Town of Marshfield

Community Resilience Building Workshop Summary of Findings

February 2020

Contents

Town of Marshfield
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, and heavy rain and wind events during the summer of 2018 have reinforced this urgency and compelled communities like the Town of Marshfield to proactively plan and mitigate potential risks through a community driven process. Ultimately, these efforts will reduce the vulnerability of Marshfield's citizens, facilities and ecosystems, and serve as a model for other Massachusetts communities.

In the fall of 2019, with funding from the Executive Office of Energy and Environmental Affairs Massachusetts Municipal Vulnerability Preparedness Program, the Town of Marshfield contracted with the Woods Hole Group to implement the Community Resilience Building (CRB) process. A municipal-based core team was established to organize and implement an 8-hour CRB Workshop on February 1, 2020. The goal of this workshop was to engage and educate community stakeholders to facilitate the development, planning and ultimately, the implementation of priority adaptation actions. The list of workshop invitees and workshop content was guided by input from the municipal core team and consultants from Woods Hole Group. 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; and
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Thirty-two (32) participants from town departments/committees/boards, community organizations, local businesses, and residents 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 presentations outlined the workshop process and goals, presented relevant hazard and community data, and shared example actions. Participants also had an opportunity to work together in small groups consisting of 7 to 9 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 shared amongst the participants, produced the findings detailed in this summary report. This report provides an overview of the top hazards, current concerns and challenges, strengths and vulnerabilities, and recommended actions to improve the Town of Marshfield's resilience to natural and climate-related hazards today and in the future.

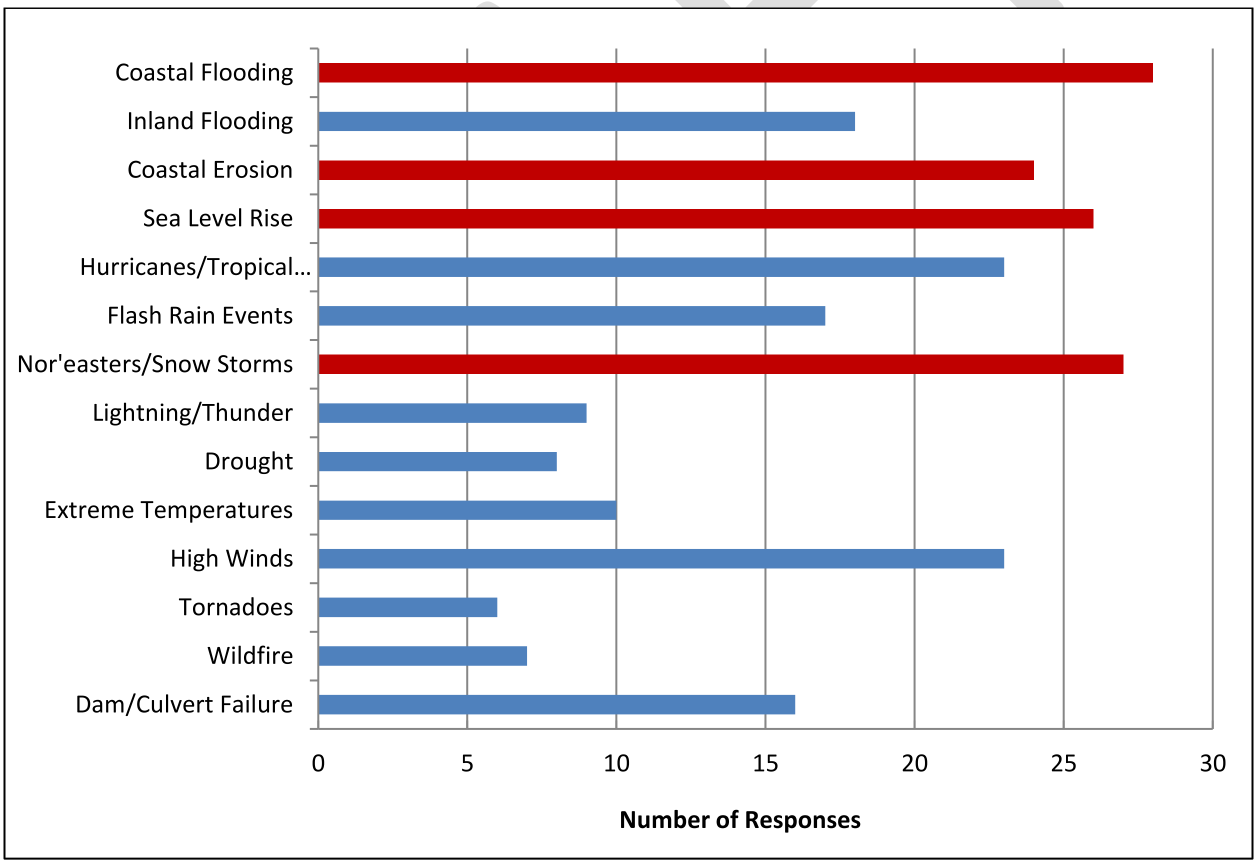
Workshop participants and other interested stakeholders are encouraged to provide comments, corrections and updates on the summary of findings described in this report. The Town of Marshfield's ongoing community resilience will benefit from the participation of all those concerned.

Top Hazards and Vulnerable Areas

Prior to the Community Resilience Building Workshop held on February 1, 2020, invited workshop participants were asked to identify the top natural hazards for the Town of Marshfield as part of a pre-workshop online survey. Coastal flooding, nor'easters and snow storms, sea level rise, and coastal erosion were identified as the hazards of greatest concern. Hurricanes and tropical storms and high winds were also identified as major concerns for the Town. Although these hazards were not specifically addressed as "top hazards" during the CRB Workshop process, the impacts from these hazards overlap with hazards that were specifically addressed (i.e., Nor'easters, Coastal Flooding, Coastal Erosion).

Top Hazards

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



Vulnerable Areas

Populations and Neighborhoods: Low-lying coastal areas subject to flooding (the Esplanade, Brant Rock), concentrations of elderly populations (nursing homes, senior housing, Grace E. Ryder housing, Ocean Bluff, etc.), coastal homes and repetitive loss properties, and historic areas (Winslow House, Daniel Webster Estate, etc.).

Ecosystems: Rexhame Beach and coastal dunes, which is one on the only unarmored ocean facing stretches of Town, the old mouth of the South River, which has breached in major storm events, fisheries and shellfish resources, salt marshes and estuaries, and forested conservation lands, which are vulnerable to tree falls and fire.

Infrastructure and Transportation: Low-lying coastal roadways (Parker Street, Dyke Road/Careswell Street, Ferry Street, Sea Street, Plymouth Avenue, Foster Avenue, Route 139, and the "numbered" streets), the wastewater treatment plant, the seawalls, septic systems, the electrical distribution system, including overhead electricity and utility wires, inadequate stormwater drainage systems (esp. Library Plaza), and aging dams and culverts.

Municipal Facilities: Wastewater treatment plant, low-lying school buildings that function as emergency shelters (Governor Winslow School, Daniel Webster School, Furnace Brook Middle School), Senior Center, and Fire Station #1 due to limited access during flood conditions.

Current Concerns and Challenges Presented by Hazards

The Town of Marshfield has many concerns and faces multiple challenges related to the impacts of natural hazards. In recent years, Marshfield 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. The impacts from recent nor'easters included significant coastal erosion at Rexhame Beach, a breach through the "old mouth" of the South River, damage to coastal homes and the seawall, as well as coastal flooding and high winds resulting in many downed trees blocking roads and disrupting the electrical supply to many areas of Town. 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 and Brant Rock commercial areas. While the seawalls provide some protection from flooding and wave impacts, they too are increasingly vulnerable as the coastal beaches fronting the seawalls continue to erode and lower in elevation; without adequate toe protection from the beach sand, sections of the seawall could start to be undermined. The forested inland areas experience the effects of tree damage from wind, snow and ice, as well as hazards from inland flooding along roads and within parking lots 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 Marshfield 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. Low lying coastal roads are experiencing greater impact from major storms, and increases in severe rain events are resulting in routine flooding of certain major roadways where stormwater systems are inadequate to effectively divert rainwater. Additionally, there was a general concern that a long-range plan needed to be developed for how to protect the wastewater treatment plant during flood and storm events, as well as how to handle the increasingly vulnerable repetitive loss properties. Finally, emergency responders commented how the trend of elevating multi-story houses is putting a strain on fire equipment and the department's ability to effectively and efficiently respond to a fire.

Specific Categories of Concerns and Challenges

Vulnerability of Wastewater Infrastructure

One of the primary concerns expressed by participants was the vulnerability of the wastewater treatment plant, as well as the entire sewer system (e.g., sewer pump stations). Both the main treatment facility, as well as the 5 auxiliary pump stations, are vulnerable to flooding. Given the increasing hazards presented by flooding, sea-level rise and storm surge, participants felt that action should be taken to mitigate risk to these vital assets. In addition to the vulnerability of the wastewater treatment plant itself, access to and from the facility is also threatened during a flood event due to low elevations along Town Pier Road.

Seawalls and Beach Nourishment

All small working groups also identified ongoing erosion along Marshfield's Atlantic coastline as a point of concern. Marshfield's beaches are not only vital to the character of the Town, but this resource area also provides protection to the Town's seawalls. Although there is little to no dry high tide beach along much of the Marshfield shoreline, and the seawalls are currently prohibiting further landward erosion of the shoreline, ongoing erosion continues to lower the vertical elevation of the beach. Overtime, continued vertical erosion will expose the toe of the seawalls, producing unstable and vulnerable conditions. Recognizing the importance of maintaining a healthy coastal beach system fronting of the seawalls, the Town is currently engaged in a planning and permitting process for long-term, Town-wide beach nourishment. A project of this scale unsurprisingly comes with numerous challenges, including obtaining easements from private property owners where their property lines extend seaward of the walls, identifying a suitable source of material, and raising adequate funds to implement the nourishment.

Roadway Flooding

Coastal flooding (e.g., standing flood waters, storm surge) presents a major threat to the Town's low-lying coastal roadways, including Parker Street, Dyke Road/Careswell Street, Ferry Street, Plymouth Avenue, Foster Avenue, Route 139, Ocean Street/the Esplanade, and the "numbered" streets; this is particularly critical because Route 139 is the Town's designated emergency evacuation route. Participants also expressed concerns about flooding along key low-lying bridges, including the Sea Street and Julian Street Bridges. Recent flooding events prompted participants to consider the future impact of coastal flooding if the extent or frequency of this hazard were exacerbated by sea-level rise, and to consider mitigation actions that would allow usable transportation corridors during flood events. 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 to coastal flooding, key roadway and parking lot areas in Town also experience significant flooding during heavy rainfall events. Stormwater systems are currently inadequate to handle the volume of precipitation produced by these large rain events, resulting in impassible roadways, inaccessible parking lots and businesses, and stranded vehicles.

Repetitive Loss Properties and Damage to Coastal Buildings

The Town of Marshfield has experienced multiple severe flooding events in the last few years. Although the Town has many properties in high risk areas for flooding, not all of those properties have flood insurance; 60% of single-family homes in flood zones are currently uninsured. Even when property owners do have flood insurance, they are hesitant to file a claim, perhaps because they don't want to be labeled as a repetitive loss property. When repairs are completed, they are often done without assistance from flood insurance programs, and repairs are completed in piecemeal (i.e., the work constitutes less than 50% of the assessed value) so the structure is not required to comply with updated building code and flood zone regulations.

Green Harbor Dike and Tide Gates

Many of the working groups identified the tide gates located at Dyke Road in Green Harbor as important Town assets that provide flood control and protection for the upstream areas. Currently, there are four hinged tide gates, which all allow water to exit the marsh system when downstream water levels fall below the upstream water levels. On a rising tide, however, only one of the hinged tide gates allows flow back into the marsh, limiting overall tidal exchange. In 2007, the Town completed an evaluation of the Green Harbor tide gates, which recommended opening a second tide gate to bidirectional flow – this would improve tidal exchange without causing high tide water elevations to rise above a critical elevation that would result in flooding to surrounding assets. This study was referenced in a number of the small group discussions, and participants wondered if the recommendations from that study could be implemented. This study did not, however, consider the impacts of future sea level rise on the system. There is a concern that because the system only drains during a quarter of the tide (i.e., when the downstream water levels are lower than those upstream), as sea level rises, the amount of time that the system will be allowed to drain will be reduced. Any actions taken to modify the size or function of the tide gates would need to fully consider upstream and downstream ecological impacts, as well as the protection and stability of Dyke Road itself (this is a designated evacuation route, as well as being co-located with a water main).

Evacuation Routes

Currently the only designated emergency evacuation route in Marshfield is Route 139, which loops through Town from route 3A near the southwestern corner of Town to Route 3 in the northwestern part of Town. This designation is part of the larger Pilgrim Nuclear Power Plant regional evacuation plan. There was concern expressed among participants that there are significant areas of Town that are far removed from Route 139, and that sections of Route 139 are quite vulnerable to flooding. There was a recommendation that additional options and/or feeder roads be added as designated evacuation routes. Consideration should also be given to neighboring communities, such as Hummarock (Scituate) and Gurnet Road (Duxbury), which would need to evacuate through Marshfield. Once developed, there would also need to be effective communication with residents and visitors to inform them of the new designations and emergency preparation procedures.

Maintaining Healthy Habitats

Open space was identified as an important asset, particularly areas of estuaries and salt marshes. Participants expressed concern about increasing fragmentation of salt marshes, and a lack of suitable buffer areas available for salt marsh migration in the face of sea level rise given the substantial development around the existing salt marsh areas. These areas were recognized for their important ecosystem services, including ecological habitat, fisheries, flood water retention and water quality improvements. With the South River not currently meeting the standards for bacteria counts due to stormwater issues, protecting and enhancing these ecosystems becomes even more important. Fisheries and shellfish resources were also discussed as incredibly important to the Town; Green Harbor has one of the largest commercial fisheries landings in the state. Many participants expressed concern about how climate change impacts would impact the long-term sustainability of the area's fisheries resources.

There was also significant discussion about the importance of conservation and protection for the Town's upland open space (i.e., forested areas). Carolina Hill, a 775-acre area of forested conservation land, is the highest point on the South Shore, making it vulnerable to wind, fire and drought. Discussion centered around protecting this and other open space from fragmentation for the purpose of wildlife habitat protection and recreation.

Long-Range Planning

Participants considered the difficult questions of: In a catastrophic event, how would the Town respond? Would it be possible to rebuild? Would it be wise to even try? When does the Town recognize repeated loss as a time for planned and managed retreat? How do you decide when to take a property off the tax rolls? How can the added value of resilience be weighed against that financial loss to the Town? It was widely recognized among the small working groups that coastal homeowners, even when faced with repeated damages and repairs, are reluctant to give up their homes, but that ultimately the status quo of constantly rebuilding structures in high hazard areas was not sustainable. Participants felt that the Town should develop long-term goals and targeted priorities for property acquisition.

Current Strengths and Assets

As a result of Marshfield'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.

- Effective inter-departmental communication and emergency response have proven to be key assets during recent natural hazards. Responsive and committed Town leadership and staff are an important asset to Marshfield, both in day-to-day operations, as well as during and immediately following a natural hazard or an emergency event.
- All four small working groups considered the Town's seawalls to be an important strength, providing the first line of storm defense for many coastal residents and roadways.
- The Town's well field, water towers and water distribution system provides a local, reliable source of drinking water.
- Healthy natural coastal ecosystems, including salt marshes, coastal beaches and dunes, and other wetland habitats, 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 Fire and Police Station, the Senior Center, and emergency shelters, such as Furnace Brook School.
- There are 16 churches located in Marshfield. With a high degree of engagement within the community, these facilities could be linked in to the current emergency response and sheltering network in the event of an emergency.

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.

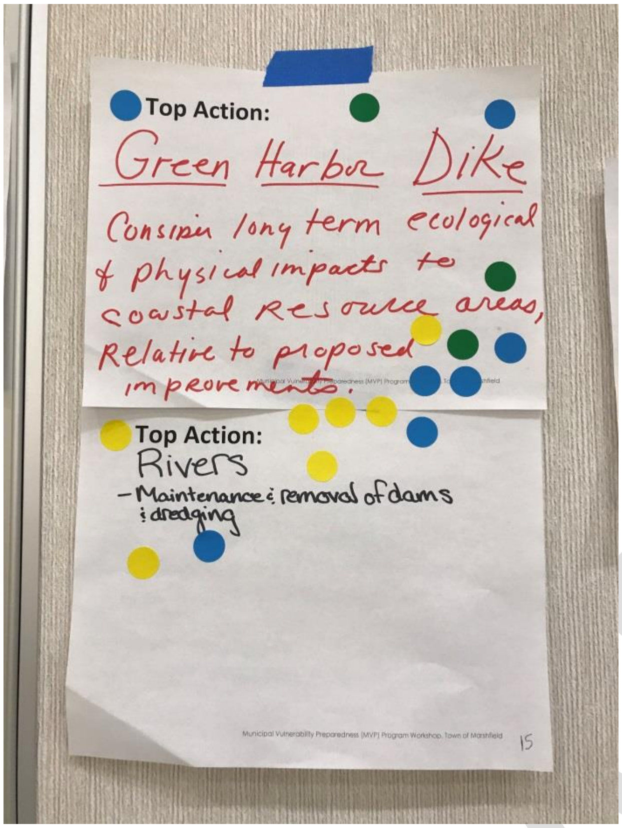
1. **Consider long-term benefits and impacts of in-river structures (e.g., Green Harbor Dike, dams):** Evaluate the long-term ecological and physical impacts to coastal resource areas relative to proposed Green Harbor Dike improvements. Consider whether it is best to maintain or remove existing dams. Consider how these structures influence dredging needs, specifically in Green Harbor.

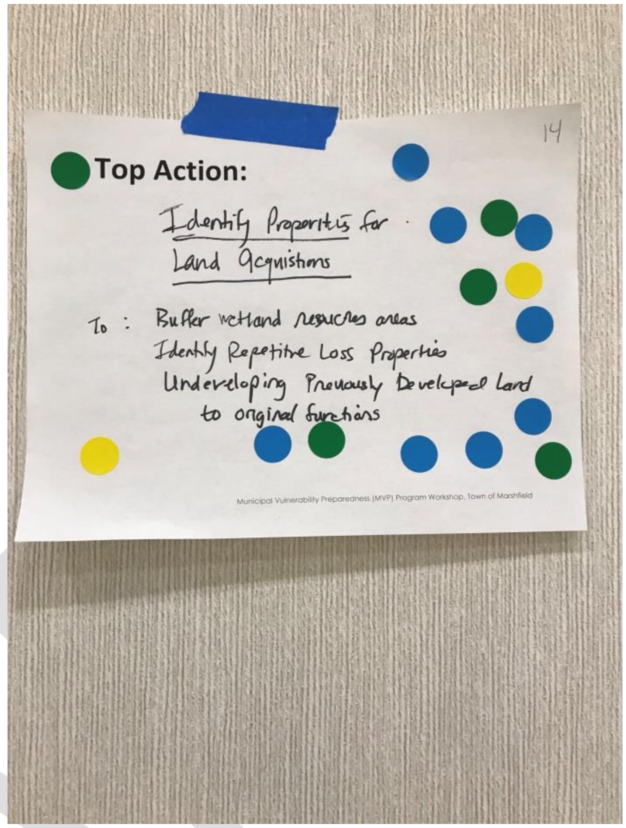
2. **Complete a study to prioritize mitigation for buildings in the SFHA:** Conduct a study to prioritize mitigation activities for buildings and properties within the flood zone. This would include collecting data on building type, age of structure, primary vs. secondary home, available elevation data, loss histories, insured vs. non-insured, damage costs within SFHA, cause of damages, and total building and property values. The town can then prioritize actions to mitigate and identify preventative measures that can be taken (e.g., building code or regulatory changes, SISD methods, etc.).

3. **Identify and Acquire Properties to Reduce Marshfield Flood Vulnerability:** Acquiring selected properties would help to buffer wetland resource areas, and by undeveloping previously developed land, especially on Repetitive Loss Properties, you can eliminate the risk of future damage to infrastructure and restore the land to its original functions.

4. **Beneficially Reuse Dredged Sediment for Beach Nourishment:** Continue to dredge Green Harbor on a regular basis but ensure that this material is not lost to the littoral system by disposing of it offshore; any beach-compatible sediment dredged from Marshfield should be beneficially reused as beach nourishment.

5. **Implement a Large-Scale Beach and Dune Nourishment Program:** Continue to seek funding to obtain the permits and resources necessary to implement the Marshfield Beach Management Plan recommendations, including large-scale beach and dune nourishment. Conduct a feasibility study, complete the necessary surveys, and obtain permits to implement beach nourishment, including obtaining the rights from property owners to nourish the beaches.


Top Action:
Green Harbor Dike
Consider long term ecological & physical impacts to coastal resource areas, Relative to proposed improvements.
Top Action:
Rivers
- Maintenance & removal of dams & dredging
15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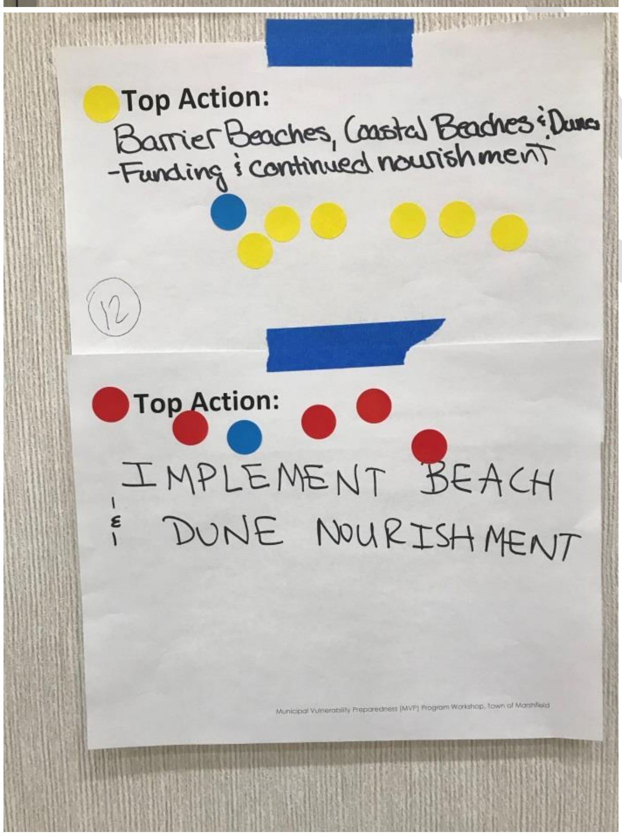
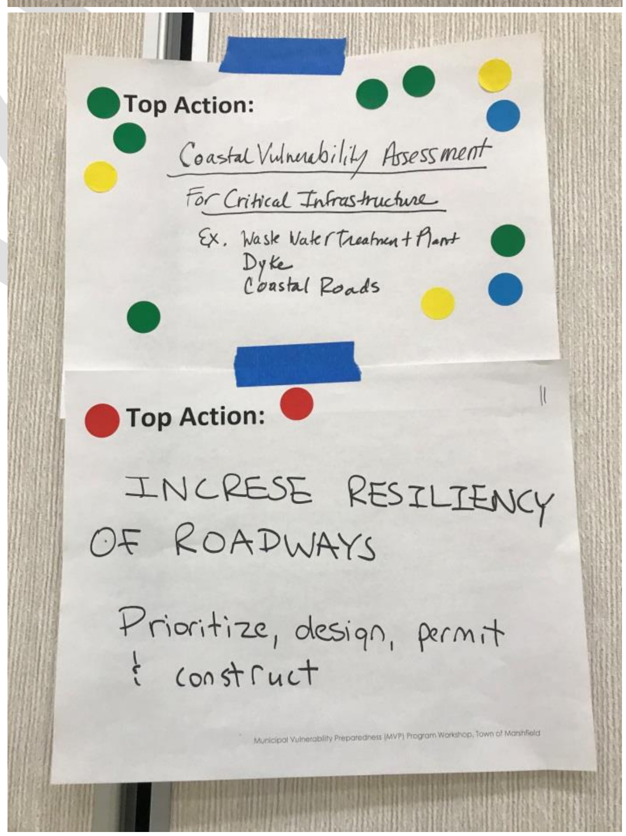
Top Action:
Identify Properties for Land Acquisitions
To: Buffer wetland resources areas
Identify Repetitive Loss Properties
Underdeveloping Previously Developed Land to original functions


Top Action:
Barrier Beaches, Coastal Beaches & Dunes
-Funding & continued nourishment
12
Top Action:
IMPLEMENT BEACH & DUNE NOURISHMENT


Top Action:
Coastal Vulnerability Assessment
For Critical Infrastructure
Ex. Waste Water Treatment Plant
Dyke
Coastal Roads
11
Top Action:
INCRESE RESILIENCY OF ROADWAYS
Prioritize, design, permit & construct

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:

- **Complete a coastal vulnerability assessment for critical infrastructure**, including roadways, the wastewater treatment plant, and the Green Harbor dike. As part of this study, develop next steps for prioritizing, designing, permitting and constructing recommended resiliency improving actions. Recommended actions could include replacing, maintaining, moving or protecting the vital infrastructure, such as the wastewater treatment systems, including sewer pump stations, the wastewater treatment plant itself, and ocean outfall.
- **Purchase and install a generator at Grace E. Ryder Housing**.
- **Incorporate resiliency planning into Town regulations and bylaws**. As a first step, this would involve identifying which regulations and bylaws are appropriate to incorporate resiliency planning. Resiliency additions could include, for example, a list of resiliency guidelines for development in flood zones.
- **Conduct a sewer line expansion study** to identity vulnerable neighborhoods that need access to improved wastewater treatment. This would involve identifying areas currently serviced by septic tanks that are, or will become increasingly vulnerable to flooding, changes in groundwater and/or saltwater intrusion due to sea level rise and increased flooding. Identified areas should be prioritized and ranked. The study should also address the potential need for an additional treatment plant, if the existing plant is already at or near capacity.
- **Maintain existing seawalls and shore protection infrastructure**. Repair and replace seawalls and shore protection structures as necessary. Explore opportunities to increase resilience in front of (e.g., beach nourishment) and behind the seawall. Continue to allocate funding for repair and replacement of existing structures. To this end, continue to identify and pursue grant opportunities for this work.
- **Improve emergency response and communication**. Upgrade cell and radio towers. As part of an improved emergency response, create an Emergency Animal Management Plan, to address issues related to pets and livestock during emergencies. In addition, work specifically to connect commercial businesses to the appropriate resources so business owners can better understand how to efficiently and cost-effectively recover from a hazard event.
- **Update the Water Protection Master Plan** to identify new aquifers and land protection needs.
- **Create a Master Stormwater Management Plan** to address insufficient drainage, water quality issues and flooding concerns.
- **Develop a long-range vision for Marshfield**. This would involve comprehensive community planning, streamlining existing planning documents, and creating a strategic public education and outreach campaign. By streamlining the existing plans and better communicating their purpose to the public, it is hoped that how these plans play off of each other and how are they moving the Town in the right direction can be better communicated.
- **Conduct an economic impacts study to evaluate climate change impacts on tourism**.

- **Develop a long-range plan for the Brant Rock area**. This could involve redesigning the area to protect it from flooding. This plan could also include incentivizing resiliency actions for private home and business owners, educating home and business owners about permitting avenues and funding for structure elevation, elevating roadways, construction of additional flood barriers or retaining walls, and/or seawall improvements. (yellow and green)
- **Evaluate the effectiveness of offshore breakwaters** to mitigate storm and wave impacts to the seawalls. (green)
- **Upgrade and/or replace the stormwater drainage system at the Library Plaza**. The existing system regularly overflows during heavy rain events. (red)
- **Fund education and certification for floodplain management of Town staff.** This would work towards developing a comprehensive internal permitting strategy for protections within the floodplain (e.g., interdepartmental meetings to review applications, hiring a certified floodplain manager, using check-list forms like FEMA480 to assist in application review, etc.)
- **Expand the coordination and regional planning** between Scituate, Marshfield, and Duxbury. This could include the identification of shared areas and resources, and having more consistent planning meetings to assess emergency response needs and to prepare for future hazard events. Improving communication would also help to bolster regional relationships during emergencies events.
- **Bolster and protect the local drivers of tourism**. Determine ways to bolster and protect natural resources, parking areas, historic structures, coastal beaches, and fishing/shellfishing grounds in the face of climate change to ensure economic sustainability of the town. As a waterfront community, these are the local drivers of tourism. Along with this, engage in public outreach to educate residents and visitors about the economic and environmental impacts climate change could have on these drivers and current town efforts to become more resilient in the face of climate change.
- **Enhance and restore salt marshes and other wetlands,** including rivers, fish runs and shellfish habitat. Identify opportunities for wetland restoration at degraded locations, as well as land acquisition opportunities where parcels could be un-developed and the natural wetland or buffer habitats restored to their original function, and habitat connectivity could be restored. This will provide areas for future salt marsh migration as sea level rises, increased flood water detention and wave attenuation, and improved habitat resiliency. Increase public education about the importance of protecting and restoring these habitats. To achieve this in the most cost-effective, targeted and feasible way, develop an overall management and protection plan for salt marshes and wetlands.
- **Improve/expand Marshfield's designated evacuation routes**. Currently, Marshfield's designated evacuation routes consist of only one road: Route 139. Additional feeder roads should be designated to make it clearer to residents in various parts of Town how best to evacuate if necessary. It may also be necessary to identify different evacuation plans for different types of hazards. For example, the routes and direction of evacuation due to a coastal flooding incident may be different from the best routes for evacuation if the Pilgrim power plant were to release radiation. Such a nuclear hazard could be an unexpected secondary impact

resulting from a natural hazard event. For example, flooding related to coastal storms could break the spent nuclear rods being stored at the site.

Other medium priority actions:

- Evaluate the feasibility for dry floodproofing the Wastewater Treatment Plant. If feasible, undergo necessary design, permitting, and construction steps.
- Improve the resiliency of the electrical utilities. This could include 1) increased redundancy, 2) tree trimming, 3) shifting infrastructure to underground utilities, and/or 4) more self-reliant electrical services, including potentially solar, wind, and hydro.
- Assess condition of existing stormwater infrastructure throughout Town and develop alternatives for expanded use of green infrastructure within the stormwater management system.
- Develop strategic education and outreach campaign and leverage partnerships to improve public understanding of community vulnerabilities and town-wide resilience planning. As part of this, educate coastal homeowners about how to prepare their homes and properties for storms and flooding.
- Designate municipal facilities as shelters and provide public education about emergency response at these facilities. Ensure these facilities have adequate facilities and supplies.
- Create a forestry management plan and seek funding for necessary forestry management actions. These could include access for fire roads, fire prevention activities, and/or trail evacuation plans.
- Acquire wetlands in the special flood hazard area (SFHA). Not only will this preserve valuable flood storage capacity and ecosystem services, but it infers an additional value to the Town since additional conservation open space causes the Town's CRS rating to go up.
- Prioritize and then seek grant funding for engineering design and permitting of culvert repair and/or replacement to enhance wetlands throughout Town.

Other low priority actions:

- Better document historic areas, determine maintenance and protection measures necessary to bolster them against future climate change and natural hazards, and implement necessary repairs/upgrades.
- Create an educational program for homeowners that rent to tourists (e.g., AirBnB) about how to notify guests about how to get emergency information.
- Increase education about sustainable agriculture, local food sources and reducing carbon footprints through 4-H programs.

CRB Workshop Participants

Below is a table of workshop participants.

Name	Department/Affiliation
Martine Anderson	Council on Aging
Ned Bangs	Trails Committee
Susan Caron	Friends of South River Park & Greenway Chair
Cindy Castro	Beach Com./Historic Society
Patrick Dello Russo	Treasurer/Collector
Michael DiMeo	Harbormaster
Bill Dodge	Marshfield Veterans Agent
Michelle Ferraro	Blackman's Point Homeowner's Assoc. Board Member
Karen Flanagan	Blackman's Point Homeowner's Assoc. President
Bill Grafton	Conservation Agent
Greg Guimond	Town Planner
Carol Hamilton	Council on Aging Director
Karen Horne	Resident
Jim Kilcoyne	Con Com Chair
Billy Last Jr.	Local Developer
Nick Lyons	Fire Department
Sue MacCallum	MassAudubon South Shore Sanctuaries Director
Michael Maresco	Town Administrator
Christine McCarthy	Town Accountant
Katie O'Donnell	Planning Board Vice-Chair
Karen O'Donnell	Open Space Committee
Nanci Porreca	CRS/ZBA
Rod Procaccino	DPW Engineer
Kay Ramsay	Exec. Planning Assistant
Tom Reynolds	DPW Superintendent
Courtney Rocha	MVP Program Regional Coordinator
Liam Rooney	Police Sergeant
Joe Rossi	CRS/MCC Chair
Arthur Shaw	Police Lieutenant
Jack Sullivan	NE Environmental Officer (FEMA)
Robert Valery	Health Depart. Director
Alyssa Young	MassAudubon

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

Department/Affiliation	Department/Affiliation
Marshfield Board of Selectmen	Marshfield Capital Budget Committee
Marshfield Building Department	Marshfield School Department
Marshfield Library	Marshfield Housing Authority
State Senators	Marshfield Chamber of Commerce
Old Colony Planning Council	GATRA
Wildlands Trust	Rockland Trust Boys & Girls Club
Town of Duxbury Planning Department	Trustees of Veterans Memorial Park

Recommended Citation

Town of Marshfield (2020) Community Resilience Building Workshop Summary of Findings, Woods Hole Group. Marshfield, Massachusetts.

CRB Workshop Project Team

<u>Town of Marshfield:</u>

- Greg Guimond, Town Planner (Project Lead – Principal Contact)
- Michael Maresco, Town Administrator (Core Team Member)
- Nanci Porreca, Zoning Board of Appeals (Core Team Member)
- Rod Procaccino, DPW (Core Team Member)
- Sue MacCallum, MassAudubon (Core Team Member)
- Louis Cipullo, Fire Department (Core Team Member)
- Bill Grafton, Conservation Department (Core Team Member)

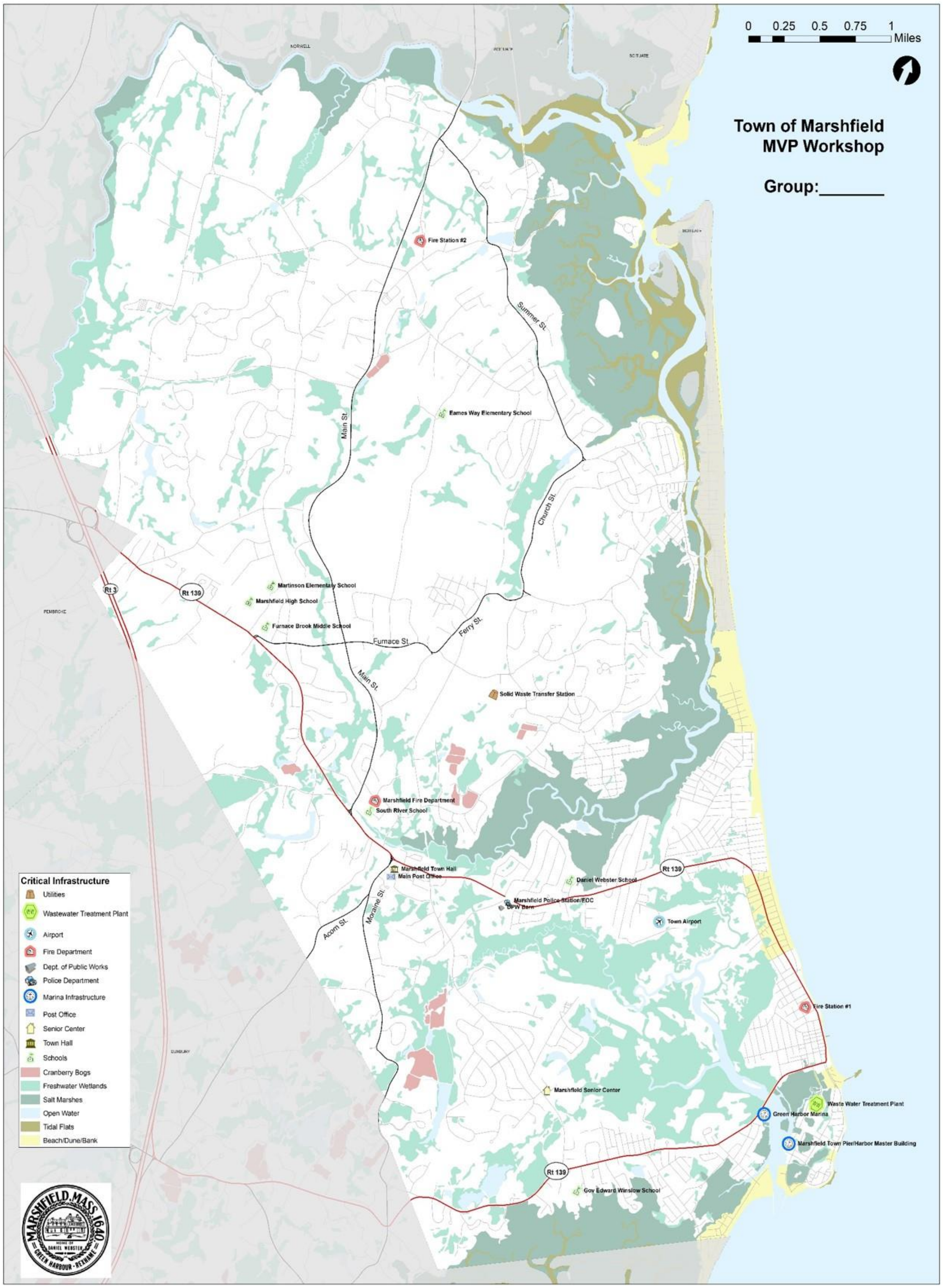
<u>Woods Hole Group:</u>

- Elise Leduc (Lead Facilitator)
- Leslie Fields (Small Group Facilitator)
- Adam Finkle (Small Group Facilitator)
- Brittany Hoffnagle (Small Group Facilitator)
- Kalinda Roberts (Small Group Facilitator)

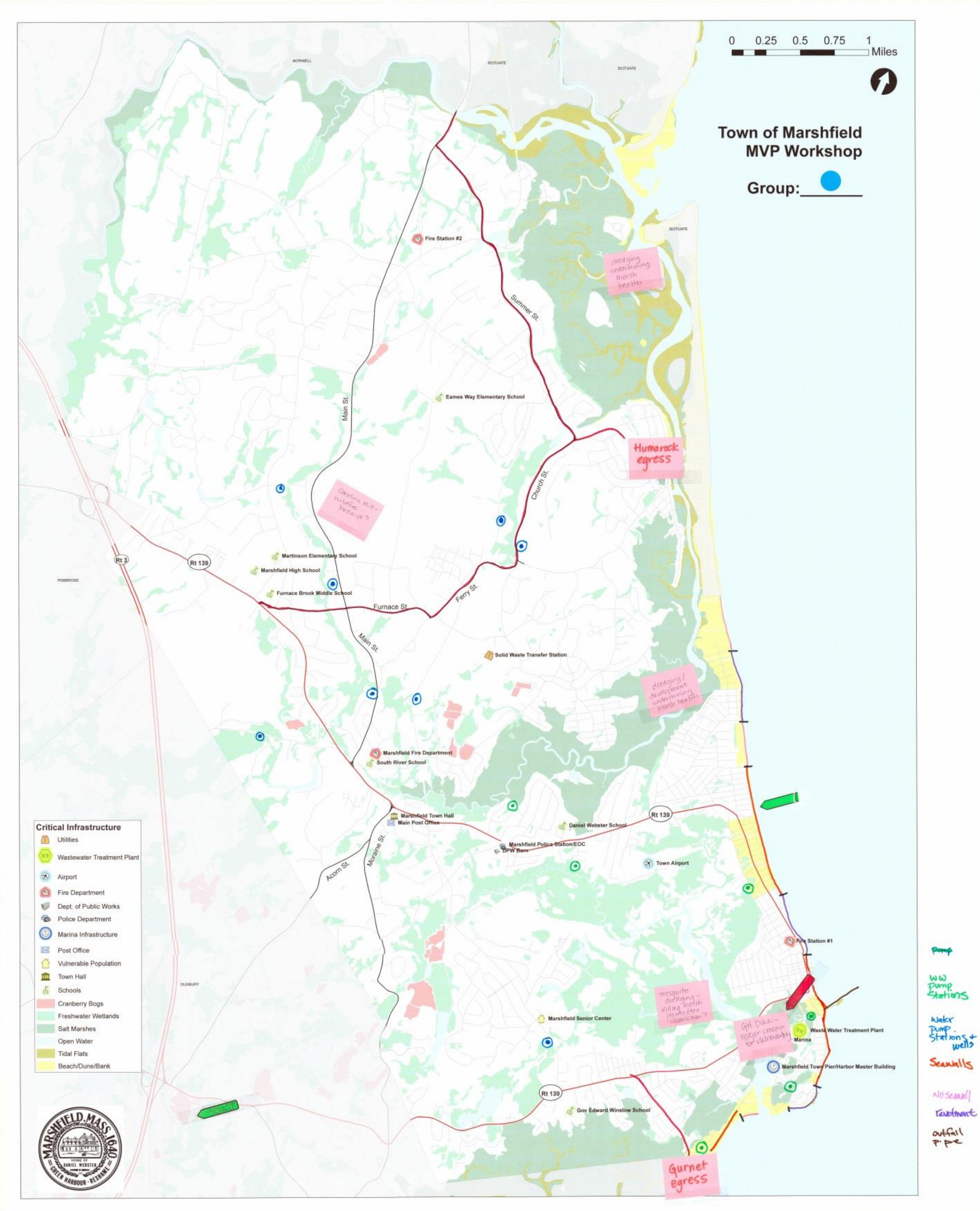
Acknowledgements

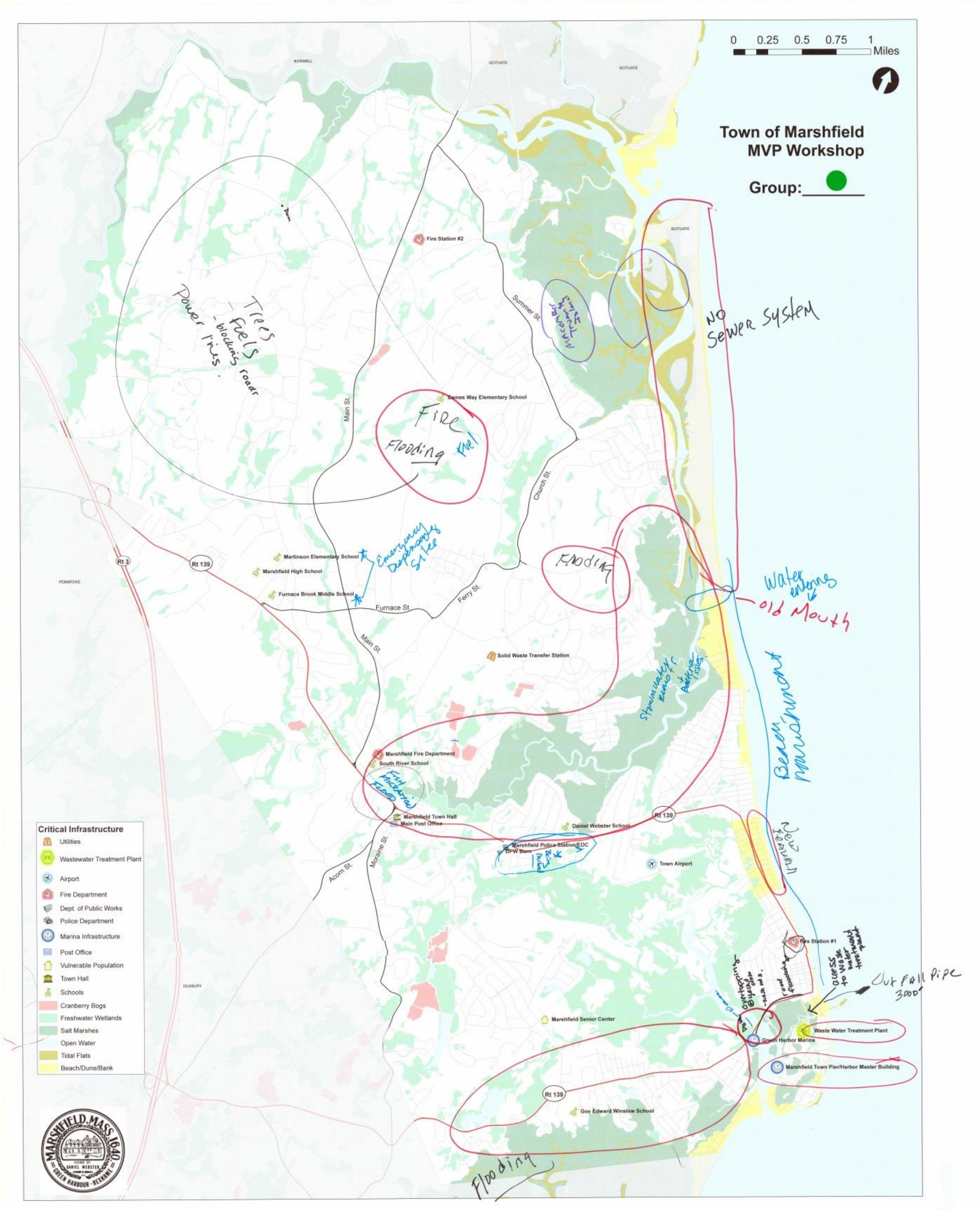
Special thanks to the Town of Marshfield for their willingness to embrace this process and engage a good cross section of workshop participants, in particular Greg Guimond and the rest of the municipal staff that comprised the core team. Finally, thank you to Carol Hamilton and the Marshfield Council on Aging for providing the Senior Center as a venue for the workshop. This project was made possible through funding from the Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program.

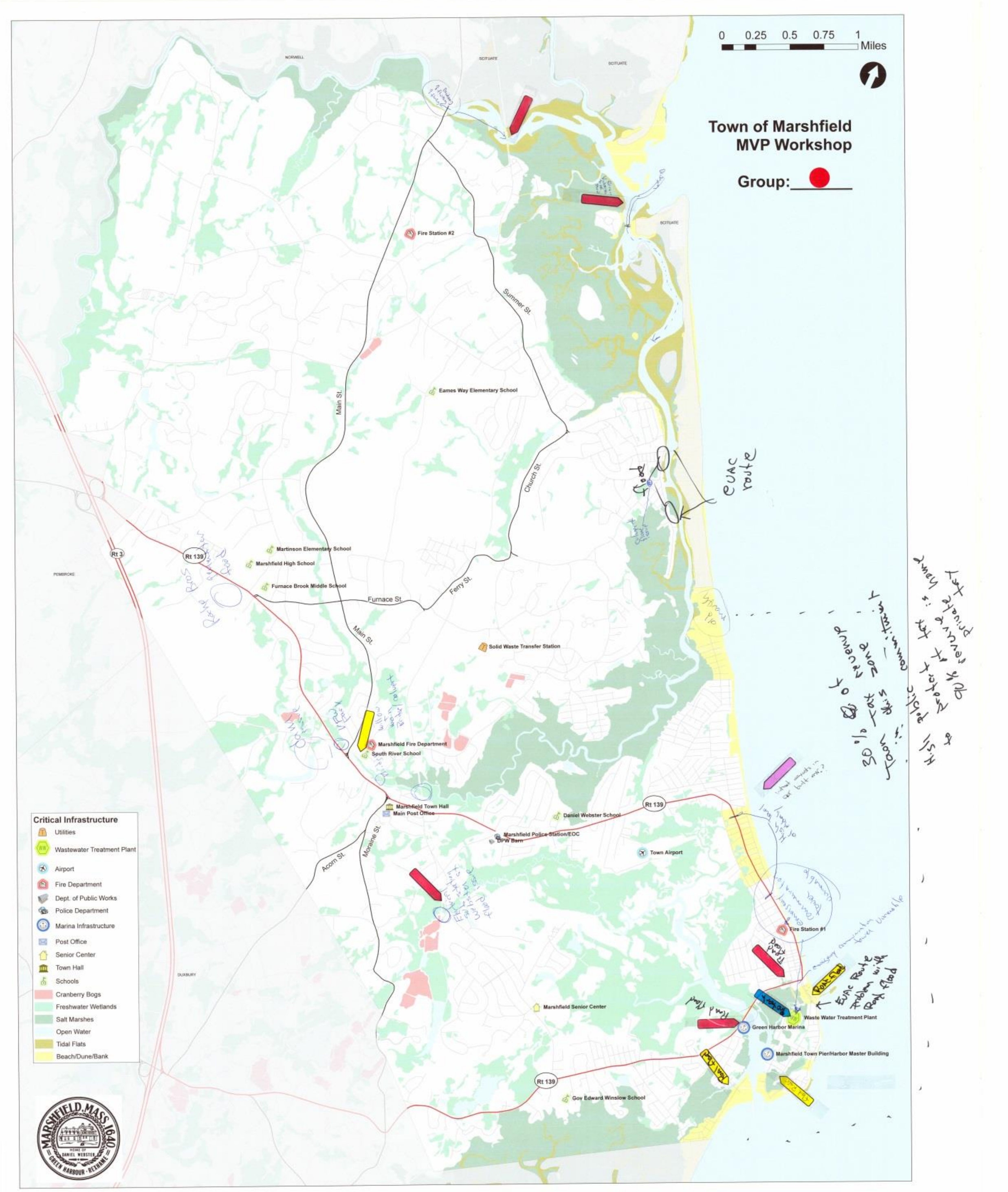
Appendix A: Workshop Base Map

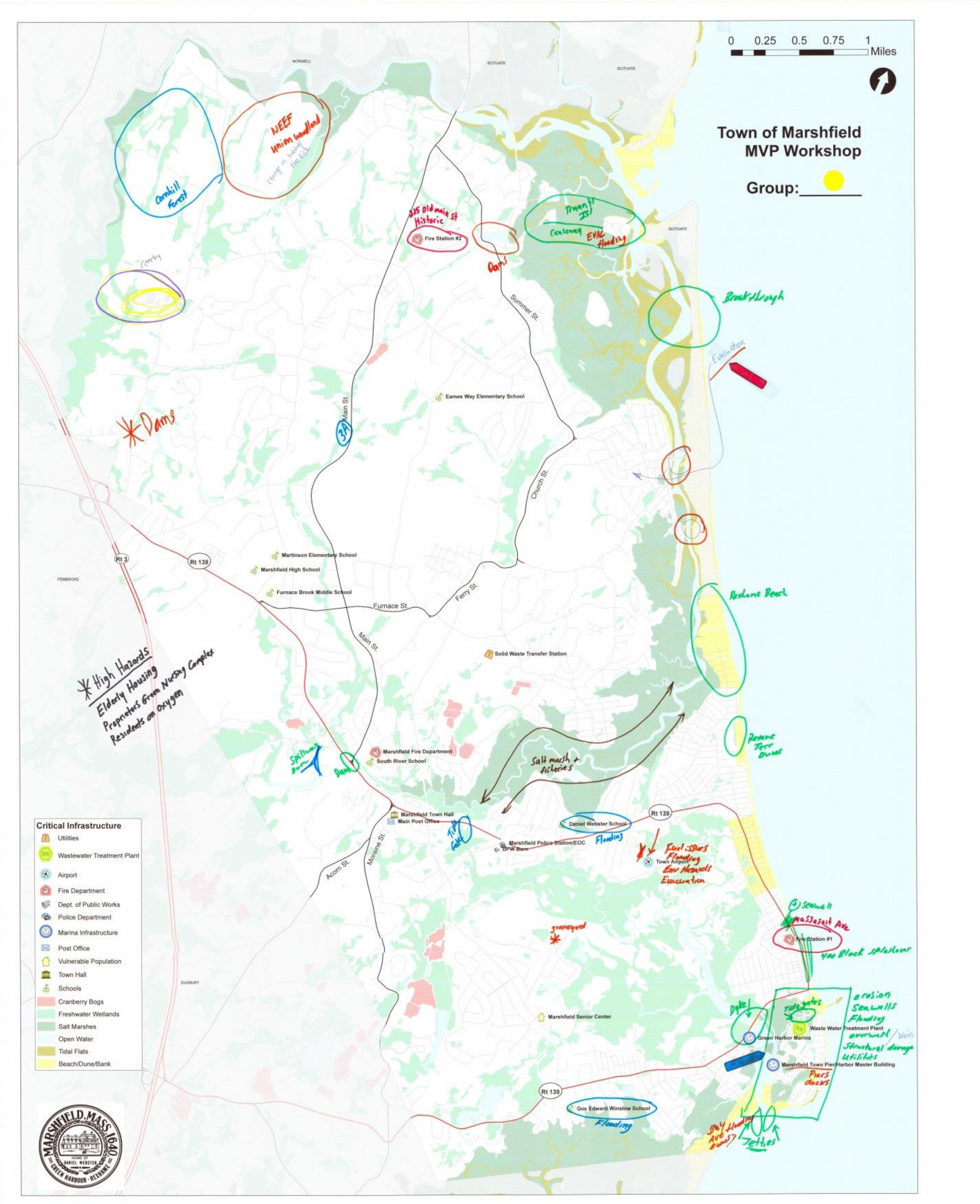

0 0.25 0.5 0.75 1
Miles
Town of Marshfield
MVP Workshop
Group:_______
Fire Station #2
Summer St.
Main St.
Eames Way Elementary School
Church St.
Martinson Elementary School
Marshfield High School
Furnace Brook Middle School
Rt 3
Rt 139
Furnace St.
Ferry St.
Solid Waste Transfer Station
Marshfield Fire Department
South River School
Marshfield Town Hall
Main Post Office
Daniel Webster School
Marshfield Police Station/EOC
DPW Barn
Town Airport
Acorn St.
Moraine St.
Fire Station #1
Marshfield Senior Center
Green Harbor Marina
Waste Water Treatment Plant
Marshfield Town Pier/Harbor Master Building
Gov Edward Winslow School
Critical Infrastructure
Utilities
Wastewater Treatment Plant
Airport
Fire Department
Dept. of Public Works
Police Department
Marina Infrastructure
Post Office
Senior Center
Town Hall
Schools
Cranberry Bogs
Freshwater Wetlands
Salt Marshes
Open Water
Tidal Flats
Beach/Dune/Bank

Appendix B: Participatory Mapping Results


Town of Marshfield
MVP Workshop
Group:
0 0.25 0.5 0.75 1 Miles
NORWELL
SCITUATE
PEMBROKE
DUXBURY
Fire Station #2
Summer St.
Main St.
Eames Way Elementary School
Church St.
Martinson Elementary School
Marshfield High School
Furnace Brook Middle School
Furnace St.
Ferry St.
Rt 3
Rt 139
Solid Waste Transfer Station
Marshfield Fire Department
South River School
Marshfield Town Hall
Main Post Office
Marshfield Police Station/EOC
DPW Barn
Daniel Webster School
Town Airport
Acorn St.
Moraine St.
Fire Station #1
Waste Water Treatment Plant
Marina
Marshfield Town Pier/Harbor Master Building
Marshfield Senior Center
Gov Edward Winslow School
dredging undermining marsh health
Humarock egress
Gurnet egress
Critical Infrastructure
Utilities
Wastewater Treatment Plant
Airport
Fire Department
Dept. of Public Works
Police Department
Marina Infrastructure
Post Office
Vulnerable Population
Town Hall
Schools
Cranberry Bogs
Freshwater Wetlands
Salt Marshes
Open Water
Tidal Flats
Beach/Dune/Bank
Pump
WW Pump Stations
Water Pump Stations + wells
Seawalls
No seawall
revetment
outfall pipe


0 0.25 0.5 0.75 1
Miles
Town of Marshfield
MVP Workshop
Group:
Critical Infrastructure
Utilities
Wastewater Treatment Plant
Airport
Fire Department
Dept. of Public Works
Police Department
Marina Infrastructure
Post Office
Vulnerable Population
Town Hall
Schools
Cranberry Bogs
Freshwater Wetlands
Salt Marshes
Open Water
Tidal Flats
Beach/Dune/Bank
Fire Station #2
Eames Way Elementary School
Martinson Elementary School
Marshfield High School
Furnace Brook Middle School
Solid Waste Transfer Station
Marshfield Fire Department
South River School
Marshfield Town Hall
Main Post Office
Daniel Webster School
Marshfield Police Station/EOC
DPW Barn
Town Airport
Fire Station #1
Marshfield Senior Center
Green Harbor Marina
Waste Water Treatment Plant
Marshfield Town Pier/Harbor Master Building
Gov Edward Winslow School
Main St.
Summer St.
Church St.
Furnace St.
Ferry St.
Acorn St.
Moraine St.
Rt 3
Rt 139
PEMBROKE
DUXBURY
NORWELL
SCITUATE
Trees
- Fuels
- blocking roads
Power lines.
Fire
Flooding
Fuel
NO
Sewer System
Flooding
Water entering
old Mouth
Beach nourishment
Emergency Dependence Sites
Flooding
Out Fall Pipe
3000'


Town of Marshfield
MVP Workshop
Group:
0 0.25 0.5 0.75 1 Miles
Critical Infrastructure
Utilities
Wastewater Treatment Plant
Airport
Fire Department
Dept. of Public Works
Police Department
Marina Infrastructure
Post Office
Senior Center
Town Hall
Schools
Cranberry Bogs
Freshwater Wetlands
Salt Marshes
Open Water
Tidal Flats
Beach/Dune/Bank
Fire Station #2
Eames Way Elementary School
Martinson Elementary School
Marshfield High School
Furnace Brook Middle School
Solid Waste Transfer Station
Marshfield Fire Department
South River School
Marshfield Town Hall
Main Post Office
Daniel Webster School
Marshfield Police Station/EOC
DPW Barn
Town Airport
Fire Station #1
Marshfield Senior Center
Green Harbor Marina
Waste Water Treatment Plant
Marshfield Town Pier/Harbor Master Building
Gov Edward Winslow School
Main St.
Summer St.
Church St.
Ferry St.
Furnace St.
Acorn St.
Moraine St.
Rt 3
Rt 139
evac route
flood
30% of revenue
Tax zone
MARSHFIELD MASS 1640


Town of Marshfield
MVP Workshop
Group:
0 0.25 0.5 0.75 1 Miles
Critical Infrastructure
Utilities
Wastewater Treatment Plant
Airport
Fire Department
Dept. of Public Works
Police Department
Marina Infrastructure
Post Office
Vulnerable Population
Town Hall
Schools
Cranberry Bogs
Freshwater Wetlands
Salt Marshes
Open Water
Tidal Flats
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Main Post Office
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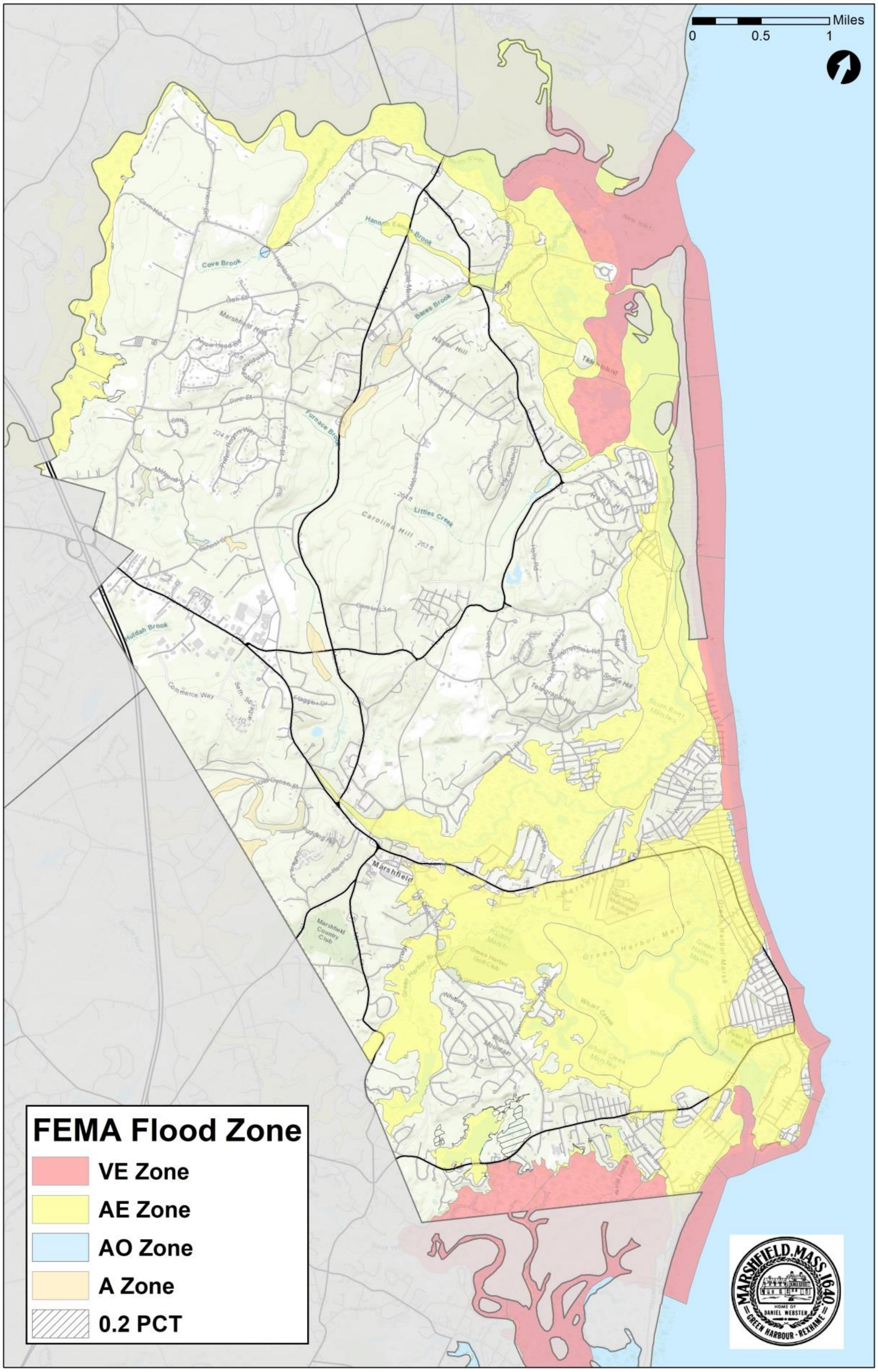
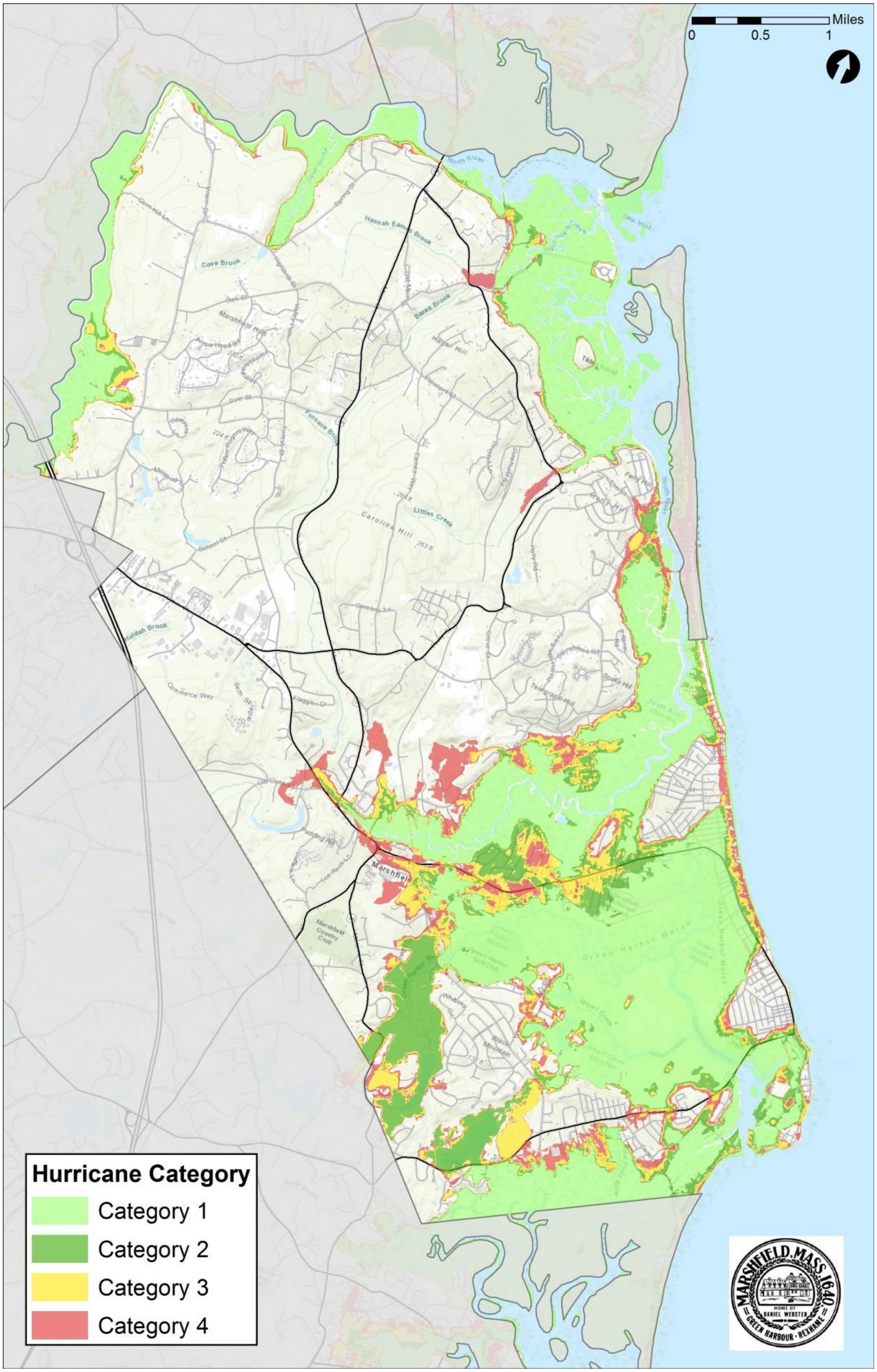
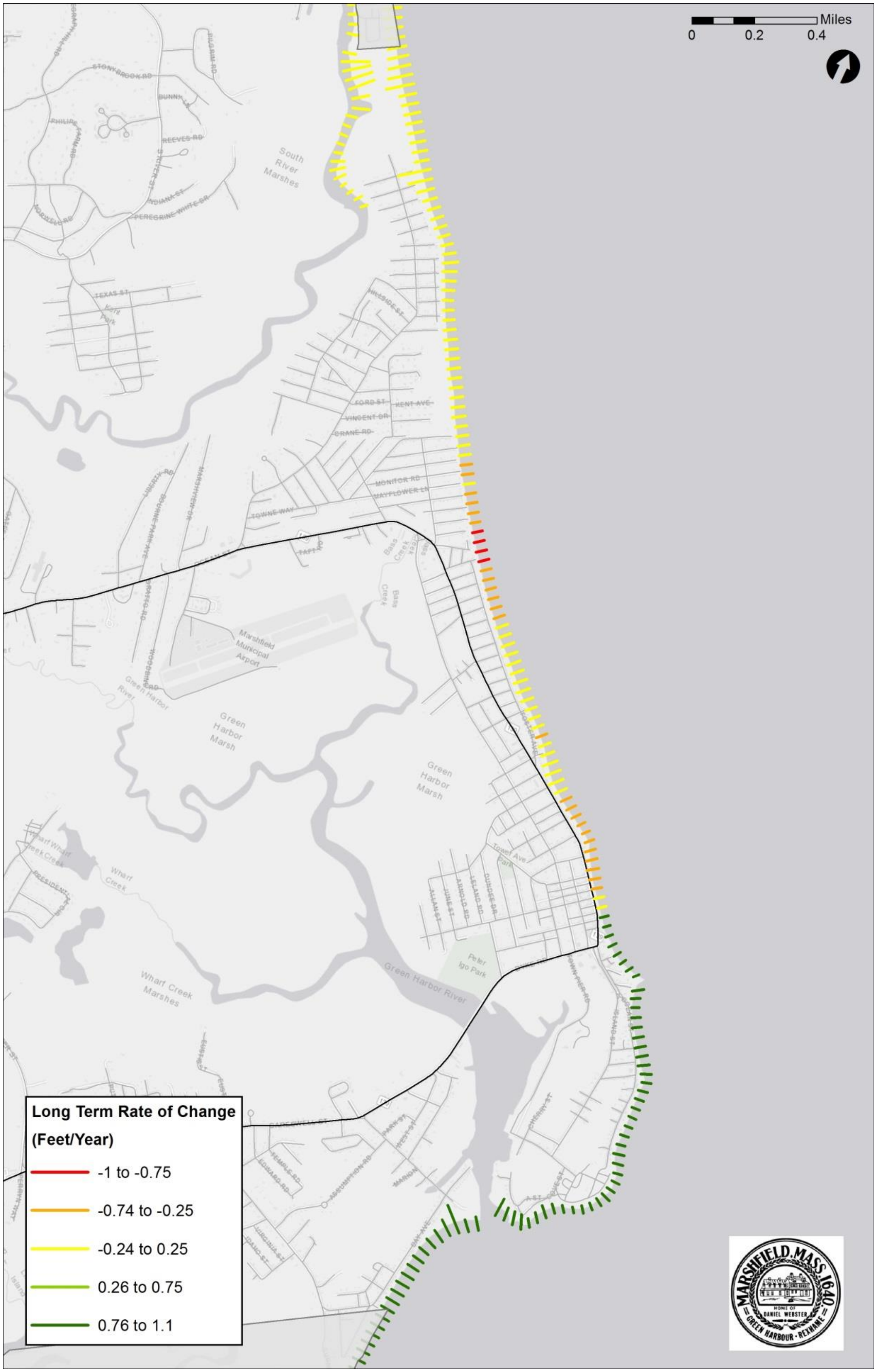
DPW Barn
Daniel Webster School
Town Airport
Marshfield Senior Center
Green Harbor Marina
Waste Water Treatment Plant
Marshfield Town Pier/Harbor Master Building
Gov Edward Winslow School
Fire Station #1
Summer St.
Main St.
Church St.
Furnace St.
Ferry St.
Acorn St.
Moraine St.
Rt 3
Rt 139
NORWELL
SCITUATE
PEMBROKE
DUXBURY
Cornhill Forest
NEEF
Union Woodland
Dams
Brant Rock
Rexhame Beach
Salt marsh + fisheries
High Hazards
Elderly Housing
Proprietors Green Nursing Complex
Residents on Oxygen
Flooding
graveyard
Seawall
Massasoit Ave
erosion
Seawalls
Flooding
Structural damage
Utilities
Piers
docks
Jetties
Dyke
Tide gates
Evacuation

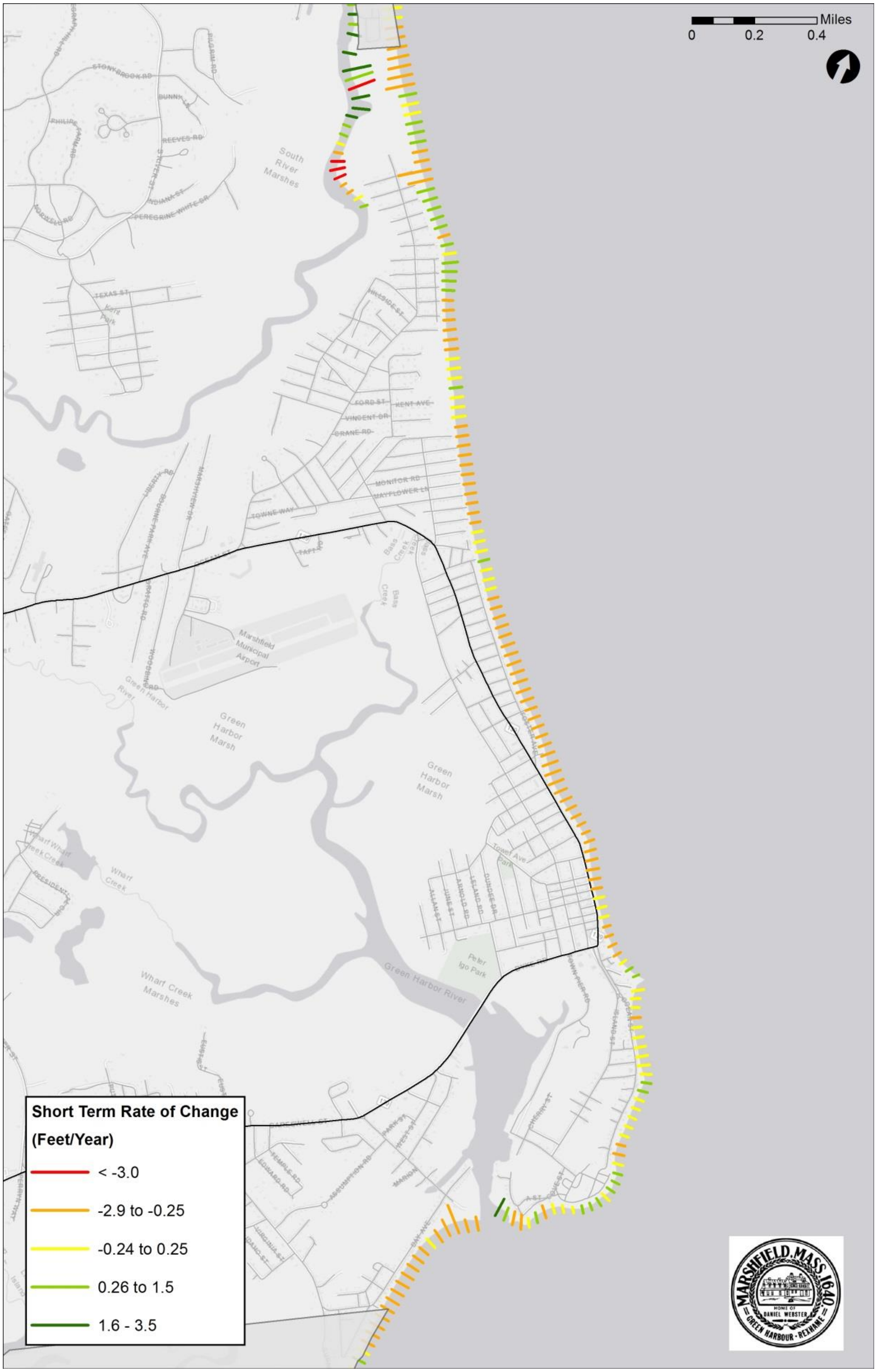
Appendix C: Marshfield Risk Maps Used During Workshop

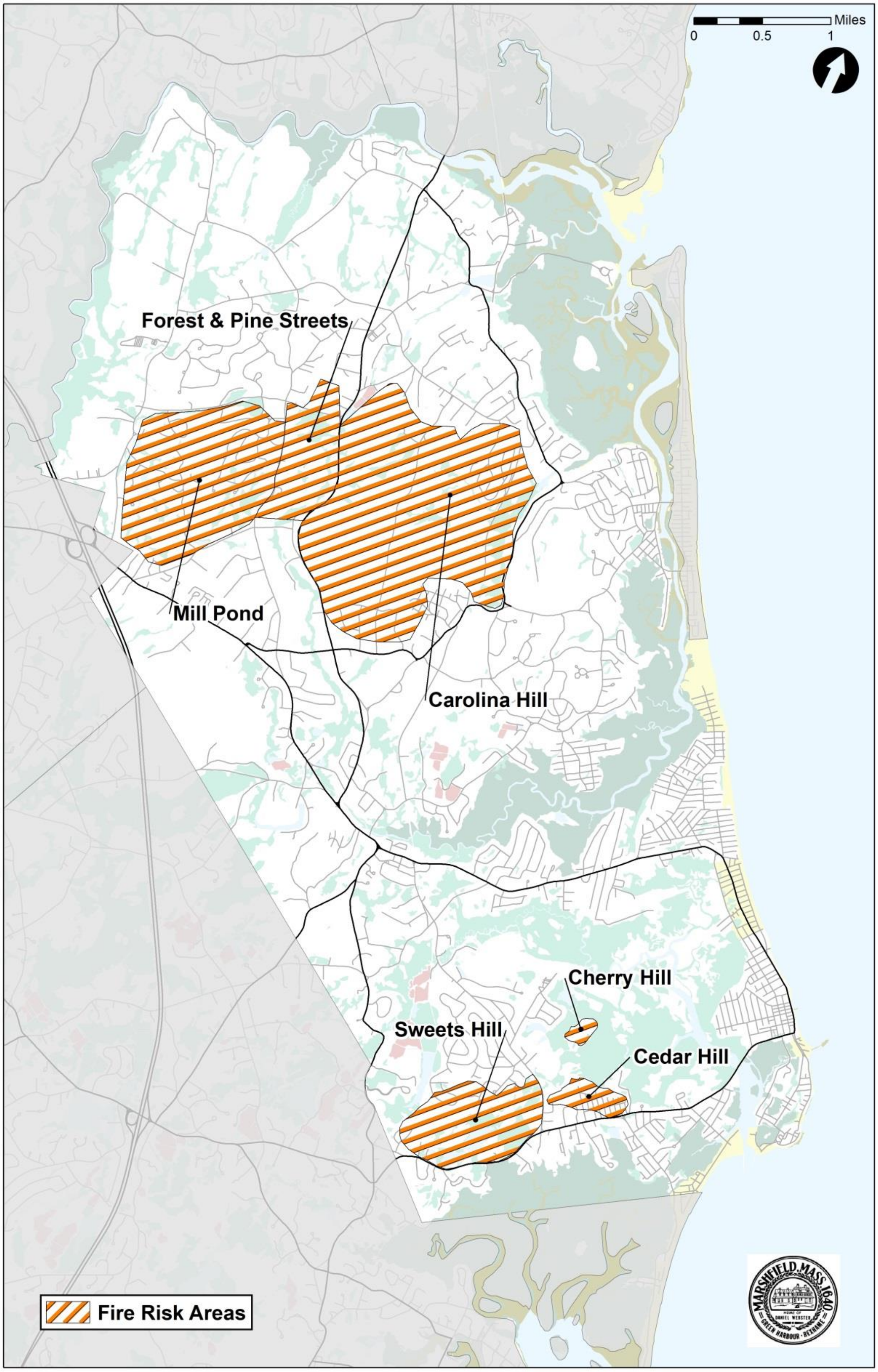
(Given as workshop handouts)

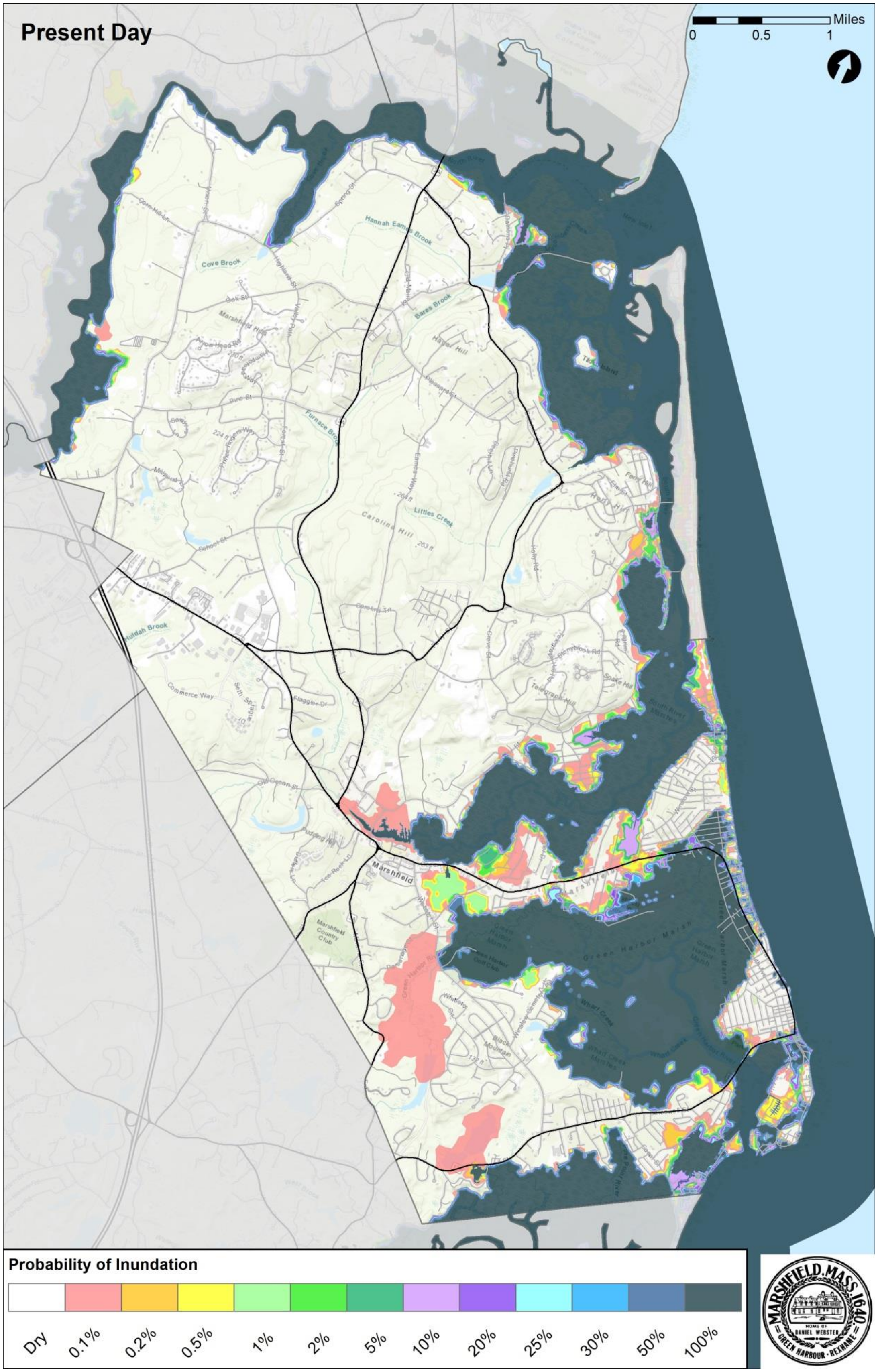

Miles
0
0.5
1
FEMA Flood Zone
VE Zone
AE Zone
AO Zone
A Zone
0.2 PCT

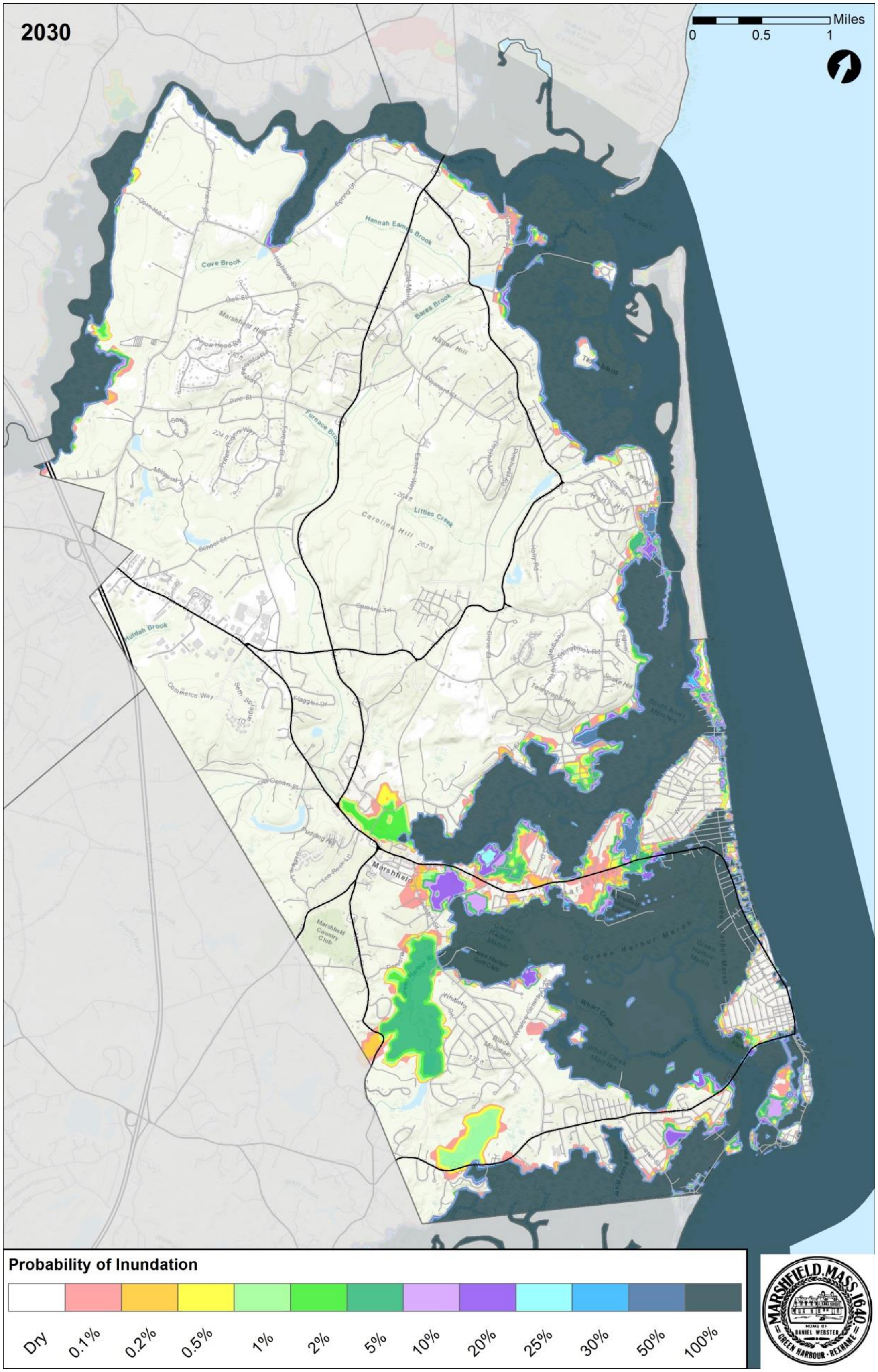

Miles
0
0.5
1
Hurricane Category
Category 1
Category 2
Category 3
Category 4
MARSHFIELD, MASS. 1640

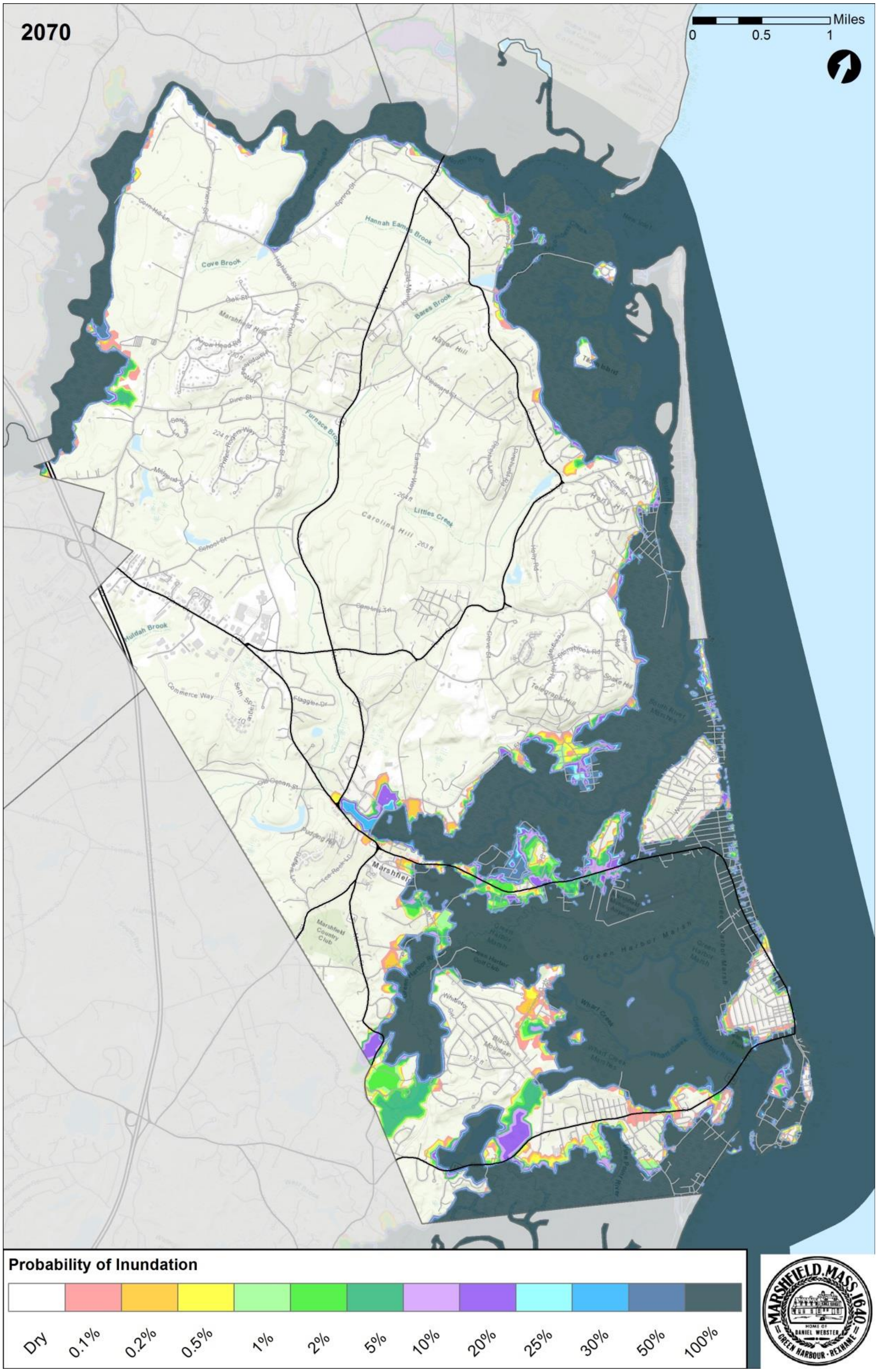

Miles
0
0.2
0.4
Long Term Rate of Change
(Feet/Year)
-1 to -0.75
-0.74 to -0.25
-0.24 to 0.25
0.26 to 0.75
0.76 to 1.1
South River Marshes
Marshfield Municipal Airport
Green Harbor Marsh
Green Harbor Marsh
Wharf Creek Marshes
Green Harbor River
Peter Igo Park


Miles
0
0.2
0.4
Short Term Rate of Change
(Feet/Year)
< -3.0
-2.9 to -0.25
-0.24 to 0.25
0.26 to 1.5
1.6 - 3.5
South River Marshes
Green Harbor Marsh
Green Harbor River
Wharf Creek Marshes
Marshfield Municipal Airport
Peter Igo Park


Miles
0
0.5
1
Forest & Pine Streets
Mill Pond
Carolina Hill
Cherry Hill
Sweets Hill
Cedar Hill
Fire Risk Areas


Present Day
Miles
0
0.5
1
Marshfield
Probability of Inundation
Dry
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%

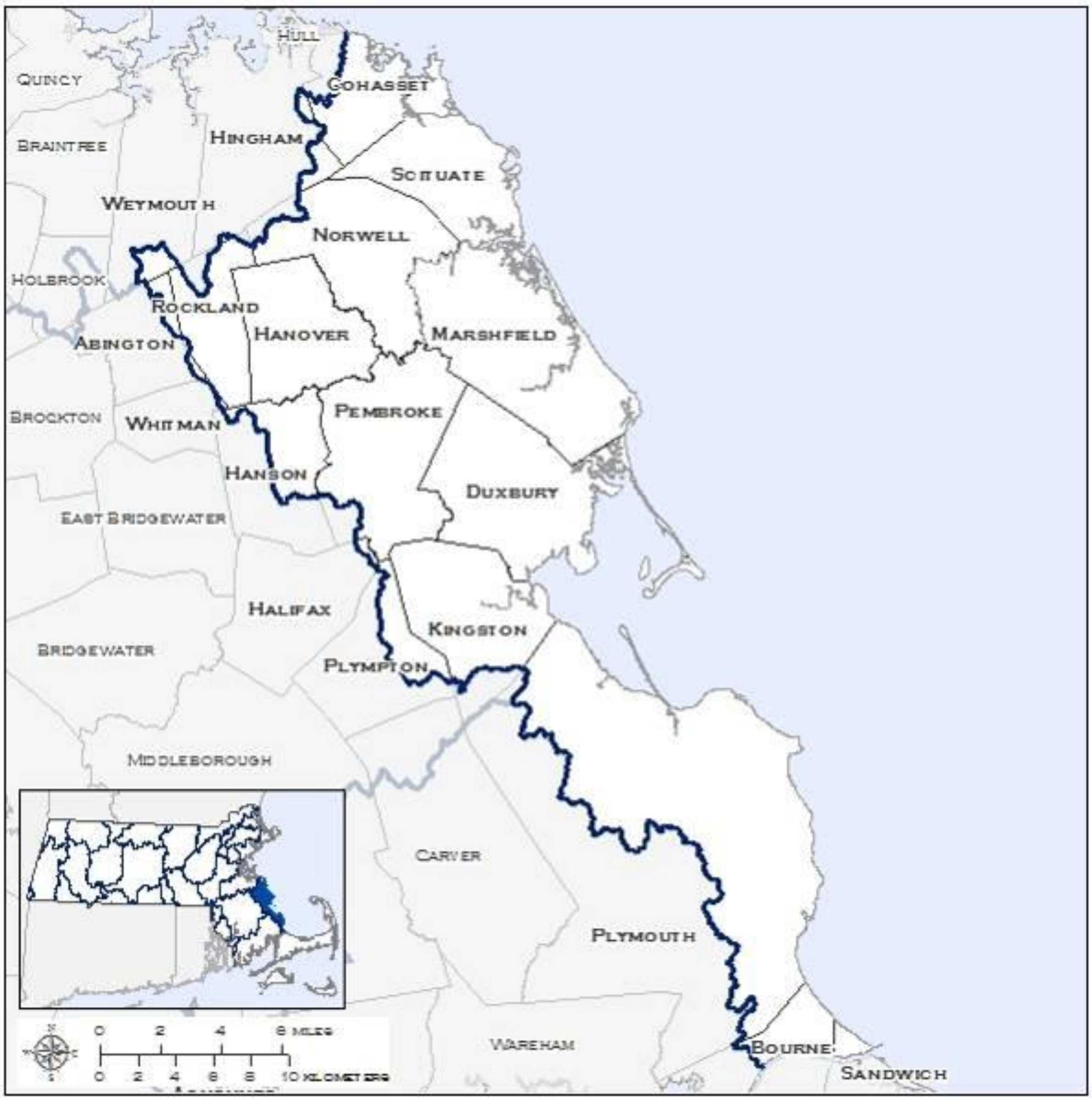

2030
Miles
0
0.5
1
Probability of Inundation
Dry
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%


2070
Miles
0
0.5
1
Probability of Inundation
Dry
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%

Appendix D: Massachusetts Updated Climate Projections
(Given as workshop handouts)

SOUTH COASTAL BASIN

MUNICIPALITIES WITHIN SOUTH COASTAL BASIN:
Abington, Bourne, Cohasset, Duxbury, Halifax, Hanover, Hanson, Hingham, Kingston, Marshfield, Norwell, Pembroke, Plymouth, Plympton, Rockland, Sandwich, Scituate, Weymouth, and Whitman



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.

SOUTH COASTAL

South Coastal 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	49.7	+1.9	to	+3.7	+2.6	to	+5.8	+2.9	to	+8.5	+3.2	to	+10.3
	Winter	30.3	+1.9	to	+4.1	+2.6	to	+6.3	+3.2	to	+8.3	+3.5	to	+9.8
	Spring	46.7	+1.8	to	+3.5	+2.4	to	+5.6	+2.7	to	+7.8	+3.2	to	+9.5
	Summer	69.1	+1.5	to	+3.7	+2.0	to	+6.1	+2.6	to	+9.2	+3.2	to	+11.4
	Fall	52.4	+2.0	to	+4.2	+3.3	to	+6.2	+3.0	to	+8.8	+3.6	to	+10.9
Maximum Temperature	Annual	59.5	+1.8	to	+3.6	+2.4	to	+5.7	+2.6	to	+8.5	+2.9	to	+10.2
	Winter	62.2	+1.9	to	+4.3	+3.1	to	+6.3	+2.9	to	+8.8	+3.3	to	+11.0
	Spring	56.7	+1.7	to	+3.4	+2.1	to	+5.4	+2.6	to	+7.9	+3.0	to	+9.4
	Summer	79.1	+1.4	to	+3.5	+1.9	to	+6.0	+2.5	to	+9.3	+2.9	to	+11.4
	Fall	62.2	+1.9	to	+4.3	+3.1	to	+6.3	+2.9	to	+8.8	+3.3	to	+11.0
Minimum Temperature	Annual	40.0	+2.0	to	+3.8	+2.8	to	+5.9	+3.2	to	+8.5	+3.5	to	+10.5
	Winter	21.1	+2.2	to	+4.4	+3.0	to	+6.7	+3.7	to	+9.0	+4.0	to	+10.5
	Spring	36.8	+1.8	to	+3.6	+2.7	to	+5.8	+2.7	to	+7.6	+3.3	to	+9.4
	Summer	59.1	+1.6	to	+3.8	+2.2	to	+6.3	+2.7	to	+9.1	+3.4	to	+11.3
	Fall	42.6	+2.0	to	+4.5	+3.4	to	+6.1	+3.2	to	+8.8	+3.8	to	+10.9

- The South Coastal 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 1.9 °F to 6 °F (2-8% increase); end of century increase of 2.9 °F to 11.4 °F (4-14% increase).
    - Fall mid-century increase of 3.1 °F to 6.3 °F (5-10% increase); end of century increase by and 3.3 °F to 11.0 °F (5-18% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 3.3 °F to 7.8 °F (14-32% increase); end of century increase by 4.6 °F to 10.9 °F (19-50% increase).
    - Fall mid-century of 3.6 °F to 6.6 °F (8-14% increase); end of century increase of 4.1°F to 11.6 °F (9-26% increase).

SOUTH COASTAL BASIN

South Coastal 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**	5	+4 to +11	+5 to +23	+7 to +41	+9 to +58
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	<1[90]	+<1[90] to +1	+<1[90] to +1	+<1[90] to +2	+<1[90] to +3
	Summer	5	+3 to +10	+4 to +20	+6 to +35	+8 to +47
	Fall	<1[90]	+<1[90] to +1	+1 to +3	+1 to +6	+1 to +8
Days with Maximum Temperature Over 95°F	**Annual**	1	+1 to +4	+1 to +9	+2 to +18	+3 to +31
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[90]	+<1[90] to +<1[90]	+<1[90] to +1	+<1[90] to +1
	Summer	1	+1 to +4	+1 to +8	+2 to +16	+3 to +27
	Fall	0	+<1[90] to +<1[90]	+<1[90] to +1	+<1[90] to +2	+<1[90] to +3
Days with Maximum Temperature Over 100°F	**Annual**	<1[90]	+<1[90] to +1	+<1[90] to +3	+<1[90] to +5	+<1[90] to +10
	Winter	0	+0 to +0	+0 to +0	+0 to +0	+0 to +0
	Spring	0	+0 to +<1[90]	+0 to +<1[90]	+0 to +<1[90]	+0 to +<1[90]
	Summer	<1[90]	+<1[90] to +1	+<1[90] to +2	+<1[90] to +5	+<1[90] to +9
	Fall	0	+0 to +<1[90]	+0 to +<1[90]	+0 to +<1[90]	+0 to +1

- Due to projected increases in average and maximum temperatures throughout the end of the century, the South Coastal basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the South Coastal basin is expected to see days with daily maximum temperatures over 90 °F increase by 5 to 23 more days by mid-century, and 9 to 58 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 4 to 20 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the South Coastal basin is expected to have 8 to 47 more days.

[90] Over the observed period, there were some years with at least 1 day with seasonal Tmax over a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

SOUTH COASTAL BASIN

South Coastal 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	2	-0 to -1	-1 to -1	-1 to -1	-1 to -1
	Winter	2	-0 to -1	-1 to -1	-1 to -1	-1 to -1
	Spring	0	-0 to +<1[91]	-0 to -0	-0 to -0	-0 to -0
	Summer	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
Days with Minimum Temperature Below 32°F	Annual	125	-13 to -27	-17 to -42	-21 to -55	-22 to -66
	Winter	77	-4 to -9	-5 to -16	-7 to -25	-8 to -33
	Spring	30	-4 to -11	-7 to -15	-8 to -19	-9 to -20
	Summer	0	-0 to -0	-0 to -0	-0 to -0	-0 to -0
	Fall	18	-4 to -8	-6 to -10	-7 to -13	-7 to -15

- Due to projected increases in average and minimum temperatures throughout the end of the century, the South Coastal 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 5 to 16 fewer days by mid-century, and 8 to 33 fewer days by end of century.
    - Spring is expected to have 7 to 15 fewer days by mid-century, and 9 to 20 fewer days by end of century.
    - Fall is expected to have 6 to 10 fewer days by mid-century, and 7 to 15 fewer days by end of century.

[91] Over the observed period, there were some years with at least 1 day with seasonal Tmin under a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

SOUTH COASTAL BASIN

South Coastal 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	6147	-492	to	-968	-682	to	-1438	-792	to	-1940	-857	to	-2311
	Winter	3146	-174	to	-374	-223	to	-571	-286	to	-753	-316	to	-891
	Spring	1697	-151	to	-294	-201	to	-463	-226	to	-633	-283	to	-741
	Summer	94	-29	to	-54	-40	to	-69	-42	to	-80	-50	to	-85
	Fall	1201	-136	to	-306	-242	to	-408	-227	to	-584	-249	to	-666
Cooling Degree-Days (Base 65°F)	Annual	543	+180	to	+379	+239	to	+674	+283	to	+1080	+334	to	+1400
	Winter	0	-1	to	+3	-2	to	+7	-1	to	+3	-1	to	+7
	Spring	17	+13	to	+27	+16	to	+51	+19	to	+83	+19	to	+116
	Summer	473	+107	to	+287	+146	to	+493	+191	to	+765	+237	to	+969
	Fall	52	+31	to	+85	+50	to	+160	+58	to	+246	+82	to	+324
Growing Degree-Days (Base 50°F)	Annual	2559	+364	to	+745	+483	to	+1165	+545	to	+1860	+631	to	+2337
	Winter	7	+1	to	+14	+2	to	+17	+6	to	+32	+6	to	+46
	Spring	270	+73	to	+145	+92	to	+246	+102	to	+376	+108	to	+487
	Summer	1759	+135	to	+337	+186	to	+558	+235	to	+845	+290	to	+1051
	Fall	522	+99	to	+266	+178	to	+405	+171	to	+606	+222	to	+760

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the South Coastal 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 7-18% (223 -571 degree-days) by mid-century, and a decrease of 10-28% (316 -891 degree-days) by the end of century.
  - The spring season is expected to decrease in heating degree-days by 12-27% (201-463 degree-days) by mid-century, and by 14-44% (283 -741 degree-days) by the end of century.
  - The fall season is expected to decreases in heating degree-days by 20-34% (242 -408 degree-days) by mid-century, and by 21-55% (249 -666 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 31-104% (146 -493 degree-days) by mid-century, and by 50-205% (237 - 969 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 11-32% (186 -558 degree-days) by mid-century, and by 16-60% (290 -1051 degree-days) by end of century.
  - Spring is expected to see an increase by 34-91% (92 -246 degree-days) by mid-century and 40-180% (108 -487 degree-days) by end of century.
  - Fall is expected to see an increase by 34-78% (178 -405 degree-days) by mid-century and 43-146% (222 -760 degree-days) by end of century.

SOUTH COASTAL BASIN

South Coastal 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	9	+<1[92] to +2	+1 to +3	+1 to +3	+1 to +4
	Winter	2	-0 to +1	+<1[92] to +1	+<1[92] to +1	+<1[92] to +2
	Spring	2	-0 to +1	+<1[92] to +1	+<1[92] to +1	+<1[92] to +1
	Summer	2	-0 to +1	+<1[92] to +1	-0 to +1	-0 to +1
	Fall	3	-0 to +1	-0 to +1	-0 to +1	-0 to +1
Days with Precipitation Over 2"	Annual	1	-0 to +1	+<1[92] to +1	+<1[92] to +1	+<1[92] to +1
	Winter	<1[92]	-0 to +<1[92]	-0 to +<1[92]	+0 to +<1[92]	-0 to +<1[92]
	Spring	<1[92]	-0 to +<1[92]	-0 to +<1[92]	+<1[92] to +<1[92]	+<1[92] to +<1[92]
	Summer	<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]
	Fall	<1[92]	-0 to +<1[92]	-0 to +<1[92]	+<1[92] to +<1[92]	-0 to +<1[92]
Days with Precipitation Over 4"	Annual	<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]
	Winter	0	-0 to +0	-0 to +0	-0 to +<1[92]	-0 to +<1[92]
	Spring	0	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]
	Summer	0	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]
	Fall	<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]	-0 to +<1[92]

- The projections for expected number of days receiving precipitation over one inch are variable for the South Coastal 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 either an increase in days with precipitation over one inch of 0-1 days by mid-century, and an increase of 0-2 days by the end of century.
  - The spring season is expected to see an increase in days with precipitation over one inch 0-1 days by mid-century, and of an increase of 0-1 days by the end of century.

[92] Over the observed period, there were some years with at least 1 day with seasonal precipitation over a certain threshold while in all the other years that threshold wasn't crossed seasonally at all.

SOUTH COASTAL BASIN

South Coastal 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	47.5	-0.2 to +3.9	+0.0 to +5.0	+0.3 to +6.2	-0.2 to +6.4
	Winter	12.5	-0.3 to +1.5	+0.1 to +1.9	+0.1 to +2.8	+0.1 to +3.7
	Spring	12.1	-0.1 to +1.8	-0.1 to +2.2	+0.1 to +2.4	+0.1 to +2.8
	Summer	10.4	-0.7 to +1.2	-0.7 to +1.8	-1.5 to +2.4	-2.1 to +2.3
	Fall	12.5	-0.9 to +1.1	-1.1 to +1.4	-1.7 to +1.7	-1.8 to +1.1

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the South Coastal basin.
  - The winter season is expected to experience the greatest change with an increase of 0-15% by mid-century, and of 0-30% 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 South Coastal or basin could see a decrease of 0.7 to an increase of 1.8 inches by mid-century (decrease of 7% to increase of 17%) and a decrease of 2.1 to an increase of 2.3 inches by the end of the century (decrease of 20% to increase of 22%).
    - The fall season projections for the South Coastal basin could see a decrease of 1.1 to an increase of 1.4 inches by mid-century (decrease of 9% to increase of 11%) and a decrease of 1.8 to an increase of 1.1 inches by the end of the century (decrease of 15% to increase of 9%).

South Coastal 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	17	-1 to +2	-0 to +3	-1 to +3	-0 to +4
	Winter	10	-0 to +2	-1 to +2	-1 to +2	-1 to +2
	Spring	11	-1 to +1	-1 to +1	-1 to +1	-1 to +2
	Summer	14	-1 to +2	-1 to +2	-1 to +3	-1 to +4
	Fall	13	+0 to +3	+0 to +3	-0 to +3	-0 to +3

- 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 South Coastal 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 an increase of 0-3 days in consecutive dry days by the end of the century.

Appendix E: Listening Session Public Comments