Town of Falmouth

Community Resilience Building Workshop Summary of Findings

June 2018

Contents

Town of Falmouth
Community Resilience Building Workshop
Summary of Findings

Overview:

The need for municipalities, regional planning organizations, states and federal agencies to increase resilience and adapt to extreme weather events and mounting natural hazards is strikingly evident amongst the communities of coastal Massachusetts. Recent events such as successive March 2018 nor'easters have reinforced this urgency and compelled leading communities like the Town of Falmouth to proactively plan and mitigate potential risks through a community driven process. Ultimately, these efforts will reduce the vulnerability of Falmouth's citizens, infrastructure and ecosystems, and serve as a model for communities across Cape Cod, Massachusetts and the Nation.

In the winter of 2017-18, with funding from the Executive Office of Energy and Environmental Affairs Massachusetts Municipal Vulnerability Preparedness Program, Falmouth's Coastal Resiliency Action Committee (CRAC) contracted with the Woods Hole Group and Stantec to implement the Community Resilience Building process. A municipal-based core team was established to organize and implement an 8-hour Community Resilience Building Workshop on March 24, 2018. The goal of this effort was to engage community stakeholders to facilitate the education, planning and ultimately, implementation of priority adaptation actions. The list of workshop invitees and workshop content was guided by input from an interdisciplinary working group comprised of Town staff, the Coastal Resiliency Action Committee, and consultants from Woods Hole Group and Stantec. The Workshop's central objectives were to:

- Define top local natural and climate-related hazards of concern;
- Identify existing and future strengths and vulnerabilities;
- Develop prioritized actions for the Community;
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Twenty-seven (27) participants from town departments/committees/boards, community organizations, local scientific institutions, and neighborhood associations were in attendance for the workshop, which employed a community-driven workshop process following the Community Resilience Building (CRB) framework (www. CommunityResilienceBuilding.com). The CRB's Risk Matrix format, large-scale maps of Town (Appendix A & B), and various datasets on natural hazards (Appendix C & D) were integrated into the workshop process to provide both decision support and risk visualization for workshop participants. The workshop included a combination of large group presentations and small group discussions. The large group presentation outlined the workshop process/goals, presented relevant hazard and community data, shared example actions, and provided an update on local planning efforts and non-profit initiatives. Participants also had an opportunity to work together in small groups consisting of 6-8 people with different roles, responsibilities and expertise to foster an exchange of ideas and perspectives. Spokespersons from the small groups then reported their findings back to the larger group. This workshop process, rich with information, and experiences and dialogues from the participants produced the findings detailed in this summary report. This report provides an overview of the top hazards, current concerns and challenges, current strengths and vulnerabilities, and recommends actions to improve the Town of Falmouth's resilience to natural and climate-related hazards today and in the future.

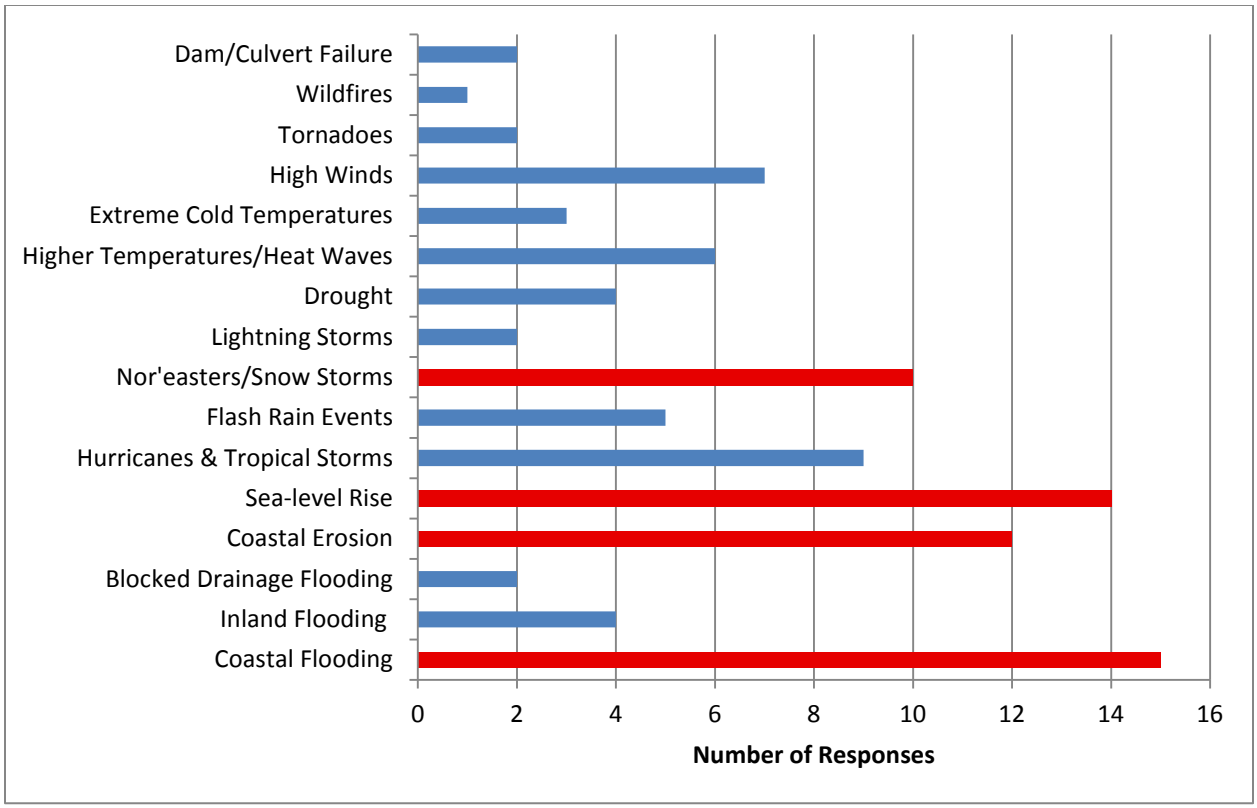
Workshop participants and other interested stakeholders are encouraged to provide comments, corrections and updates on the summary of findings described in this report. The Town of Falmouth's ongoing community resilience will benefit from the participation of all those concerned.

Top Hazards and Vulnerable Areas

Prior to the Community Resilience Building Workshop in March 2018, invited workshop participants were asked to identify the top natural hazards for the Town of Falmouth as part of a pre-workshop online survey. Coastal flooding from intense storms and coastal storm surge, along with sea-level rise were identified as the hazards of greatest concern. Coastal erosion resulting from intense coastal storms was also identified as a top hazard for the Town. Finally, additional hazards, such as snow, ice, and high winds resulting in downed trees, blocked roads and power outages associated with nor'easters and major snow storms were also highlighted as major concerns by the survey respondents.

Top Hazards

- Coastal Flooding
- Sea-level Rise
- Coastal Erosion
- Nor'easters/Snow Storms


Dam/Culvert Failure
Wildfires
Tornadoes
High Winds
Extreme Cold Temperatures
Higher Temperatures/Heat Waves
Drought
Lightning Storms
Nor'easters/Snow Storms
Flash Rain Events
Hurricanes & Tropical Storms
Sea-level Rise
Coastal Erosion
Blocked Drainage Flooding
Inland Flooding
Coastal Flooding
0
2
4
6
8
10
12
14
16
Number of Responses

Vulnerable Areas

Neighborhoods: Woods Hole, Chappoquoit, Menauhant Road, New Silver Beach

Populations: Concentrations of elderly residences (nursing homes and residents living at home), low income housing and low income neighborhoods, seasonal visitors and tourists

Ecosystems: Great Sippewissett Marsh, beaches (Woodneck Beach, Surf Drive Beach, Menauhant, Chappoquoit Beach, Washburn Island), south coastal salt ponds, Waquoit Bay National Estuarine Research Reserve Site, the Knob, Long Pond (drinking water supply), shellfish habitat, cranberry bogs, coastal waterways and harbors, large areas of forest (Beebe Woods), Natural Heritage and Endangered Species Program (NHESP) habitats

Transportation: Ferry terminals, roads blocked by wind-blown trees, regional bridges

Infrastructure: Shoreline roads (Surf Drive, Menauhant Road), septic systems, Shining Sea Bike Path, wastewater treatment facilities, drinking water treatment plant, overhead electricity and utility wires, cell phone towers, stormwater drains

Facilities: Town Hall, schools, Woods Hole scientific facilities

Current Concerns and Challenges Presented by Hazards

The Town of Falmouth has many concerns and faces multiple challenges related to the impacts of natural hazards. In recent years, Falmouth has experienced a series of highly disruptive and damaging weather events, including three successive nor'easters in March 2018, as well as significant rainfall events, such as the >4 inches of rain that fell on a single day in July 2017. The impacts from recent nor'easters included significant coastal flooding, inundating some neighborhoods for days, high winds resulting in approximately 65% of the town without power and more than one hundred downed trees blocking roads, and coastal erosion resulting from heavy surf and storm surge. The frequency of these storms in March 2018 exacerbated the impacts, as the Town was still recovering from the last storm when the next one arrived. The magnitude and severity of the impacts of these storms produced a heightened level of awareness in Town and provided additional motivation to comprehensively improve resilience and reduce local vulnerabilities to natural hazards.

This series of extreme weather events highlighted that impacts from hazards are felt differently across the Town from the low-lying coastal areas to the forested uplands to the more developed downtown area. The western and southern parts of Falmouth border Buzzards Bay and Vineyard Sound, respectively, and are exposed to damage from coastal flooding and storm surge. The forested inland areas experience the effects of tree damage from wind, snow and ice, as well as hazards from inland flooding along roads due to poor drainage. The combination of these issues presents a challenge to emergency preparedness and response, and requires comprehensive yet tailored actions for establishing mitigation priorities for different areas of Town.

The workshop participants were generally in agreement that the Town of Falmouth is experiencing more intense and frequent storms. The impacts, particularly during the series of March 2018 nor'easters, affected the daily activities of every resident. Coastal areas are experiencing greater impact from major storms and increases in average tidal ranges are resulting in routine flooding events in certain low lying places during lunar high tides. Additionally, there was a general concern that a long-range plan needed to be developed for how to manage the coastal roads, particularly Menauhant Road and Surf Drive, in the face of ongoing erosion and sea-level rise.

Specific Categories of Concerns and Challenges

Vulnerability of Coastal Road Network

One of the primary concerns expressed by participants was the vulnerability of the Town's coastal road network given the increasing hazards presented by flooding, sea-level rise and coastal erosion. Coastal roads, including Menauhant Road, Surf Drive, and Chappoquoit Road are regularly inundated during storm events and are repeatedly damaged by wave action and coastal erosion. Debris and sand are often washed up onto the roads, preventing travel as well as emergency management services from reaching impacted areas. Utilities that run along these roadways are also disrupted frequently. Workshop participants from all small working groups addressed this as an important concern.

Utility (electrical and water) Distribution Systems

Electric service outages can be caused by a number of different natural hazard types, but most recently the Town's utility lines were impacted by high winds (>80mph) and heavy snow. The power distribution system was cited as one of the most critical pieces of infrastructure in Town and can impact all residents regardless of where they live. Mature trees and overhanging limbs along roadways are a primary culprit because they can bring down power lines if they are toppled by high winds. Power interruptions due to storms can cause disruption to heating or cooling systems. Workshop participants identified elderly and less mobile residents at particular risk during electric service outages.

Key portions of the Town's water and wastewater infrastructure are located in vulnerable areas, including being sited alongside coastal bridges and culverts (ex: sewer main co-located with the Shining Sea Bike Path over Trunk River outlet), which are threatened by salt damage when inundated by flood waters and physical damage by coastal erosion.

Finally, recent storms highlighted the vulnerability of the Town's communications infrastructure. Many parts of Town were without functioning cell phone towers or internet service for days, greatly impacting residents' ability to communicate and businesses ability to operate effectively.

Coastal Flood Damage

Coastal flooding (standing flood waters, storm surge, resulting erosion) presents a major threat to the Town's infrastructure, facilities, neighborhoods, and individual homes and property. Recent flooding events had prompted participants to consider the future impact of coastal flooding events when exacerbated by sea-level rise, and to reevaluated the costs of maintaining and/or rebuilding versus relocating roads, facilities and utilities to less vulnerable areas. Of particular concern is that coastal flooding has and will continue to inundate roads and neighborhoods, isolating certain areas from the rest of Town and making it difficult for first responders and other services to access those areas during emergencies. In addition, several participants highlighted that hazardous materials stored at water front facilities (particular gas and oil storage at marinas and harbors) could be distributed by flood waters creating a water pollution problem in addition to inundated areas.

Part of downtown Falmouth is also vulnerable to flooding during a major coastal storm event. There are a series of culverts and ponds that get backed up during a storm surge event, resulting in flooding along

Main Street (Rt. 28). Other major locations of concern are Woods Hole (where the recent nor'easters left an entire neighborhood inundated for days), Surf Drive and the Shining Sea Bike Path.

Town Facilities (Town Hall)

Falmouth's Town Hall is located within the 100-year floodplain and is vulnerable to both inland and coastal flooding. This is a concern because the Town Hall is not only the centralized location for the majority of municipal functions, but it also houses important documents and records that can be damaged or destroyed during a flood event. This facility and its current essential functions are in jeopardy from several flooding scenarios as explored during the CRB workshop. Participants also raised the concern that other key Town facilities and buildings located in or near a flood zone should also be evaluated and addressed.

Beach and Coastal Erosion

All small working groups also identified ongoing erosion along Falmouth's coastline as a point of concern. Town beaches of particular concern included Woodneck Beach, Surf Drive Beach, Menauhant Beach, Chappoquoit Beach and Washburn Island. Falmouth's coastline is not only inherent to the character of the Town, but these beaches also provide valuable tourism and recreation benefits, vital habitat for threatened and endangered species, such as piping plovers, and provide the first line of defense against coastal storms, flooding, wave action and storm surge. Beach nourishment projects to date have been relatively small, single-property projects, targeted predominantly at popular public beaches and individual private properties.

Current Strengths and Assets

As a result of Falmouth's recent experiences with extreme weather, the Town is well acquainted with its existing strengths. Reinforcing and expanding these supportive practices and assets will improve resilience against future storms, with greater frequencies and intensities. Additional planning will help the Town address anticipated increases in storm surge, sea-level rise and precipitation.

- Falmouth's residents have proven a key asset during recent natural hazards. On a neighborhood level, residents face common challenges and have demonstrated desire to help one another recover quickly.
- Volunteerism and supportive social services (e.g., meals on wheels, transportation systems) were highlighted as important community assets. These services often provide vital support to elderly or vulnerable populations in Town.
- Responsive and committed Town leadership and staff are an important asset to Falmouth, both in day-to-day operations, as well as during and immediately following a natural hazard or an emergency event.
- Marshes, beaches, coastal banks, and salt ponds along Falmouth's coasts were recognized as an important buffer, offering the first line of defense against storms through storm surge attenuation and reduction of wave energy. Without these natural resources in place, the Town's coastal and inland infrastructure and homes would suffer greater damage during storm events.
- Key facilities in Town have proven to be important strengths. The Falmouth Hospital, for example, provides high-level medical service in Town, avoiding lengthy transport times to out-of-Town medical facilities. Additionally, the Falmouth High School, which is centrally located and can function as an emergency shelter, provides residents with vital amenities such as shelter, heat, and electricity during and following a hazard event.

Top Recommendations to Improve Resilience

A common thread throughout the Workshop discussions was the recognition that the Town and residents need to be better prepared through longer-term, community-based, contingency planning across key areas of concern. This and additional core highlights are addressed below. The following were the top five actions selected by workshop participants.

1. **Develop a retreat plan for coastal roadways**

   Given the threat that flooding, sea-level rise and coastal erosion pose to Falmouth's coastal roadways, workshop participants felt that this was the highest priority action for the Town to consider. Discussions focused on selecting what criteria to use for determining when a roadway should be abandoned in response to these hazards, effectively triaging coastal roadways and prioritizing them by necessity. The decision should also fully weigh the benefits of adapting versus retreating or abandoning coastal roads, considering both the residential and economic implications of such actions, and should consider different potential alternative routes. Whether or not roadways are relocated or abandoned, consideration should be given to relocating critical utilities (e.g. water mains) that are currently co-located with these vulnerable roadways. Finally, workshop participants also mentioned that improving public education concerning this issue is critical to not only inform residents about likely future conditions, but hopefully get their buy-in on these proposed changes.

2. **Develop sediment management plan for Falmouth's coastline**

   Many of Falmouth's beaches are experiencing significant and ongoing erosion. As one of the highest priority actions, workshop participants identified the need for a Town-wide sediment management plan to increase coastal resiliency. The Town-wide approach to this problem recognizes that erosion cannot be dealt with effectively parcel by parcel. This Town-wide sediment management plan would evaluate the sediment budget and available transport volumes at each beach. Areas of need should be specifically identified. Participants also identified the potential need for revised legislation to better manage public-private beach ownership for regional beach nourishment projects.

3. **Replace, maintain, or relocate vital water and sewer infrastructure as necessary**

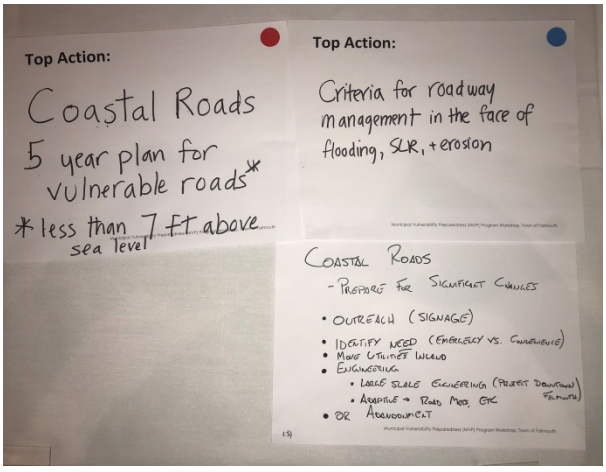
   As coastal infrastructure is continually threatened by flooding and erosion, the workshop participants identified the need to develop a plan to replace, maintain, and/or move water mains and sewer lines as one of the top priority actions. This infrastructure is necessary to carry drinking water as well as wastewater to and from residences and buildings throughout key areas of Town, but many are co-located with vulnerable bridges and culverts, or along threatened coastal roadways. (Note that not all of Falmouth is sewered.) The Trunk River water main was identified as an example of aging infrastructure that should be replaced and relocated.

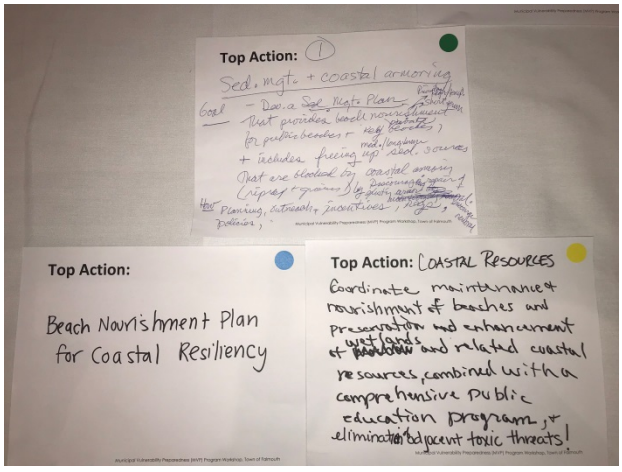
4. **Relocate critical Town facilities out of the floodplain**

   The Falmouth Town Hall is currently located in the 100-year floodplain and its vulnerability will only increase with sea-level rise and increasing storm frequencies and intensities. The Town already fully recognizes this vulnerability and is already taking steps to move vital records and other items out of the basement. To further protect this important Town feature, workshop participants identified consideration of relocating Town Hall to a more upland location or elevating the building above the Base Flood Elevation (BFE) as one of the top priority actions. This discussion also included evaluation of all Town buildings to withstand natural hazards, and upgrading them if necessary (e.g. retrofitting, relocation, armoring, etc.) to ensure community services continue to be provided during and following a natural hazard event.

5. **Coordinate with utility companies to increase preparedness and hazard response**

   Participants also identified coordination with utility companies to better minimize power outages due to storms or help implement power outage response strategies as one of the top priority actions. Example activities might include identifying vulnerable power line areas and implementing tree removal, consideration of buried utility lines (especially along future roadways or when repairs are needed anyway), development of microgrids to improve system resiliency or a plan to reduce the potential for the loss of cell phone service through redundancy in cell phone towers or other measures.





In addition to the top five priority actions chosen by the workshop participants, the participants also developed a larger series of recommended actions, which they prioritized into "high", "medium" and "low" priority actions:

Other high priority actions:

- Triage risks from natural hazards, using available hazard data, risk projections and vulnerability assessments to determine what the most effective use of Town and outside resources and wisest resiliency investments are. This "triage" strategy could be applied to roads, salt marshes, and beaches, as well as other Town assets.
- Identify appropriate mechanisms for relocation of repetitive loss properties, inundated by SLR (e.g. land banking)
- Increase public communication and outreach
    - Improved Town-wide communications using robo-calls
    - Improved public education and outreach concerning how to prepare and respond to various hazards and what services are available
    - Use local radio station and Town website to send regularly hourly updates on current conditions, important messages from the emergency management center, and announce locations of warming centers and shelters.
- Address private septic systems that will likely be impacted by sea-level rise in the future. Local regulations may need to be developed to address/manage this issue. Sewer system may need to be extended to take the place of abandoned/failed septic systems. Consider ways that individual neighborhoods could pay for construction of extended sewer systems. Need to consider long-term planning.
- Improve drainage near Bank of America/Friendly's on Main Street to eliminate flooding during heavy rain events. Consider beneficial water pollution control structures.
- With regards to bridges and culverts, there should be more public outreach for stormwater management, and culverts should be assessed to determine the proper size for maintaining adequate tidal range and a healthy ecosystem, as well as for preventing flooding. Various funding opportunities to provide on the ground assessments of bridges and culverts necessary for this evaluation should be sought.
- Evaluate the existing regulatory environment to analyze 10-15 year buildout vulnerabilities, and how plans and regulations may need to change.

Other medium priority actions:

- Protect land and open space adjacent to estuaries and coastal wetlands to allow for future migration to adapt to sea-level rise. Consider "undeveloping" certain areas to provide this space, where necessary.
- Coastal facilities that store hazardous materials (including marinas and wharves) should be evaluated for the benefits and tradeoffs of storing hazardous materials in a flood prone area.

Special considerations should be made to ensure spills do not occur to release these materials into the coastal and marine environments.

- Gas and other fueling stations should be assessed for vulnerability and upgraded to best practices if necessary.
- Understand the dynamics and potential future wetland changes within Great Sippewissett Marsh and other salt marshes, due to sea-level rise and other coastal processes using available projections and tools.
- Determine how landforms in the vicinity of the Town's many coastal inlets will respond. This could be included as part of the sediment management plan focused on the Town's beaches.
- Continue to protect and supplement conserved open space in Town.
- Evaluate potential impacts to coastal banks, specifically along Grand Avenue, Great Bay Street, and Eel River, and prioritize actions to stabilize highly erosional areas.
- Engage private businesses and employers, particularly in the tourism economy, that are vulnerable to coastal erosion, flooding and sea-level rise. Consider peer-to-peer exchange, highlighting the economic impacts, and/or working with the Chamber of Commerce.
- Mobilize volunteer led efforts to reach at risk populations, specifically elderly residents. Conduct an inventory of individuals and document their needs, so they can be appropriately met during a hazard event.
- Develop a workshop or emergency response education program for elderly residents (perhaps run them twice a year at the Senior Center) to ensure residents are adequately informed about hazard response options.
- Explore potential collaborations between the Town and the local scientific community.

Other low priority actions:

- Consider relocating parts of the Shining Sea Bike Path that will likely be regularly inundated due to sea-level rise. Consideration should include implications of relocating the utilities sited alongside/under the bike path.
- Review the USGS/APCC Study on sea-level rise affecting ground water in reference to how it could impact Long Pond, which supplies up to 70% of the Town's drinking water supply.
    - "Potential Effects of Sea-Level Rise on the Depth to Saturated Sediments of the Sagamore and Monomoy Flow Lenses on Cape Cod, Massachusetts," by Donald A. Walter, Timothy D. McCobb, John P. Masterson, and Michael N. Fienen
- Maintain connectivity through culverts leading to/from Falmouth's freshwater ponds. Consider the potential storm water impacts.
- Maintain protections that already exist for Natural Heritage and Endangered Species Program (NHESP) habitat. Consider working cooperatively with local land trusts to explore potential additions for preserved (or restored?) open space, and continue to find ways to reduce people vs. threatened and endangered species conflicts, possibly through improved public education.
- Ensure adequate generators and warming facilities are available to meet the needs of senior and low income housing.

CRB Workshop Participants

Below is a table of workshop participants.

Name	Department/Affiliation
Julian Suso	Town Manager
Peter Johnson-Staub	Assistant Town Manager
Susan Moran	Chairman of the Board of Selectmen
Doug Brown	Board of Selectmen
Dylan Fernandes	State Representative
Kim Strohm	Fire Department/Emergency Management
Peter McConarty	Department of Public Works
James McLoughlin	Department of Public Works
Jennifer McKay	Conservation Administrator
Jamie Matthews	Conservation Commission
Mark Gurnee	Conservation Commission
Jeff Thomas	Waterways Committee
Paul Dreyer	Planning Board
Kelly Welch	School Committee
Charles McCaffrey	Coastal Resilience Action Committee
Melissa Freitag	Coastal Resilience Action Committee
Edward Schmitt	Coastal Resilience Action Committee
Andrew Ashton	Woods Hole Oceanographic Institute
Rob Thieler	United States Geological Survey (USGS)
Jo Ann Muramoto	Association to Preserve Cape Cod/The 300 Committee
Vicki Lowell	The 300 Committee
Wendi Buesseler	Oyster Pond Environmental Trust/Coonamessett River Trust
Heather McElroy	Cape Cod Commission
Barbara Kanellopoulos	Precinct Two Captain
Cheryl Williams	Precinct Three Captain
Austin Heath	Precinct Eight Captain
Mary Little	Teaticket Village Association

Below is a table of additional entities that were invited but were unable to attend.

Department/Affiliation	Department/Affiliation
Police Department	Community Development Partnership
Harbormaster	Falmouth Chamber of Commerce
Wastewater Department	National Grid
Water Department	Island Queen Ferry
Beach Committee	Steamship Authority
Board of Health Committee	Cape Cod Regional Transit Authority
Council on Aging	MacDougalls' Cape Cod Marine Service
Energy Committee	Kinlin Grover Real Estate
Water Quality Management Committee	Captains from Precincts 1, 4-7, and 9
Woods Hole Research Center	Massachusetts Department of Transportation
NOAA	

Recommended Citation

Town of Falmouth (2018) Community Resilience Building Workshop Summary of Findings. Coastal Resiliency Action Committee, the Woods Hole Group and Stantec. Falmouth, Massachusetts.

CRB Workshop Project Team

Town of Falmouth:

Jennifer McKay, Conservation Administrator (Project Lead – Principal Contact)
Doug Brown, Board of Selectmen (Core Team Member)
Bob Shea, GIS (Core Team Member)
Peter McConarty, DPW (Core Team Member)
James McLoughlin, DPW (Core Team Member)
Corey Pacheco, Planning Department (Core Team Member)

Coastal Resiliency Action Committee:

Charles McCaffrey (Core Team Member)
Paul Dreyer (Core Team Member)
Jamie Matthews (Core Team Member)
Andrew Ashton (Core Team Member)
Melissa Freitag (Core Team Member)
Edward Schmitt (Core Team Member)

Woods Hole Group:

Elise Leduc (Lead Facilitator)
Joseph Famely (Small Group Facilitator)
Brittany Hoffnagle (Small Group Facilitator)

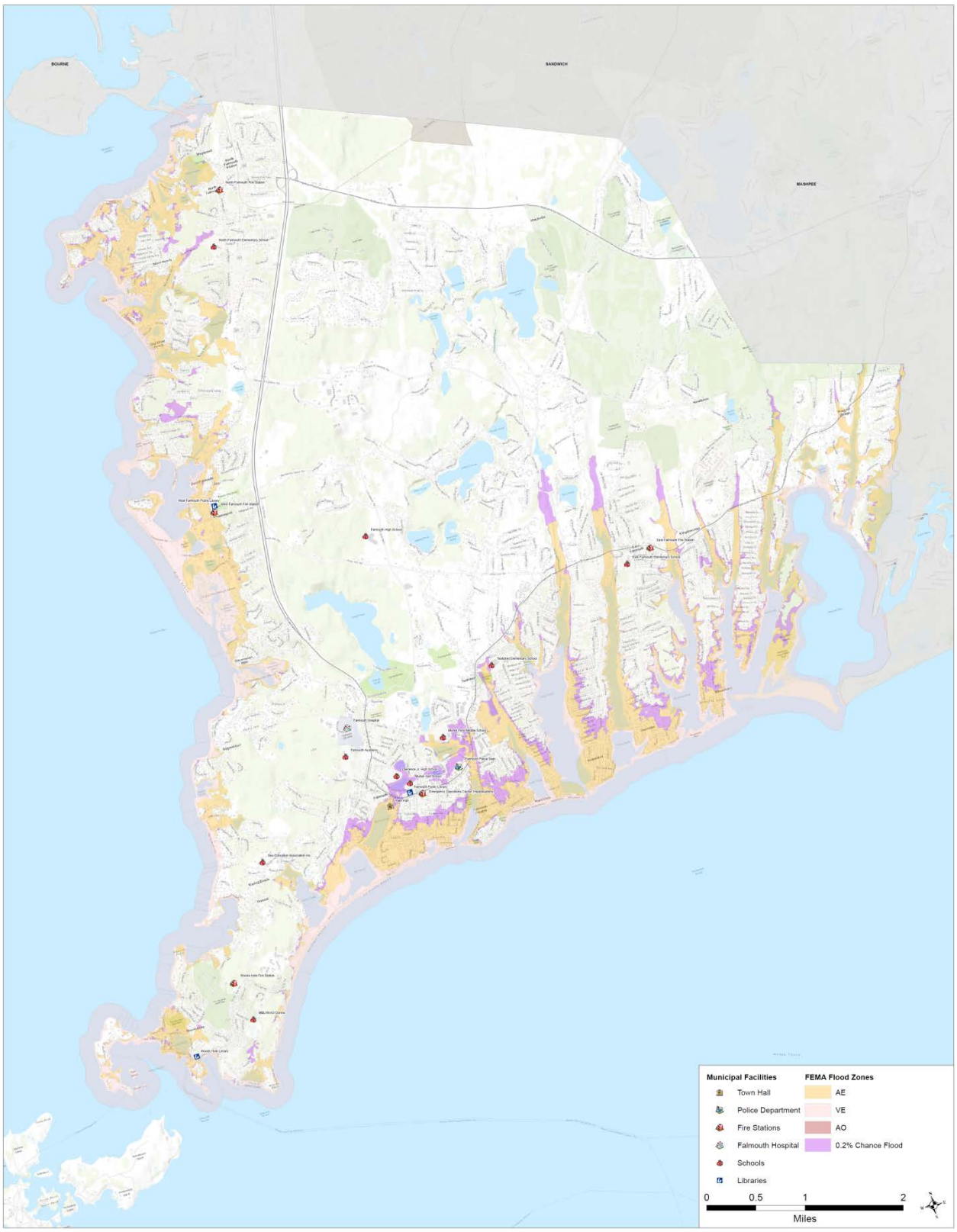
Stantec:

Jennifer Ducey (Small Group Facilitator)
Hillary King (Small Group Facilitator)

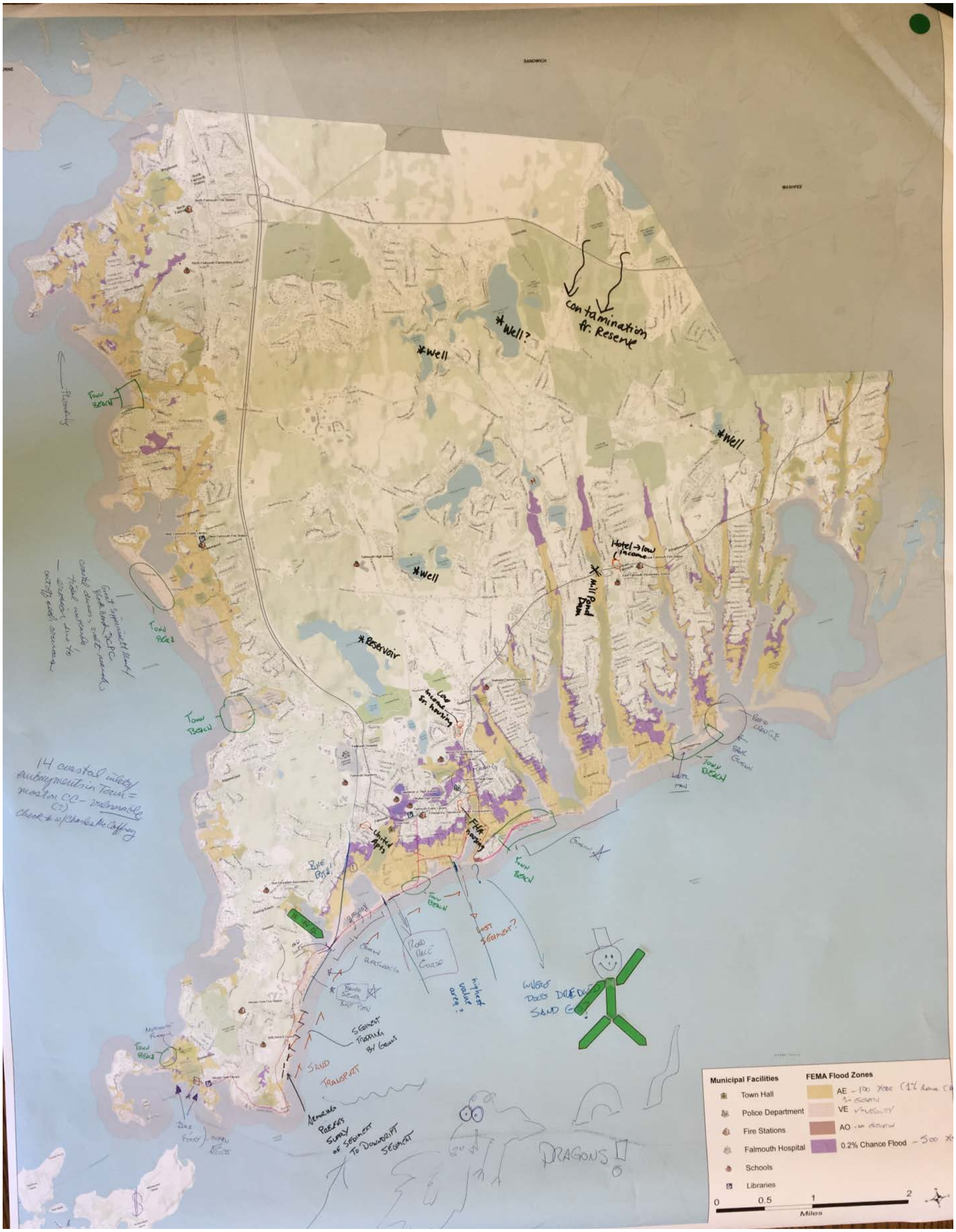
Acknowledgements

Special thanks to the Town of Falmouth for their willingness to embrace this process and engage a good cross section of workshop participants, in particular Jennifer McKay, Doug Brown, Julian Suso, and Charlie McCaffrey. Thanks also to the Sea Crest Beach Hotel for providing the facilities to convene. This project was made possible through funding from the Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program.

Appendix A: Workshop Base Map


BOURNE
SANDWICH
MASHPEE
Municipal Facilities
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
FEMA Flood Zones
AE
VE
AO
0.2% Chance Flood
0
0.5
1
2
Miles

Appendix B: Participatory Mapping Results



contamination fr. Reserve
*Well?
*Well
*Well
*Well
*Reservoir
Hotel → low income
Mill Pond Dam
Low income Sr. housing
Town Beach
DRAGONS!
Municipal Facilities
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
FEMA Flood Zones
AE
VE
AO
0.2% Chance Flood
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Municipal Facilities
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
FEMA Flood Zones
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0.2% Chance Flood
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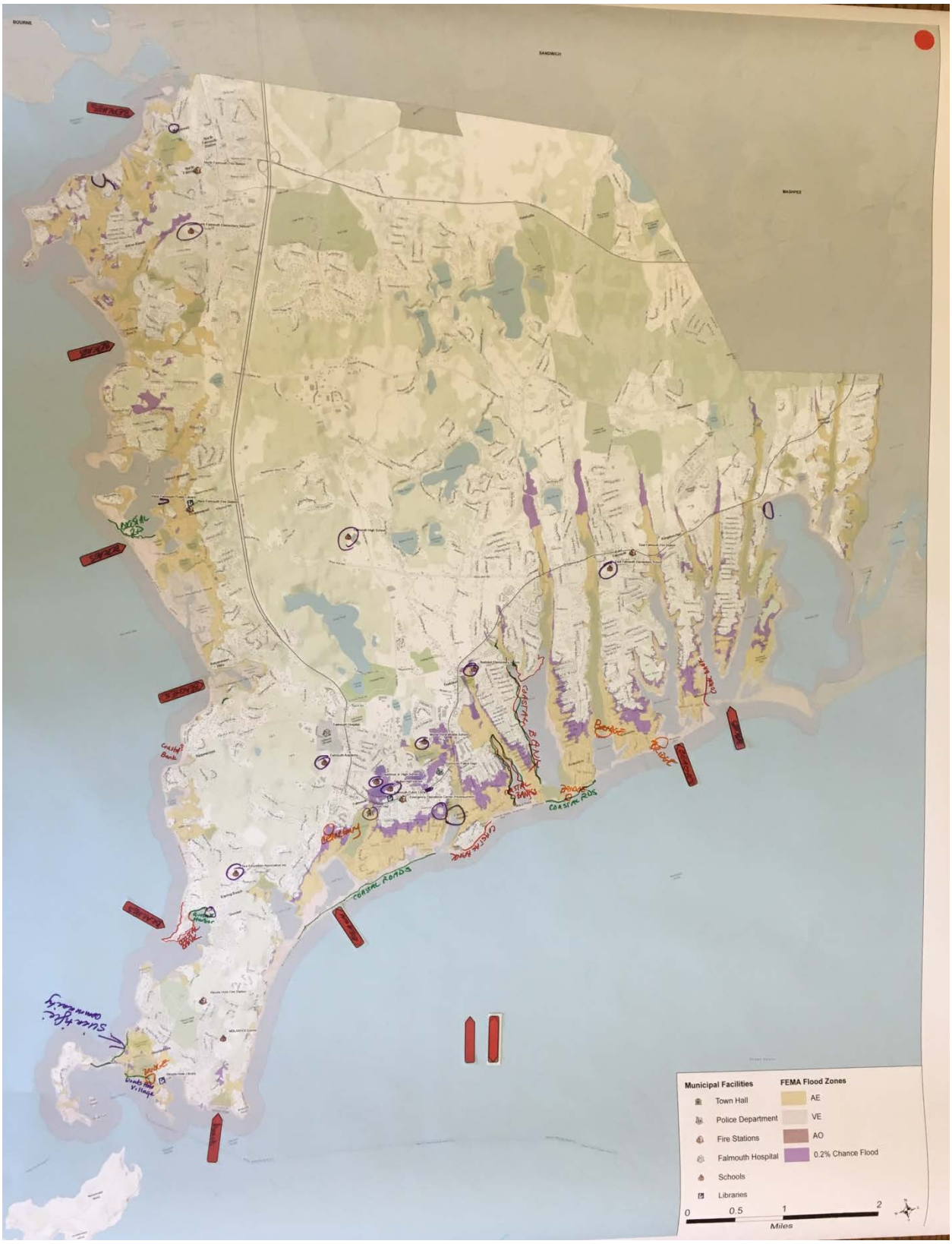
Miles
Herring
Herring Beach
Data
Infrastructure
Societal
Environmental


BOURNE
SANDWICH
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Municipal Facilities
Town Hall
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Falmouth Hospital
Schools
Libraries
FEMA Flood Zones
AE
VE
AO
0.2% Chance Flood
0
0.5
1
2
Miles


Lots of Groins seawalls revetments
WWTP
WTP
WATER MAIN! EVAC. ROUTES.
BEACH
Lots of Groins
EVAC ROUTE WASH OUT W.W. LINE BIKE PATH
FLOOD DRAINAGE
Municipal Facilities
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
FEMA Flood Zones
AE
VE
AO
0.2% Chance Flood
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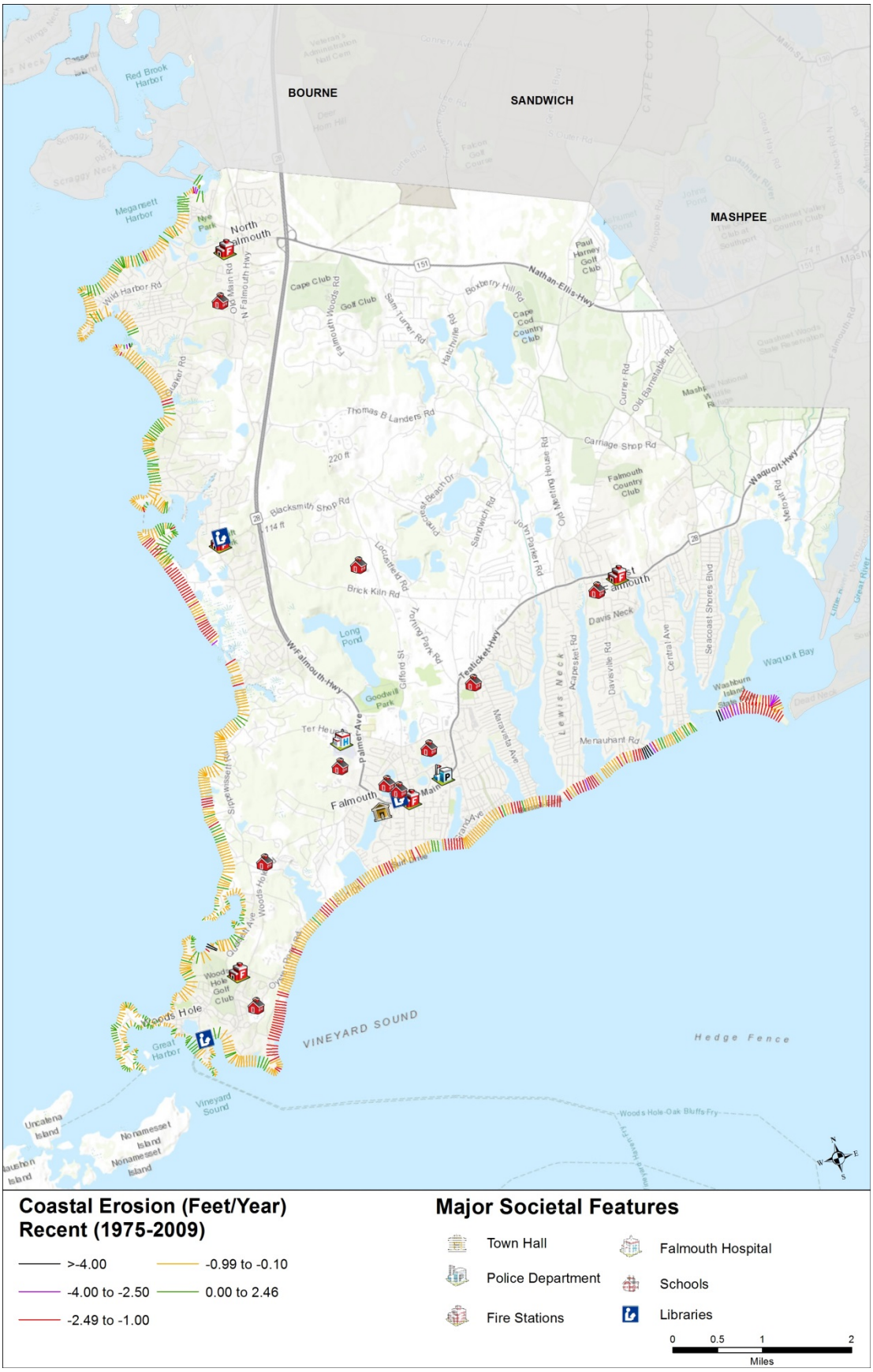
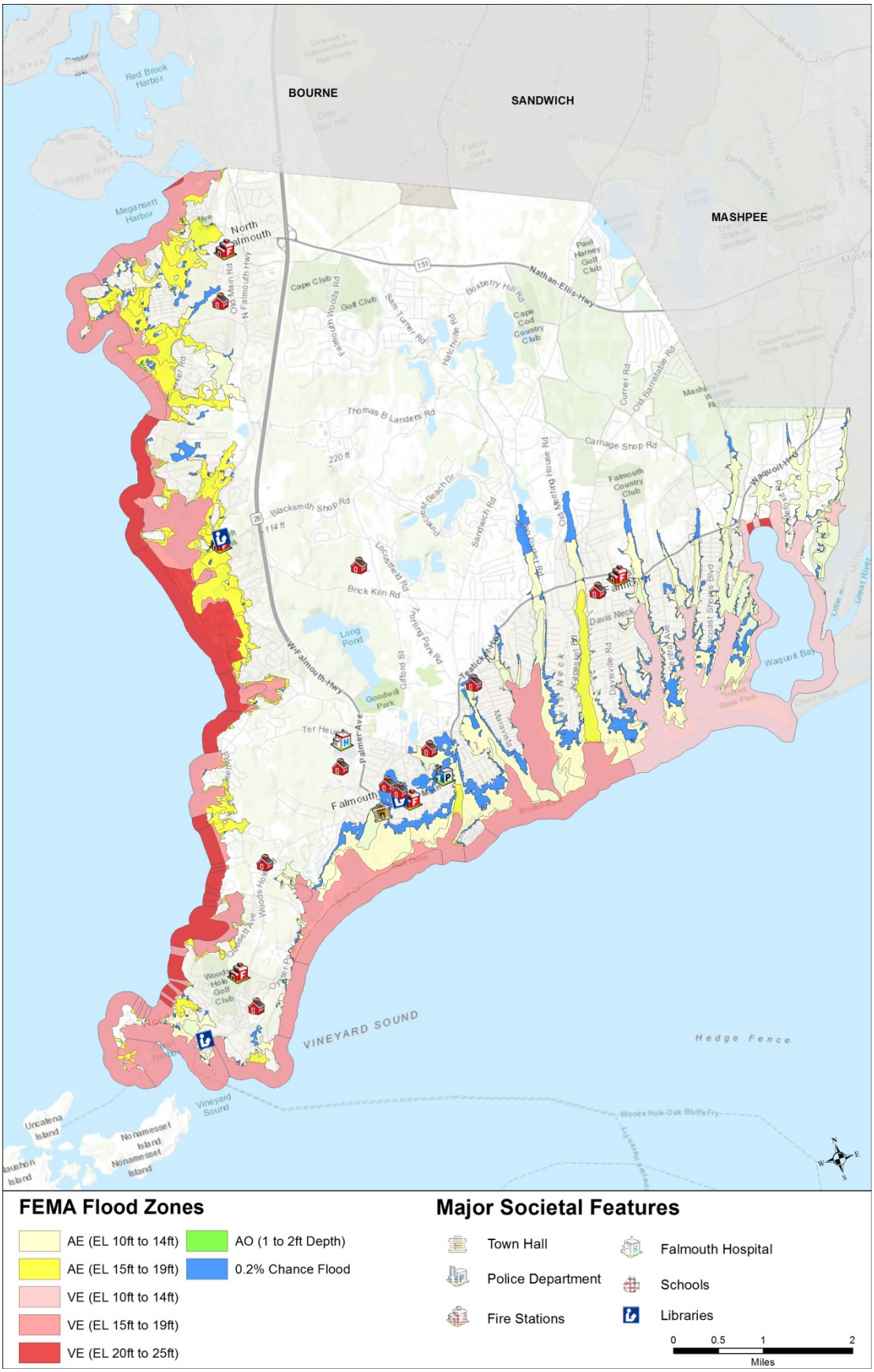
Appendix C: Falmouth Risk Maps Used During Workshop

(Given as workshop handouts)


BOURNE
SANDWICH
MASHPEE
Red Brook Harbor
Megansett Harbor
North Falmouth
Nye Park
Wild Harbor Rd
Old Main Rd
N Falmouth Hwy
Cape Club
Golf Club
Sam Turner Rd
Boxberry Hill Rd
Nathan Ellis Hwy
Paul Harney Golf Club
Cape Cod Country Club
Currier Rd
Old Barnstable Rd
Thomas B Landers Rd
Carriage Shop Rd
Falmouth Country Club
Waquoit Hwy
Blacksmith Shop Rd
Locustfield Rd
Brick Kiln Rd
Sandwich Rd
John Parker Rd
Old Meeting Rd
Davis Neck
Seacoast Shores Blvd
Central Ave
Lewis Neck
Acapesket Rd
Davisville Rd
Waquoit Bay
Washburn Island
Great River
Long Pond
W Falmouth Hwy
Gifford St
Goodwill Park
Palmer Ave
Teaticket Hwy
Menauhant Rd
Maravista Ave
Falmouth
Main
Grand Ave
Surf Drive
Woods Hole
Woods Hole Golf Club
Great Harbor
VINEYARD SOUND
Hedge Fence
Vineyard Sound
Uncatena Island
Nonamesset Island
Woods Hole-Oak Bluffs Fry
Coastal Erosion (Feet/Year)
Recent (1975-2009)
>-4.00
-4.00 to -2.50
-2.49 to -1.00
-0.99 to -0.10
0.00 to 2.46
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0 0.5 1 2
Miles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Vineyard Sound
Uncatena Island
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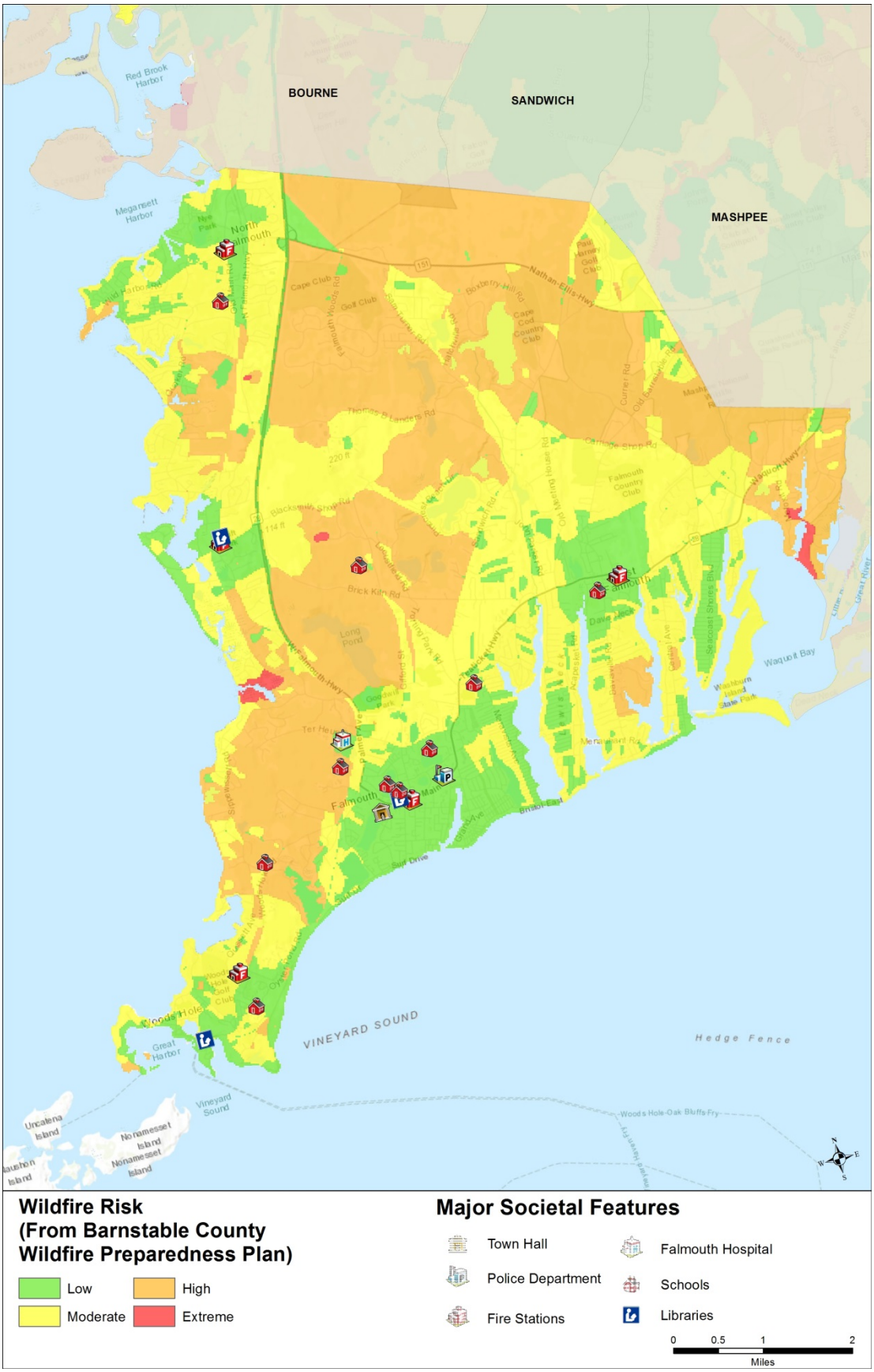
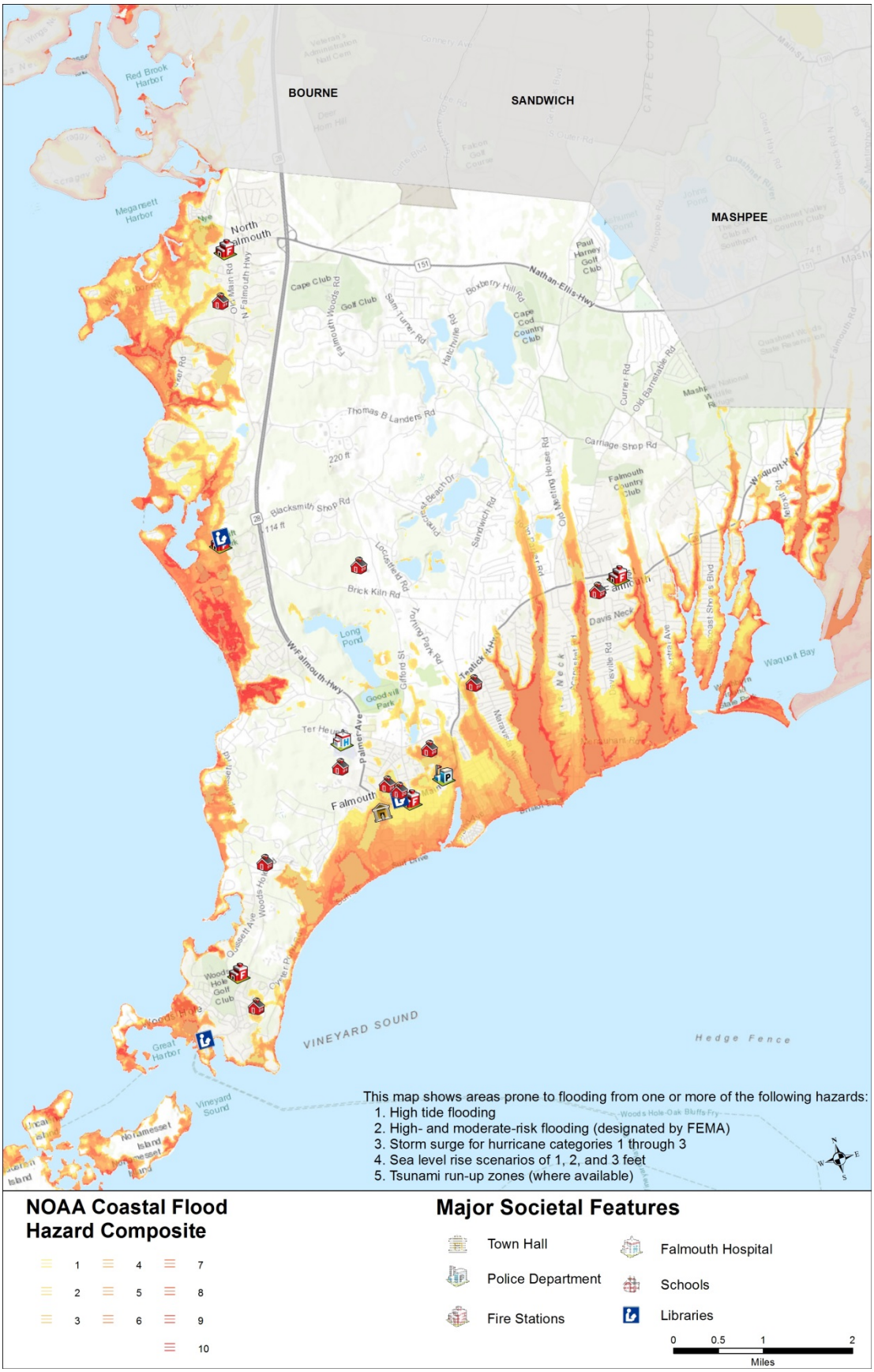
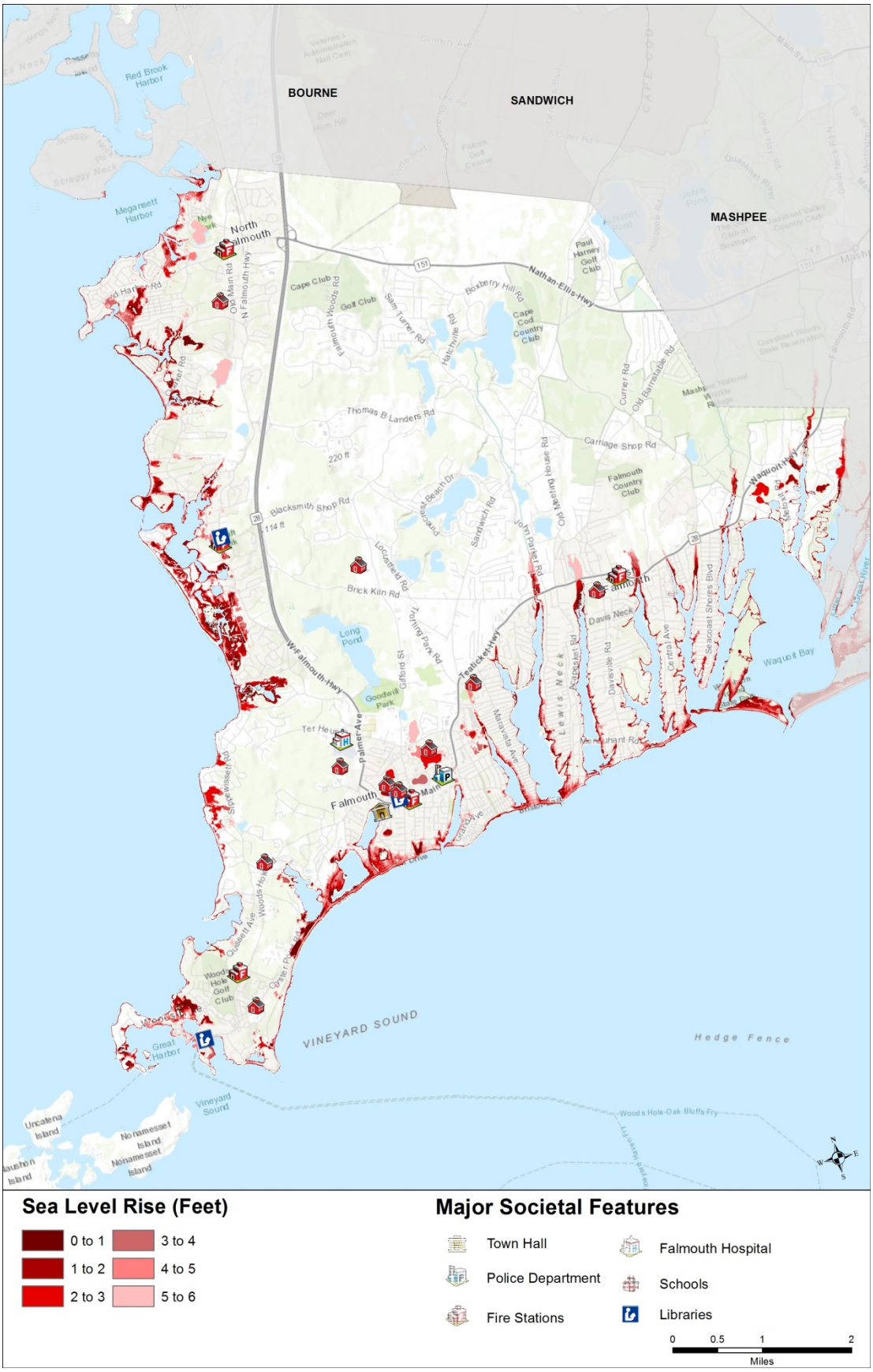
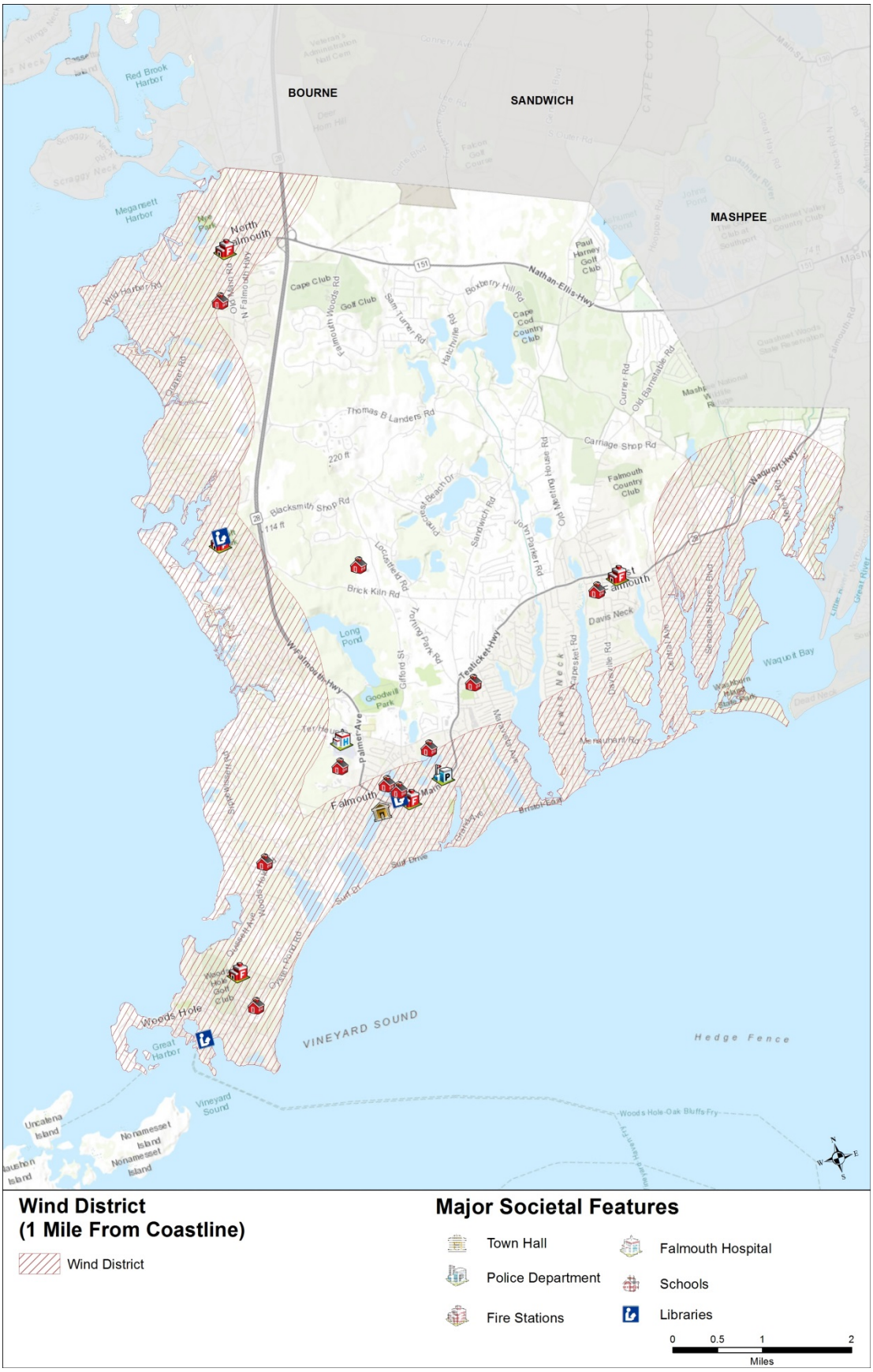
Woods Hole-Oak Bluffs Fry
Nathan Ellis Hwy
Thomas B Landers Rd
Carriage Shop Rd
Blacksmith Shop Rd
Brick Kiln Rd
W Falmouth Hwy
Palmer Ave
Davis Neck Rd
Waquoit Bay
Waquoit Hwy
Cape Cod Country Club
Falmouth Country Club
Paul Harney Golf Club
Woods Hole Golf Club
Megansett Harbor
Red Brook Harbor
FEMA Flood Zones
AE (EL 10ft to 14ft)
AE (EL 15ft to 19ft)
VE (EL 10ft to 14ft)
VE (EL 15ft to 19ft)
VE (EL 20ft to 25ft)
AO (1 to 2ft Depth)
0.2% Chance Flood
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0 0.5 1 2
Miles


BOURNE
SANDWICH
MASHPEE
Red Brook Harbor
Megansett Harbor
North Falmouth
Nye Park
Cape Cod Golf Club
Nathan Ellis Hwy
Boxberry Hill Rd
Cape Cod Country Club
Paul Harney Golf Club
Currier Rd
Old Barnstable Rd
Thomas B Landers Rd
Blacksmith Shop Rd
Brick Kiln Rd
Long Pond
W Falmouth Hwy
Old Meeting House Rd
Falmouth Country Club
Mashpee Rd
Waquoit Hwy
Seacoast Shores Blvd
Great River
Waquoit Bay
Washburn Island State Park
Falmouth
Main St
Grand Ave
Surf Drive
Menahaunt Rd
Woods Hole
Great Harbor
VINEYARD SOUND
Hedge Fence
Vineyard Sound
Woods Hole-Oak Bluffs Ferry
Uncatena Island
Nonamesset Island
Wildfire Risk
(From Barnstable County
Wildfire Preparedness Plan)
Low
High
Moderate
Extreme
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0 0.5 1 2
Miles


BOURNE
SANDWICH
MASHPEE
Red Brook Harbor
Megansett Harbor
North Falmouth
Cape Club
Golf Club
Sam Turner Rd
Boxberry Hill Rd
Nathan Ellis Hwy
Cape Cod Country Club
Paul Harney Golf Club
Thomas B Landers Rd
Carriage Shop Rd
Falmouth Country Club
Blacksmith Shop Rd
Brick Kiln Rd
Long Pond
W Falmouth Hwy
Palmer Ave
Falmouth
Davis Neck
Waquoit Bay
Woods Hole
Woods Hole Golf Club
Great Harbor
VINEYARD SOUND
Hedge Fence
Vineyard Sound
Nonamessett Island
This map shows areas prone to flooding from one or more of the following hazards:
1. High tide flooding
2. High- and moderate-risk flooding (designated by FEMA)
3. Storm surge for hurricane categories 1 through 3
4. Sea level rise scenarios of 1, 2, and 3 feet
5. Tsunami run-up zones (where available)
NOAA Coastal Flood Hazard Composite
1
2
3
4
5
6
7
8
9
10
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0
0.5
1
2
Miles


BOURNE
SANDWICH
MASHPEE
Red Brook Harbor
Megansett Harbor
North Falmouth
Nathan Ellis Hwy
Cape Cod Country Club
Paul Harney Golf Club
Thomas B Landers Rd
Carriage Shop Rd
Falmouth Country Club
Blacksmith Shop Rd
Brick Kiln Rd
Long Pond
W Falmouth Hwy
Teaticket Hwy
Falmouth
Davis Neck
Waquoit Bay
Lewis Neck
VINEYARD SOUND
Hedge Fence
Great Harbor
Vineyard Sound
Uncatena Island
Nonamesset Island
Woods Hole-Oak Bluffs Fry
Sea Level Rise (Feet)
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0 0.5 1 2
Miles


BOURNE
SANDWICH
MASHPEE
Red Brook Harbor
Megansett Harbor
North Falmouth
Nathan Ellis Hwy
Cape Cod Country Club
Falmouth Country Club
Thomas B Landers Rd
Carriage Shop Rd
Blacksmith Shop Rd
Brick Kiln Rd
Waquoit Hwy
Davis Neck
Waquoit Bay
Long Pond
Teaticket Hwy
Falmouth
Woods Hole
Great Harbor
VINEYARD SOUND
Hedge Fence
Vineyard Sound
Uncatena Island
Nonamesset Island
Woods Hole-Oak Bluffs Fry
Wind District
(1 Mile From Coastline)
Wind District
Major Societal Features
Town Hall
Police Department
Fire Stations
Falmouth Hospital
Schools
Libraries
0
0.5
1
2
Miles

Appendix D: Massachusetts Updated Climate Projections

(Given as workshop handouts)

CAPE COD BASIN

MUNICIPALITIES WITHIN CAPE COD BASIN:

Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, Yarmouth

Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)	Mid-Century Projected Change in 2050s (°F)	Projected Change in 2070s (°F)	End of Century Projected Change in 2090s (°F)
Average Temperature	Annual	49.92	+1.78 to +3.41	+2.41 to +5.39	+2.74 to +7.78	+3.11 to +9.52
	Winter	31.92	+1.76 to +3.72	+2.50 to +5.70	+3.07 to +7.69	+3.35 to +9.20
	Spring	45.98	+1.73 to +3.23	+2.16 to +5.04	+2.59 to +6.74	+2.94 to +7.69
	Summer	68.15	+1.50 to +3.62	+2.08 to +5.66	+2.45 to +8.58	+3.03 to +10.43
	Fall	53.32	+1.92 to +3.83	+3.03 to +5.86	+2.85 to +8.29	+3.35 to +10.06
Maximum Temperature	Annual	57.74	+1.63 to +3.38	+2.19 to +5.23	+2.43 to +7.73	+2.82 to +9.26
	Winter	39.76	+1.52 to +3.60	+2.10 to +5.27	+2.60 to +7.27	+3.01 to +8.65
	Spring	53.74	+1.44 to +3.11	+1.92 to +4.80	+2.30 to +6.54	+2.62 to +7.55
	Summer	75.95	+1.35 to +3.48	+1.95 to +5.60	+2.29 to +8.47	+2.68 to +10.27
	Fall	61.24	+1.84 to +3.80	+2.81 to +5.83	+2.76 to +8.00	+3.08 to +9.97
Minimum Temperature	Annual	42.09	+1.92 to +3.53	+2.67 to +5.50	+3.06 to +7.84	+3.42 to +9.67
	Winter	24.08	+2.06 to +3.97	+2.90 to +6.16	+3.53 to +8.34	+3.81 to +9.85
	Spring	38.23	+1.74 to +3.47	+2.51 to +5.28	+2.71 to +6.93	+3.19 to +7.83
	Summer	60.35	+1.65 to +3.75	+2.23 to +5.72	+2.61 to +8.66	+3.32 to +10.64
	Fall	45.41	+1.92 to +4.01	+3.14 to +5.88	+2.96 to +8.49	+3.63 to +10.28

- The Cape Cod basin is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.
- Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century.
    - Summer mid-century increase of 2 °F to 5.6 °F (3-7% increase); end of century increase of 2.7 °F to 10.3 °F (4-14% increase).
    - Fall mid-century increase of 2.8°F to 5.8°F (5-10% increase); end of century increase by and 2.8 °F to 5.8 °F (5-16% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 2.9 °F to 6.2 °F (12-26% increase); end of century increase by 3.8 °F to 9.9 °F (16-41% increase).
    - Fall mid-century of 3.1 °F to 5.9 °F (7-13% increase); end of century increase of 3.6 °F to 10.3 °F (8-23% increase).

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Maximum Temperature Over 90°F	Annual	0.76	+1.17 to +3.89	+1.93 to +9.25	+2.46 to +21.33	+3.23 to +33.89
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.01	-0.02 to +0.09	-0.02 to +0.13	+0.00 to +0.20	+0.00 to +0.29
	Summer	0.73	+1.06 to +3.58	+1.79 to +8.62	+2.34 to +19.96	+3.04 to +31.61
	Fall	0.01	+0.06 to +0.28	+0.10 to +0.68	+0.13 to +1.26	+0.19 to +2.26
Days with Maximum Temperature Over 95°F	Annual	0.06	+0.08 to +0.63	+0.19 to +1.88	+0.25 to +4.51	+0.26 to +9.49
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	-0.00 to +0.02	+0.00 to +0.05	+0.00 to +0.08
	Summer	0.06	+0.07 to +0.61	+0.18 to +1.85	+0.25 to +4.32	+0.26 to +9.11
	Fall	0.00	+0.00 to +0.03	+0.00 to +0.06	+0.00 to +0.17	+0.00 to +0.42
Days with Maximum Temperature Over 100°F	Annual	0.00	+0.00 to +0.07	+0.00 to +0.31	+0.01 to +0.80	+0.03 to +1.71
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.01
	Summer	0.00	+0.00 to +0.07	+0.00 to +0.31	+0.01 to +0.80	+0.02 to +1.69
	Fall	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.01	+0.00 to +0.04

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Cape Cod basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the Cape Cod basin is expected to see days with daily maximum temperatures over 90 °F increase by 2 to 9 more days by mid-century, and 3 to 34 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 2 to 9 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the Cape Cod basin is expected to have 3 to 32 more days.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Minimum Temperature Below 0°F	Annual	0.79	-0.08 to -0.37	-0.09 to -0.39	-0.14 to -0.4	-0.15 to -0.4
	Winter	0.79	-0.08 to -0.37	-0.09 to -0.39	-0.14 to -0.4	-0.15 to -0.4
	Spring	0.00	-0.01 to -0.00	-0.01 to -0.00	-0.01 to -0.00	-0.01 to -0.00
	Summer	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
	Fall	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
Days with Minimum Temperature Below 32°F	Annual	104.75	-13.60 to -27.72	-19.29 to -41.91	-23.29 to -54.38	-24.54 to -66.71
	Winter	70.7	-5.68 to -12.20	-7.00 to -20.22	-10.21 to -29.71	-11.46 to -38.36
	Spring	23.8	-5.16 to -11.14	-7.22 to -14.64	-7.87 to -17.32	-9.50 to -18.96
	Summer	0.00	-0.05 to -0.00	-0.04 to -0.00	-0.04 to -0.00	-0.05 to -0.00
	Fall	10.16	-3.40 to -6.37	-4.69 to -8.2	-5.09 to -9.62	-5.34 to -10.71

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Cape Cod basin is expected to experience a decrease in days with daily minimum temperatures below 32 °F and 0 °F.
- Seasonally, winter, spring and fall are expected to see the largest decreases in days with daily minimum temperatures below 32 °F.
    - Winter is expected to have 7 to 20 fewer days by mid-century, and 11 to 38 fewer days by end of century.
    - Spring is expected to have 7 to 15 fewer days by mid-century, and 10 to 19 fewer days by end of century.
    - Fall is expected to have 5 to 8 fewer days by mid-century, and 5 to 11 fewer days by end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)	Mid-Century Projected Change in 2050s (Degree-Days)	Projected Change in 2070s (Degree-Days)	End of Century Projected Change in 2090s (Degree-Days)
Heating Degree-Days (Base 65°F)	Annual	5956.64	-475.48 to -913.39	-685.90 to -1374.26	-773.67 to -1828.23	-854.04 to -2171.56
	Winter	2996.33	-164.51 to -347.77	-220.16 to -520.87	-277.06 to -697.53	-304.13 to -831.96
	Spring	1753.89	-152.01 to -285.19	-190.19 to -444.68	-229.91 to -584.74	-267.48 to -649.94
	Summer	94.49	-30.02 to -57.56	-41.95 to -69.89	-44.65 to -80.65	-44.99 to -85.45
	Fall	1105.61	-131.82 to -268.87	-226.73 to -393.30	-215.14 to -547.22	-242.01 to -619.87
Cooling Degree-Days (Base 65°F)	Annual	435.71	+144.74 to +364.43	+224.26 to +601.17	+250.48 to +965.18	+314.49 to +1226.21
	Winter	nan	+0.13 to +1.43	+0.38 to +3.50	+0.92 to +3.19	-0.34 to +3.91
	Spring	7.08	+3.48 to +9.44	+4.94 to +20.08	+5.86 to +34.34	+7.02 to +52.03
	Summer	384.03	+107.28 to +279.41	+148.81 to +457.16	+184.27 to +701.82	+229.32 to +875.35
	Fall	43.77	+30.85 to +80.41	+41.77 to +138.18	+48.96 to +224.33	+71.67 to +296.72
Growing Degree-Days (Base 50°F)	Annual	2421.38	+343.19 to +690.79	+460.30 to +1078.12	+519.05 to +1678.13	+617.96 to +2104.38
	Winter	4.84	+0.24 to +9.74	+0.28 to +15.26	+2.10 to +25.74	+4.23 to +35.89
	Spring	197.63	+50.56 to +105.22	+69.23 to +195.43	+77.64 to +277.13	+77.88 to +342.92
	Summer	1669.64	+137.95 to +332.36	+190.73 to +520.48	+224.93 to +789.31	+278.12 to +958.80
	Fall	546.41	+107.92 to +248.13	+174.67 to +396.65	+168.86 to +571.84	+215.05 to +716.85

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Cape Cod basin is expected to experience a decrease in heating degree-days, and increases in both cooling degree-days and growing degree-days.
- Seasonally, winter historically exhibits the highest number of heating degree-days and is expected to see the largest decrease of any season, but spring and fall are also expected to see significant change.
    - The winter season is expected to see a decrease of 220-521 degree-days by mid-century (a decrease of 7-17%), and a decrease of 304-832 degree-days by the end of century (a decrease of 10-28%).
    - The spring season is expected to decrease in heating degree-days by 11-25% (190-445 degree-days) by mid-century, and by 15-37% (267-650 degree-days) by the end of century.
    - The fall season is expected to decreases in heating degree-days by 21-36% (227-393 degree-days) by mid-century, and by and 22-56% (242-620 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 39-119% (149-457 degree-days) by mid-century, and by 60-228% (229-875 degree-days) by end of century.

- Seasonally, summer historically exhibits the highest number of growing degree-days and is expected to see the largest decrease of any season, but the shoulder seasons of spring and fall are also expected to see an increase in growing degree-days.
    - The summer season is projected to increase by 11-31% (190.73-520.48 degree-days) by mid-century, and by 17-57% (278-959 degree-days) by end of century.
    - Spring is expected to see an increase by 35-99% (69-195 degree-days) by mid-century and 39-174% (78-343 degree-days) by end of century.
    - Fall is expected to see an increase by 32-73% (175-397 degree-days) by mid-century and 39-131% (215-717 degree-days) by end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Precipitation Over 1”	Annual	7.02	+0.16 to +1.76	+0.66 to +2.66	+0.45 to +2.92	+0.55 to +3.41
	Winter	1.45	-0.10 to +0.62	+0.08 to +0.67	+0.02 to +1.04	+0.09 to +1.35
	Spring	1.65	+0.08 to +0.65	+0.08 to +0.90	+0.22 to +1.05	+0.29 to +1.20
	Summer	1.92	-0.18 to +0.55	-0.13 to +0.78	-0.40 to +0.66	-0.46 to +0.58
	Fall	2.01	-0.23 to +0.62	-0.13 to +0.85	-0.31 to +0.94	-0.35 to +1.11
Days with Precipitation Over 2”	Annual	0.75	-0.04 to +0.43	+0.07 to +0.52	+0.08 to +0.71	+0.05 to +0.74
	Winter	0.09	-0.05 to +0.16	-0.02 to +0.15	-0.02 to +0.20	-0.02 to +0.27
	Spring	0.05	-0.03 to +0.13	+0.01 to +0.18	+0.02 to +0.19	-0.01 to +0.25
	Summer	0.33	-0.07 to +0.15	-0.05 to +0.23	-0.05 to +0.20	-0.05 to +0.22
	Fall	0.28	-0.04 to +0.13	-0.01 to +0.20	-0.01 to +0.23	-0.07 to +0.31
Days with Precipitation Over 4”	Annual	0.01	+0.00 to +0.03	+0.00 to +0.03	-0.01 to +0.05	-0.01 to +0.05
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.01	-0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	+0.00 to +0.00	+0.00 to +0.01	+0.00 to +0.00
	Summer	0.00	-0.01 to +0.02	-0.01 to +0.02	-0.01 to +0.03	-0.01 to +0.03
	Fall	0.01	-0.00 to +0.02	+0.00 to +0.01	+0.00 to +0.02	+0.00 to +0.03

- The projections for expected number of days receiving precipitation over one inch are variable for the Cape Cod basin, fluctuating between loss and gain of days.
    - Seasonally, the winter season is generally expected to see the highest projected increase.
    - The winter season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and by 0-1 days by the end of century.
    - The spring season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and by 0-1 days by the end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century Projected Change in 2090s (Inches)
Total Precipitation	Annual	44.94	-1.08 to +3.47	-0.38 to +4.54	-0.78 to +5.79	-0.83 to +5.45
	Winter	11.63	-0.40 to +1.24	-0.22 to +1.59	-0.05 to +2.10	-0.04 to +3.13
	Spring	11.51	-0.04 to +1.48	-0.26 to +1.67	-0.21 to +2.08	+0.08 to +2.45
	Summer	10.24	-0.95 to +1.19	-1.05 to +1.73	-1.64 to +2.00	-2.22 to +1.66
	Fall	11.62	-0.96 to +0.90	-0.99 to +1.09	-1.40 to +1.64	-1.52 to +1.26

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Cape Cod basin.
    - The winter season is expected to experience the greatest change with a decrease of 2% to an increase of 14% by mid-century, and an increase of 0-27% by end of century.
    - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
        - The summer season projections for the Cape Cod or basin could see a decrease of 1.1 to an increase of 1.7 inches by mid-century (decrease of 10% to increase of 17%), and a decrease of 2.2 to an increase of 1.7 inches by the end of the century (decrease of 22% to increase of 16%).
        - The fall season projections for the Cape Cod basin could see a decrease of -1 to an increase of 1.1 inches by mid-century (decrease of 9% to increase of 9%), and a decrease of 1.5 to an increase of 1.3 inches by the end of the century (decrease of 13% to increase of 11%).

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Consecutive Dry Days	Annual	18.72	-1.06 to +1.99	-0.56 to +2.62	-0.34 to +3.63	-0.26 to +4.65
	Winter	10.19	-0.52 to +1.53	-0.44 to +1.46	-0.31 to +1.83	-0.94 to +1.97
	Spring	11.59	-0.99 to +1.21	-0.86 to +1.50	-1.00 to +1.48	-1.34 to +1.58
	Summer	15.38	-1.00 to +2.02	-0.83 to +2.61	-0.89 to +4.38	-1.03 to +5.26
	Fall	13.05	-0.57 to +2.45	-0.04 to +2.29	+0.17 to +2.82	+0.04 to +3.45

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
    - For all the temporal parameters, the Cape Cod basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
    - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
        - The summer season is expected to experience a decrease of 1 day to an increase of 5 days in consecutive dry days by the end of the century.

Appendix E: Listening Session Public Comments

Falmouth MVP Listening Session (May 8, 2018) Public Comments

There were a number of questions related to the MVP process and the potential for applying for grant funding to implement some of the actions developed through the MVP process. Specific questions included:

- Question: How much money is available through the MVP Action Grant program?
    - Answer: In April 2018, the Baker-Polito Administration announced $5 million in supplemental funding for the MVP program. Applicants may request up to $400,000 in funding and awards are expected to range from $10,000-$400,000.
- Question: Are the grants directed towards studies (ex: further our knowledge about sediment transport dynamics) or are they targeted at infrastructure projects?
    - Answer: MVP action grants can be used for both, and more. Eligible project types include detailed vulnerability or risk assessments, public education and communication, developing or amending local bylaws, ordinances, plans and other management measures, redesigns and retrofits, nature-based solutions, and ecological restoration and habitat management to increase resiliency.
- Question: Will the workshop matrices and maps be available online for public review.
    - Answer: All workshop materials will be posted online for review.
- Question: Are there any other funding outside of Town budgets for these types of studies or projects?
    - Answer: Yes, the state has other grant programs available in addition to the MVP Grant Program.
- Question: How will the comments made here and at the workshop be reported back to the state?
    - Answer: The workshop findings and comments made at the listening session will be included as part of a Summary Report that will be submitted to the State before the end of June.
- Question: What is the upshot of this summary report? CRAC is only focused on coastal issues but the CRB process covers broader issues related to infrastructure, energy, regulations, etc. Are there recommendations that the committees work together? Identified policies, changes, suggested regulations for the Town to consider adopting?
    - Answer: The CRB workshop addressed broad issues related to environmental, infrastructural, and societal strengths and vulnerabilities. A wide range of resilience building actions were identified during the workshop and the Town is looking for community input on if there are additional priority actions that should be considered.

Attendees were encouraged to offer their thoughts and not just ask questions about the MVP process and grant program. The Town MVP leads stressed that the point of the listening session was to gather public input on where there are issues, what people are concerned about, and potential actions that should be taken to make Falmouth more resilient.

General comments from the public included:

- Efforts should seek to tackle multiple issues. For example, can oyster reefs help remove nitrogen and protect against coastal erosion.
- Falmouth should integrate a systems level approach to improve resiliency– transportation, energy, food, ecosystems, etc.
- We need to consider whether "resilience" means maintaining what we have in spite of the changes that are coming, or if we should be changing to adapt.
- We need a practical way to identify what to preserve in the short term in order to maintain our economy and our way of life in the face of climate change.
- We need to coordinate better with the utilities. But what is the best level to do this? Should the Town work directly with utilities, or should the initiate come from the state?
- The Town is vulnerable to a number of things, not just sea-level rise. Damage to the power lines has been a major problem. It's unlikely that we can get the utility companies to bury the lines, but we could focus on the trees. Many of the issues arise as oak trees drop limbs on the wires. Can we test/locate which trees should be trimmed or felled prior to a storm to avoid these impacts in the future?
- There's a presumption that a detailed coastal study is a priority for the Town, but what is a new study going to show us that the previous coastal studies have not? If you only have a certain amount of money and resources, at some point you need to transition from planning to doing.
- The wind turbines should be able to run radio communications during a major storm/power outage to give a constant stream report of what is closed and what isn't.
- It may not be wise to spend large amounts of money on road repairs and enhancements to roadways that will likely be inundated and unusable by mid-century due to sea-level rise.
- We should identify high density areas of residential homes that are in areas vulnerable to sea-level rise, flooding and/or erosion. But how does the Town proceed? Is it the Town's responsibility to defend private property?
- Surf Drive is a lovely area, but it won't always be that way as sea level rises. That's not a road we'll be able to save. But what do we do with all of the houses that are already there? What's the responsibility of the Town to continue to provide services and emergency response to this area that will be regularly inundated by high tides in the future?
- Is there a plan to determine which public roads should be reclassified as private roads?
- Consider re-zoning for sea-level rise areas.
- The Town should encourage residences to develop a response kit for major storm events. Just like almost everyone has fire alarms and fire extinguishers in their homes, people should also have things like an inflatable raft. This could be encouraged through better public outreach and communication. Maps of potential hazards could also be included in the kit to raise awareness.
- We should determine which beaches are worth saving and which are not. What is the criteria for prioritizing sailing vs. beach use vs. flood protection, for example?

- Some beach nourishment projects would result in negative impacts to adjacent harbors. For instance, if Chappoquoit Beach were nourished, the sediment would be transported into the inlet to West Falmouth Harbor, disrupting boat traffic and sailing opportunities.
- When we build new Town facilities, we need to be careful to site them in less vulnerable areas.
- Should we maintain the armoring around Nobska lighthouse or relocate it farther inland and along the shoreline to return to a more natural state?
- We need to be able to deal with more water [from precipitation] coming from a single storm. The Town should consider where this additional water could be stored in the short term.
- There may be ways to deal with storage or improving drainage for precipitation events, but there's no way we can find a way to soak up all the water that will affect Falmouth during a storm surge. Being able to store rainwater may help when there are drought conditions in the summer.
- The Town should reconsider issuing variances for new buildings that are going to be built in harm's way. There should be teeth behind limiting variances.
- The Town needs a plan that clearly identifies a structure of authority, including who can declare an emergency, and what new rules will take over at that time.
- We also need to consider food security. We should invest in local food banks, which can have stored food in case we get cut off from the mainland.

There were multiple comments related to the need to focus on mitigating climate change, rather than simply planning to be more resilient to the changes and impacts it will cause. Specific comments included:

- Falmouth should emphasize energy resilience in terms of microgrids and wind power and a general policy of moving towards renewables and higher efficiency.
- The Town should be doing everything it can for climate mitigation and local energy independence.
- We should consider whether regulations can change to require that new development must incorporate renewal energy into their design. To this end, we should determine what the best and most resilient kind of renewable energy is – solar? wind?
- This is not the time to think about dismantling wind turbines.
- We should be installing more wind turbines.

Following the Public Listening Session, one additional comment letter was received by the Town. The main points highlighted in that letter are as follows:

- Falmouth should reduce its greenhouse gas emissions, and keep reducing them until they get to zero, in an effort to address global warming directly, rather than simply mitigate the effects of global warming.
- Falmouth should join other communities across the state, the country and the world in an effort to reduce global greenhouse gas emissions.

- Falmouth should adopt the Massachusetts State Energy Code, which would reduce emissions from new residential and commercial buildings and help make Falmouth eligible for Green Community Status, and the grant opportunities associated with that.
- Falmouth should take immediate actions to become energy independent. We need to be ready for long periods of time following a natural hazard during which traditional power grids are not functioning. We should put more reliance on energy sources such as wind, solar and hydrogen fuel cells, and invest in a battery storage system to store the power generated by these systems.

During the Listening Session, the public also had the opportunity to mark up an additional map similar to those used during the MVP workshop, to indicate critical infrastructure or vulnerable areas.