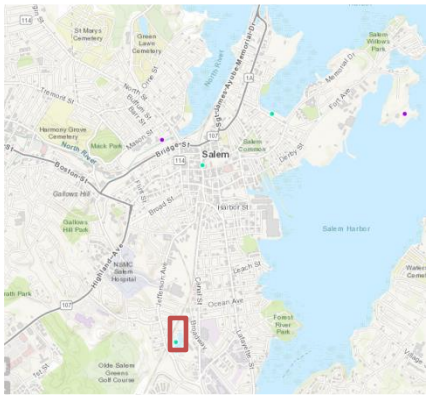
CZM Coastal Resilience Grant Program

Provides technical and financial assistance to coastal communities to reduce risks associated with coastal storms, flooding, erosion & sea level rise through innovative and transferable local initiatives

Fiscal Year	Awarded ($M)	# Projects
FY14 (2014)	$2.0	19
FY15 (2014)	$2.7	17
FY16 (2015)	$2.2	16
FY17 (2016)	$1.8	18
FY18 (2017)	$2.3	16
Total	$11+	86

Photos: (top) Martha's Vineyard Shellfish Group, (bottom) Town of Newbury

Salem: Rosie's Pond Flood Mitigation ($200K FY14 award)



- Hydraulically connects upstream reaches of South River and South River Conduit, drains into Salem Harbor
- Adjacent to critical community infrastructure and residential properties
- Frequently overtops during significant storm (rainfall and tidal) events
  - ➢ priority vulnerability identified in City's *Climate Change Vulnerability Assessment and Adaptation Plan (2014)*
- Existing earthen berms constructed along banks of South River (Brooks St. area) are overwhelmed during 100-year flood

- 2011 conceptual flood mitigation project involved construction of low-gravity retaining walls along portions of Rosie's Pond and South River and minor regrading of berms to protect up to 100-year rainfall event
- City proposed to re-assess flood risk using updated climate change projections and re-design flood mitigation project to take into account increased storm intensity and sea level rise

Flooding along Jefferson Ave. and Laurent Rd. during a 3-day "100-year storm" event (Mother's Day Storm, May 2006)
Photo: City of Salem

- **Increased rainfall intensity:** updated hydrologic/hydraulic study based on City's Climate Change Vulnerability Assessment and published by Northeast Regional Climate Center at Cornell University

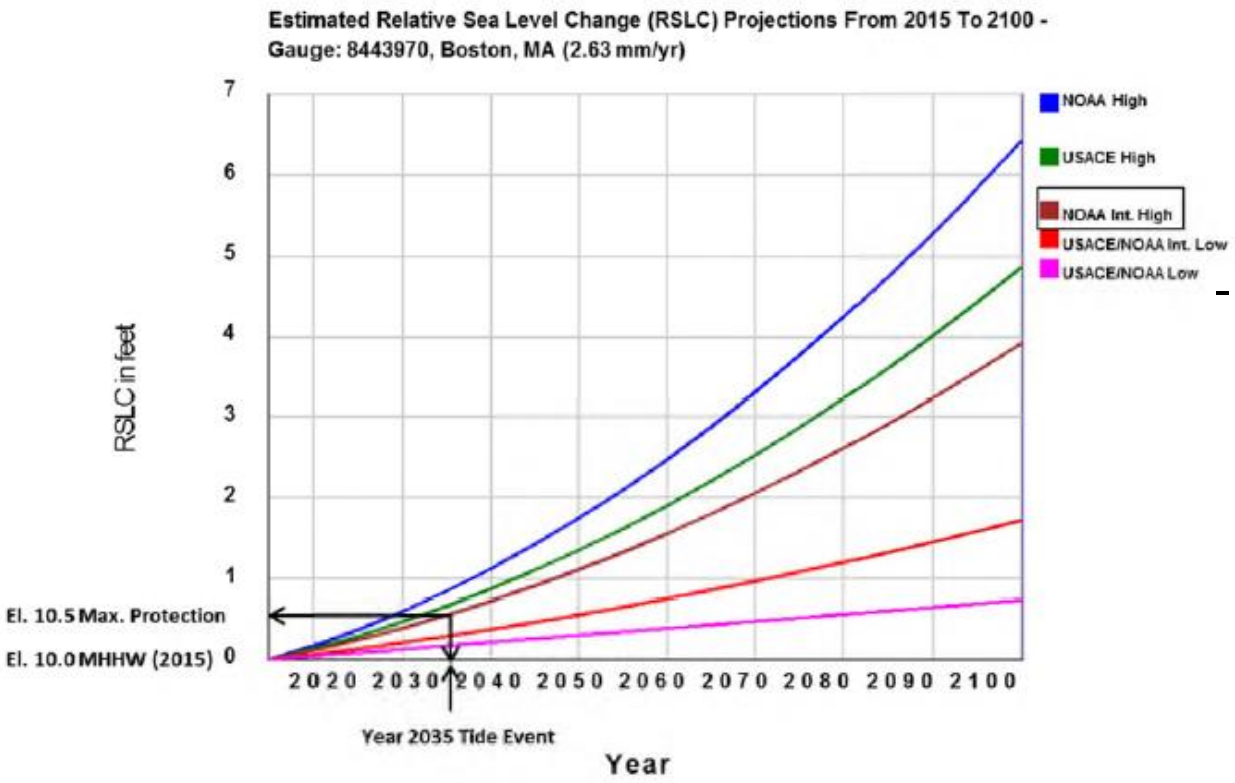
Rainfall event (Return Period)	TP-40 Rainfall Intensity (inches per 24 hours)	Northeast Regional Climate Center- Cornell (inches per 24 hours)
2% (50-yr storm)	6.0	7.35
1% (100-yr)	6.7	8.76

- **Sea Level Rise:**
  - current MHHW at Boston tide gate = 4.76' (NAVD88)
  - MHHW by 2100 = 9.03' (NAVD88), 4.27' increase by 2100

Engineering limits

Maximum tide elevation the proposed flood mitigation improvements could accommodate while considering projected rainfall?

Figure 1: Projected Relative Change in Sea Level – Year 2015 to 2100



- **100-year storm:** proposed top of wall/berm would be exceeded under current mean water elevation

- **50-year storm:** proposed top of wall/berm could accommodate 0.5’ over current MHHW

  (projected to occur in 2035 under Intermediate-High SLR)

Scituate: Roadway elevation & dune nourishment ($313,500 FY17-18 awards)

- Low-lying public roadway (Central Ave.) provides only access to Air Force 4th Cliff Recreation Area and numerous private properties
- Existing barrier beach/dune and roadway elevations not sufficient to withstand modest nor'easters
- Wave-driven overwash material (sand, gravel, cobble) and stillwater flooding from South River blocks Central Ave.
- Continued narrowing and lowering of barrier beach increases breach potential

Photo: Bill Schmid

- Approximately $6.7 M in FEMA claims from 1978-2015 (in North Humarock area)
- Significant post-storm efforts required to clear sand and cobble from roadway ($30,000 - $60,000 per storm event)
- One of the highest priority areas for adaptation as identified in Scituate's Assessment of Coastal Erosion, Sediment Transport, and Prioritization Management Strategy (2016)

Photos: Jason Burtner, CZM

Elevating Roadway Improvements and Dune/Beach Nourishment along North Humarock for Improved Coastal Resiliency

North Humarock, Scituate, Massachusetts

June 2017

Prepared by:

Applied Coastal Research and Engineering, Inc.
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Prepared for:

Town of Scituate
600 Chief Justice Cushing Highway
Scituate, Massachusetts 02066

Massachusetts Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, Massachusetts 02114

Alternatives Analysis:

- Beach nourishment (4 different alternatives based on varying width and length of nourishment)
- Constructed mixed-sediment dunes
- Elevating Central Ave.
- Construct seawall and revetment
- Buy-out
- Maintain status-quo

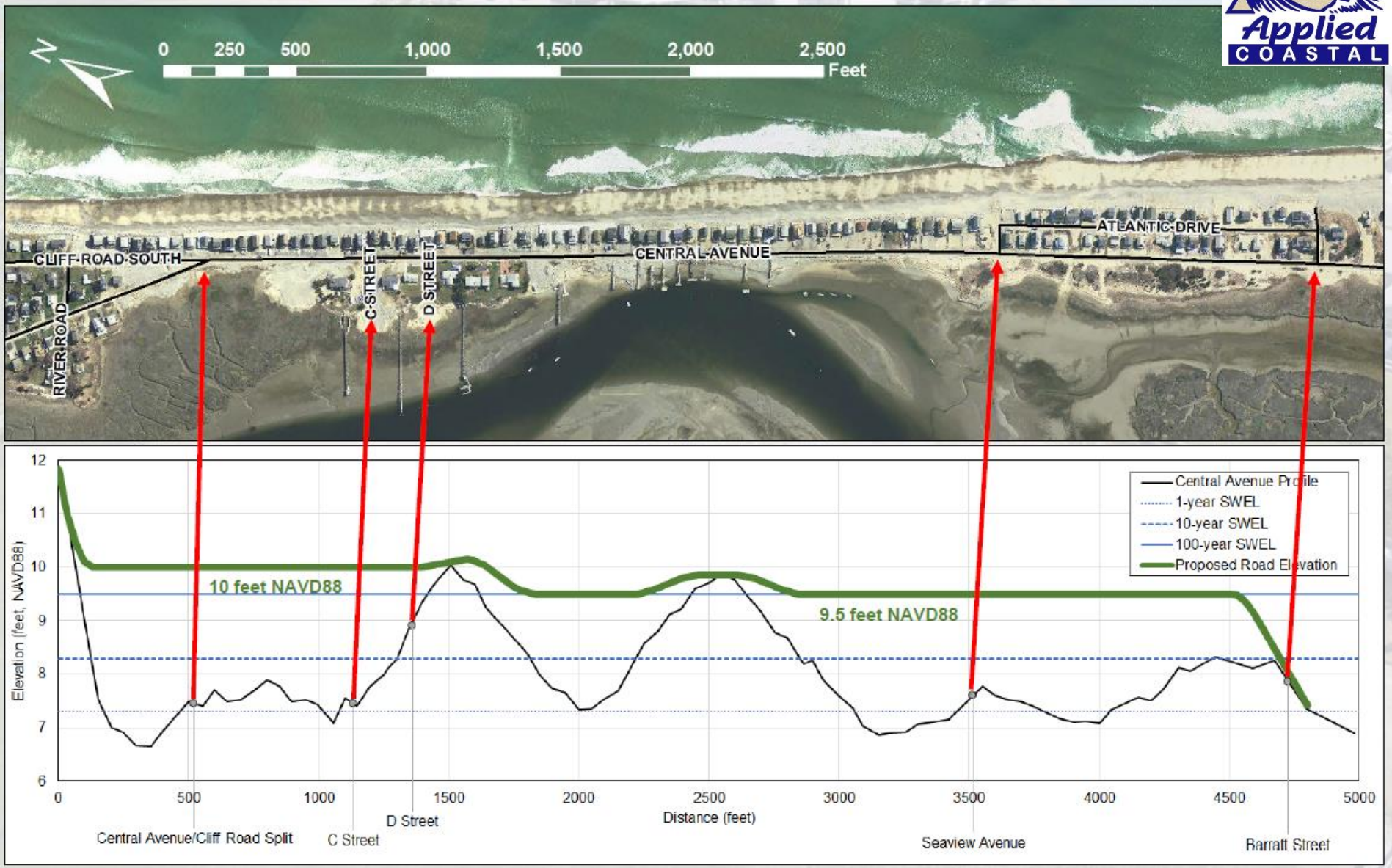
Recommended Approach:

- Elevate Central Ave. to maintain access and emergency egress
- Engineer dune design that would provide a 10+ year design life under anticipated storm activity and future sea level rise

Adaptive Management:

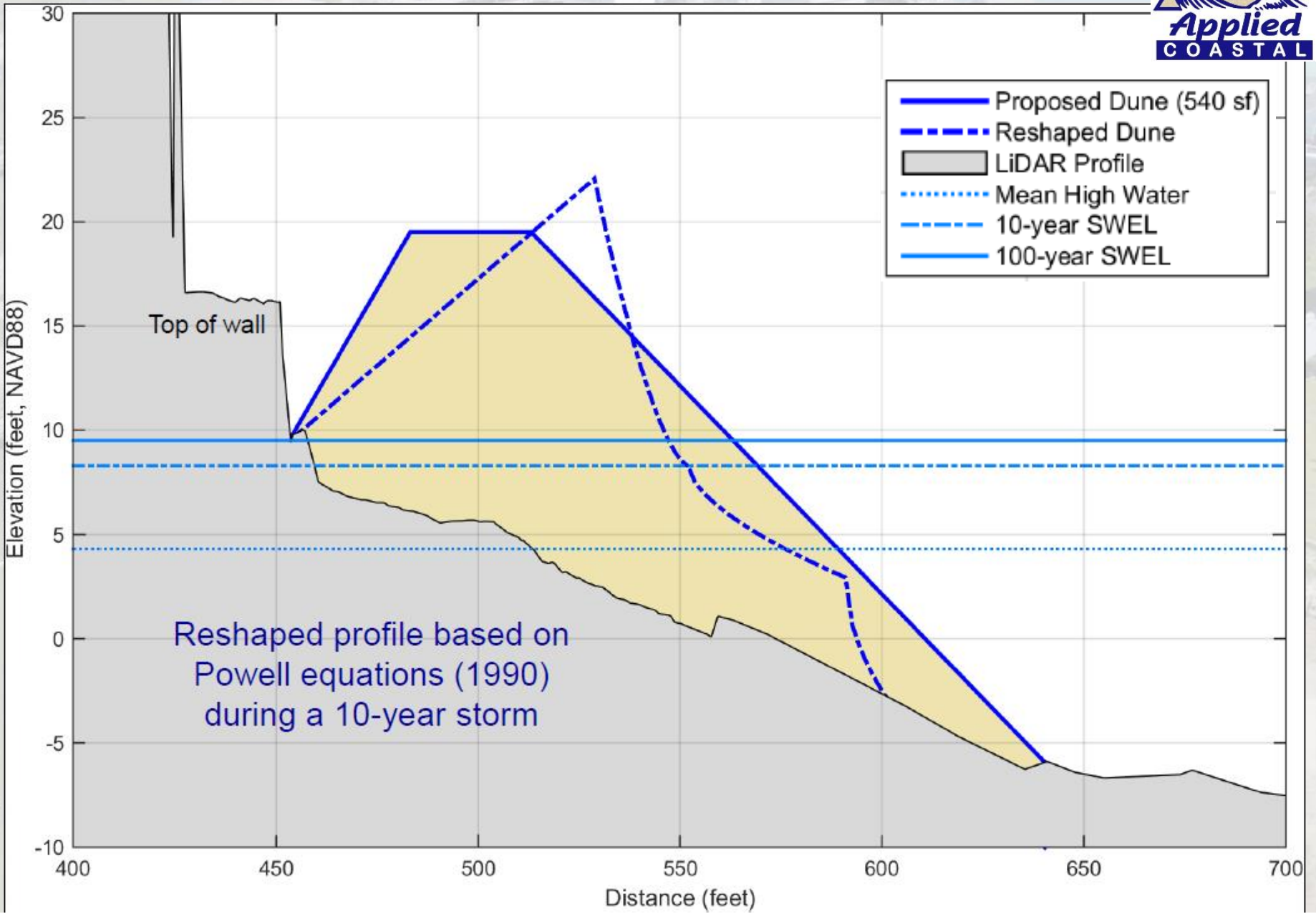
- Projected relative sea level rise of 1.08 feet by 2038 and 2.8 feet by 2063 (25- and 50-year planning horizons, respectively)

Proposed Road Elevation



Elevate roadway to provide protection from a 100-year storm event

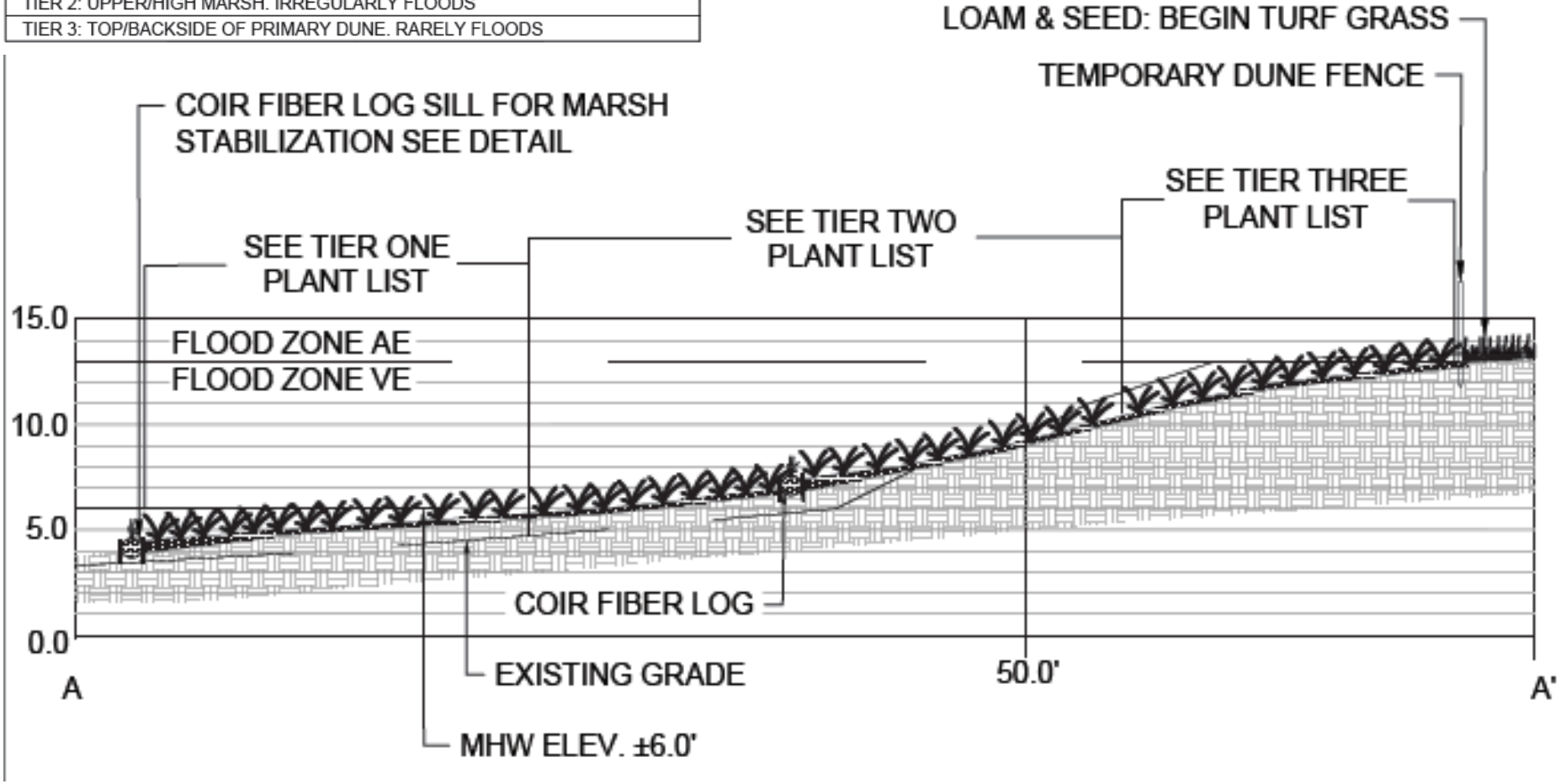
Proposed Constructed Dune Profile - Reshaped



Kingston: Gray's Beach Park Coastal Restoration, Retreat & Site Improvement ($427K FY18 award)

- Town's only public beach
- Coastal storms destabilize bank and stone revetment, requiring ongoing maintenance
- Public safety issues
- Vulnerable concession/ restroom facility and drainage infrastructure located within V Zone
- Restore coastal area to a more natural state by deconstructing the existing stone revetment and replace with salt marsh and coastal dune habitat

PLANT SCHEDULE		
BOTANICAL NAME	COMMON NAME	NOTES
AMMOPHILIA BREVILIGULATA	AMERICAN BEACH GRASS	TIER 3
DISTICHLIS SPICATA	SALTGRASS	TIER 2-3
JUNCUS EFFUSUS	COMMON RUSH	TIER 2-3
JUNCUS GERARDII	SALTMEADOW RUSH	TIER 2-3
LIMONIUM CAROLINIANUM	CAROLINA SEA-LAVENDER	TIER 3
PANICUM VIRGATUM	SWITCH GRASS	TIER 3
SALICORNIA DEPRESSA	COMMON GLASSWORT	TIER 2-3
SOLIDAGO SEMPERVIRENS	SEASIDE GOLDENROD	TIER 3
SPARTINA ALTERNIFLORA	SMOOTH CORDGRASS	TIER 1-2
SPARTINA PATENS	SALTMEADOW CORDGRASS	TIER 2-3
TIER 1: INTERTIDAL ZONE/FOREDUNE. REGULARLY FLOODS		
TIER 2: UPPER/HIGH MARSH. IRREGULARLY FLOODS		
TIER 3: TOP/BACKSIDE OF PRIMARY DUNE. RARELY FLOODS		



Design Considerations:

- Stabilize toe of fringing marsh during first few growing seasons using coir pillows or coir rolls

- Target higher elevation of marsh growing range to accommodate future sea level rise

- Develop monitoring plan for salt marsh restoration (Options for protocols available in A Volunteer's Handbook for Monitoring New England Salt Marshes) and record post-storm impacts in MyCoast.org

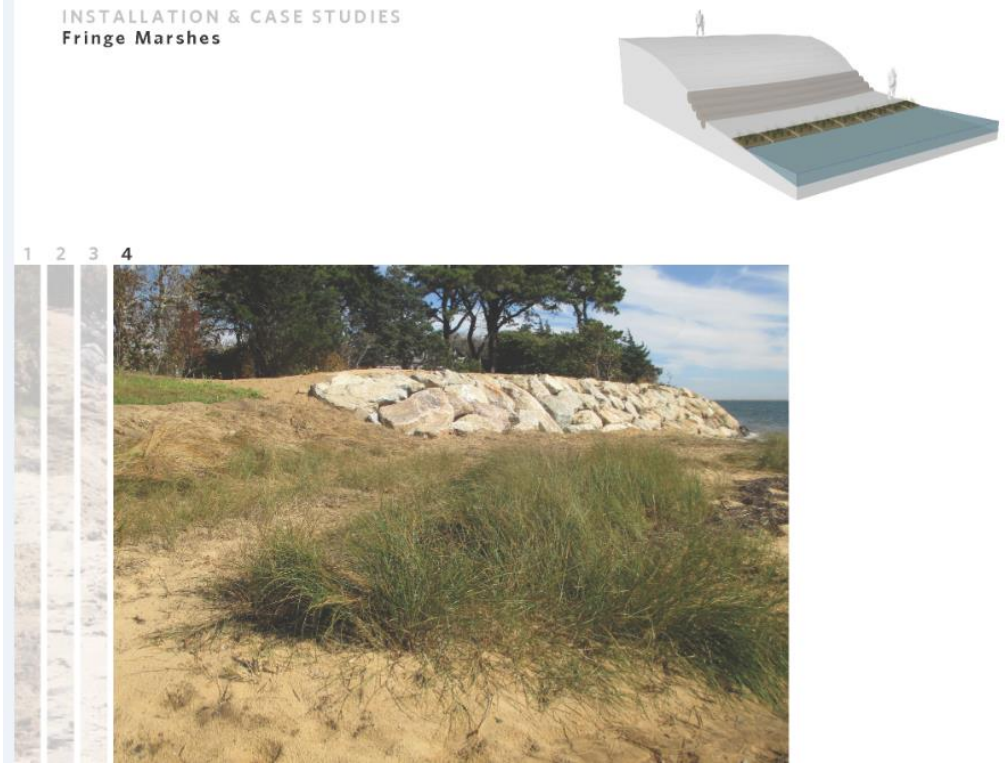


Photo: Wilkinson Ecological Design, Inc.

Coastal Resilience Grant Program Eligibility

Applicants:

- 78 coastal cities and towns
- Non-profits with vulnerable coastal property that is open and accessible to the public (Project Type #5 only)

Project Types:

1. Vulnerability and Risk Assessment
2. Public Education and Communication
3. Local Bylaws, Adaptation Plans, Other Management Measures
4. Redesigns and Retrofits
5. Natural Storm-damage Protection (coastal green infrastructure)

stormsmart coasts

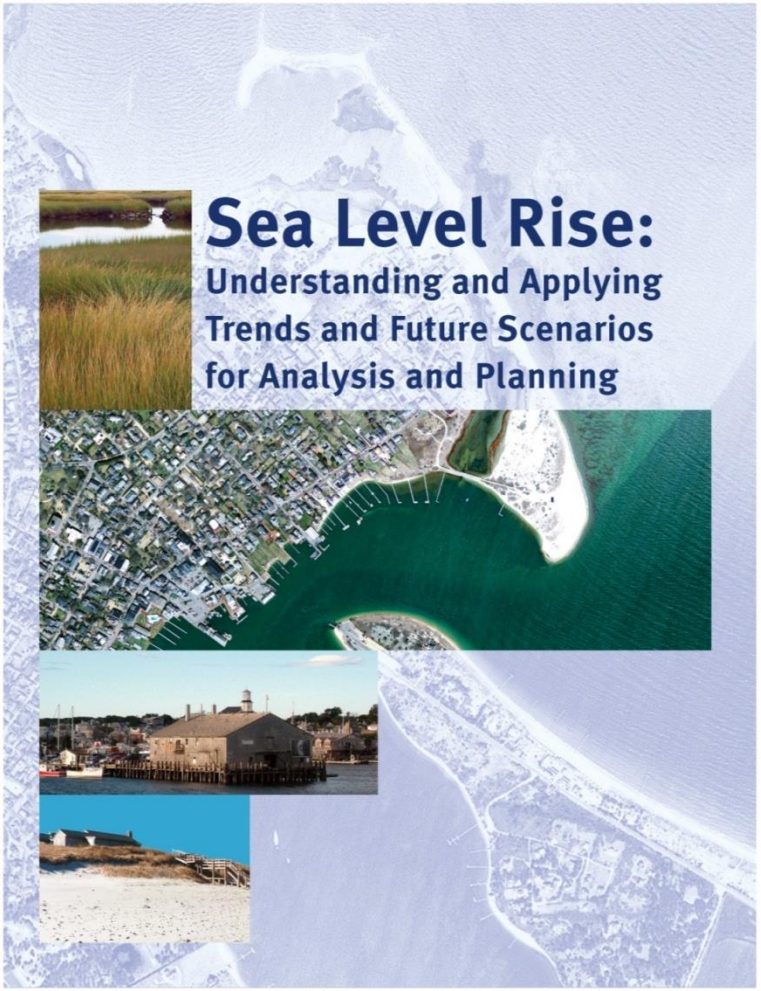
supporting community efforts to manage coastal floodplains

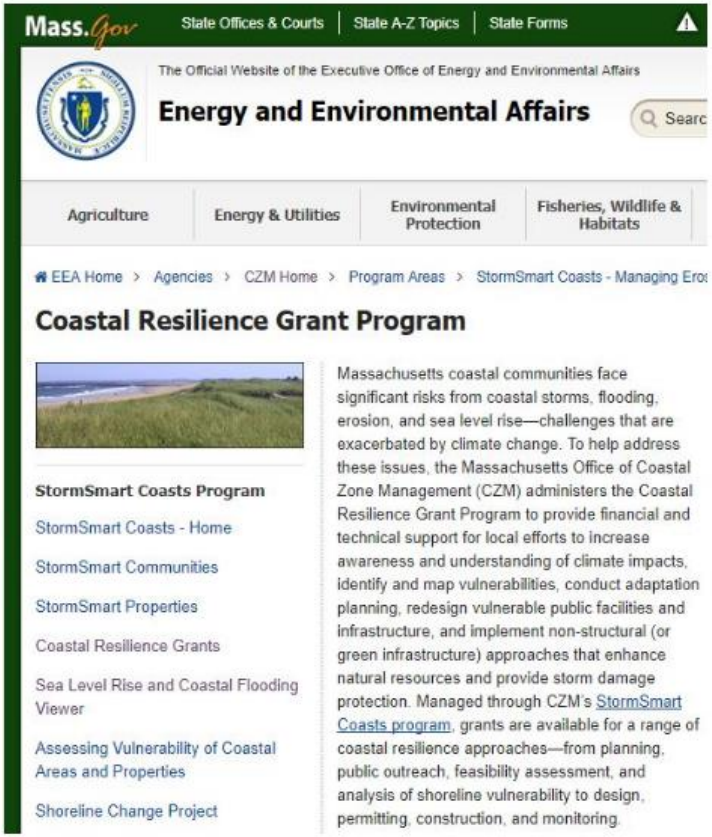
mass.gov/czm/stormsmart

mycoast.org/ma

www.resilientma.org

www.mass.gov/czm/stormsmart





Coastal Resilience Grant Program

Questions?

Extras

Massachusetts Sea Level Rise and Coastal Flooding Viewer

Interactive maps of coastal flooding areas and community facilities and infrastructure based on: sea level rise scenarios, Federal Emergency Management A
zones, and hurricane surge models.

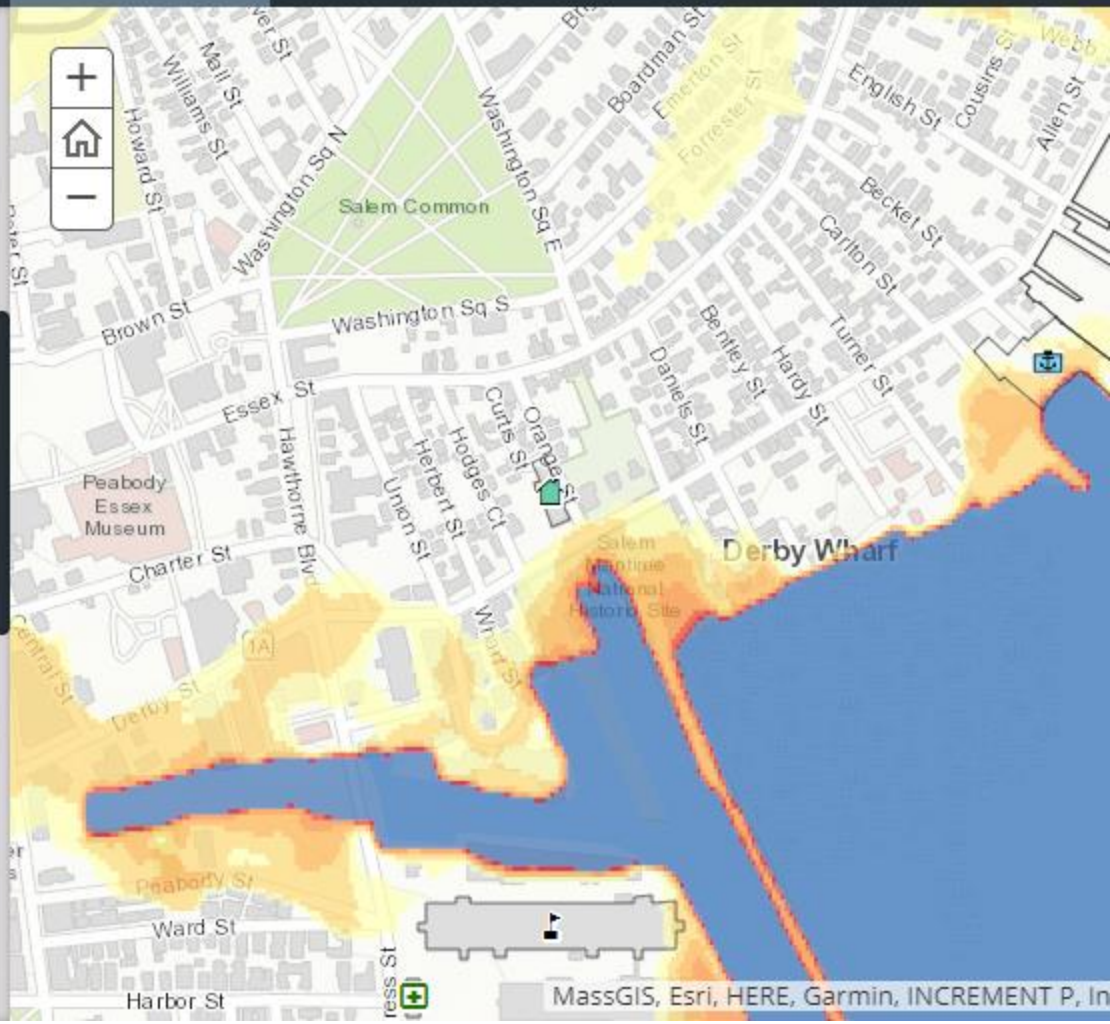
Intro | Sea Level Rise | FEMA Coastal Flood Zones | Hurricane Surge

Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise

- MHHW
- MHHW + 1 ft Sea Level Rise
- MHHW + 2 ft Sea Level Rise
- MHHW + 3 ft Sea Level Rise
- MHHW + 4 ft Sea Level Rise
- MHHW + 5 ft Sea Level Rise
- MHHW + 6 ft Sea Level Rise

Public Facilities and Infrastructure

- Airport
- Community Health Center
- Electrical Generation Facility
- Fire Station
- Harbormaster
- Hospital



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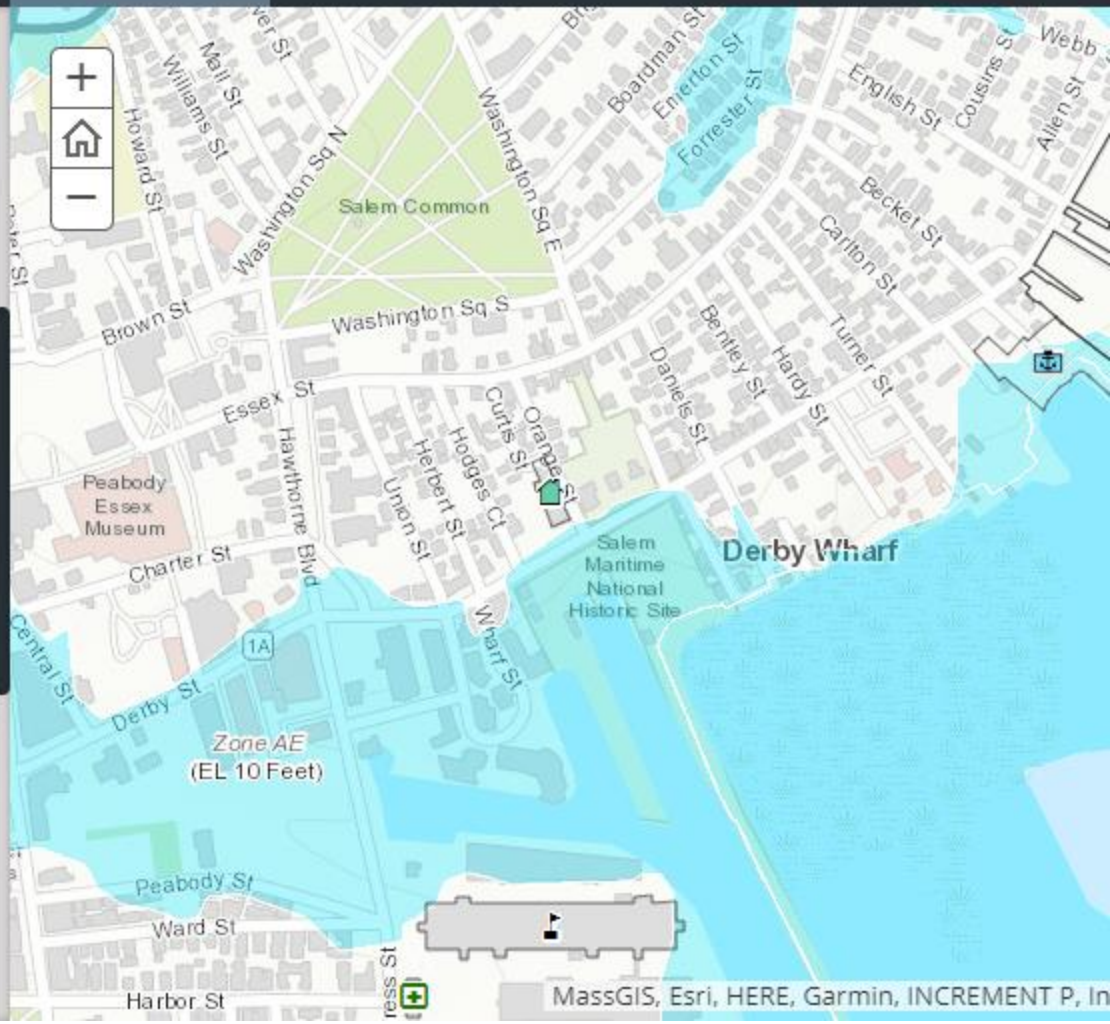
FEMA Coastal Flood Zones

1% Annual Chance Flood Hazard (includes both A and V zones; zoom in to view zone labels)

Public Facilities and Infrastructure

- Airport
- Community Health Center
- Electrical Generation Facility
- Fire Station
- Harbormaster
- Hospital
- Landfill
- Library
- Long-Term Care Residence
- MBTA Commuter Rail Station
- MBTA Subway Station
- Police Station
- Port Facility



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Hurricane Surge Scenarios

- Category 1
- Category 2
- Category 3
- Category 4

Public Facilities and Infrastructure

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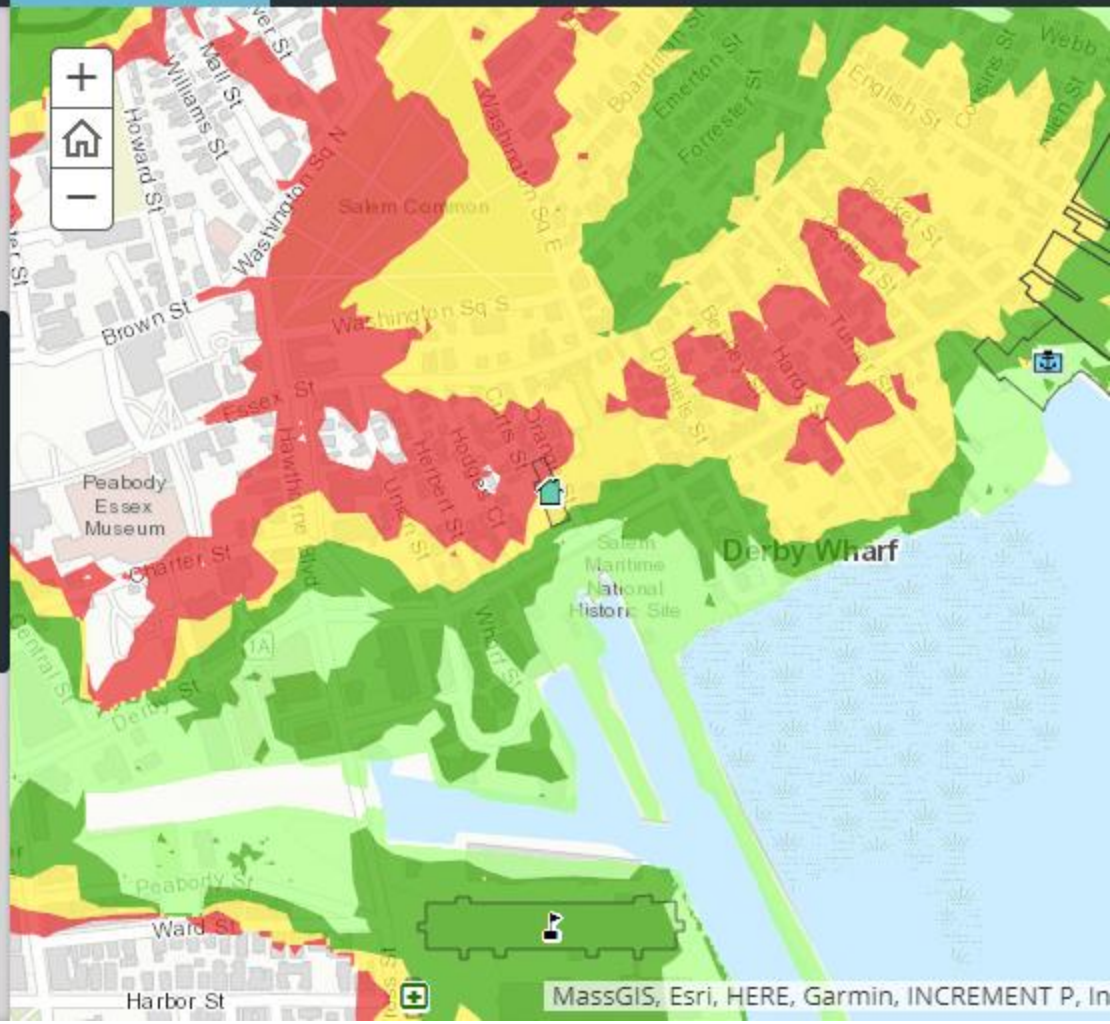

MyCoast Reports (Apr. 2014 – Sep. 2017)