EASTHAM

2020 Hazard Mitigation Plan

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Introduction

The purpose of hazard mitigation is to reduce loss from future natural disasters. Storms and other natural disasters can cause loss of life, damage to buildings and infrastructure, and have devastating consequences to a community's economic, social, and environmental well-being. One step towards reducing loss in a community is to have a plan for the future. To accomplish this, most communities develop a local Hazard Mitigation Plan, also known as a single jurisdiction Hazard Mitigation Plan. Town officials, residents, and other local stakeholders develop the plan and, when completed, submit the document to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for their review and approval.

The purpose of the Eastham Hazard Mitigation Plan is to reduce damages resulting from natural hazards by implementing sustained actions to reduce or eliminate long-term risk to human life and property from hazards. The Eastham Hazard Mitigation Plan also helps build a successful, long-term outreach strategy to educate residents about natural hazards that could affect the town, to prepare them in case a storm impacts the town, and create a resilient town that can recover after a storm event. Town staff, residents, and local stakeholders worked together for several months to develop a single jurisdiction hazard plan that meets FEMA requirements and reflects the character and individuality of Eastham.

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It is important to note that when the 2020 Eastham Hazard Plan Update is approved by FEMA and adopted by the Board of Selectmen, the town becomes eligible to receive funding from FEMA's Hazard Mitigation Assistance (HMA) program, which includes the following programs:

- **Hazard Mitigation Grant Program (HMGP):** assists in implementing long-term, "forward thinking" hazard mitigation measures following a major disaster
- **Pre-Disaster Mitigation (PDM):** provides funds for hazard mitigation planning and projects on an annual basis
- **Flood Mitigation Assistance (FMA):** provides funds for projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis

Review Tool Description:

FEMA developed a "Local Mitigation Review Guide" to help Federal and State officials assess Local Hazard Mitigation Plans in a fair and consistent manner and to ensure approved local plans meet the requirements of the Stafford Act and Title 44 Code of Federal Regulations (CFR) 201.6. The "Local Mitigation Review Guide" was used as guidance in updating the Eastham Hazard Plan. When text in the Eastham Hazard Mitigation Plan Update meets an element identified in the Review Guide, it is called out in a colored box in the margin.

The Planning Process

CHAPTER ONE

Municipal plans require expertise from a core team of Town officials and input from stakeholders, the public and neighboring communities. When community-wide plans have the support from a diverse cross-section of stakeholders, residents and Town officials, the final plan becomes a "living" document that is useful for the community on a long-term basis. A hazard plan, in particular, is considered successful if it educates residents about the risk and vulnerability related to natural hazards and builds support for policies, actions and tools that reduce future losses from natural hazards. **Chapter 1 provides a narrative on the hazard planning team and the outreach process used to develop the 2020 Eastham Hazard Mitigation Plan Update.**

Eastham recognized the need to update its hazard mitigation plan and to align that effort with a plan to increase the community's resilience to climate change. As a coastal community bordered to the east by the Atlantic Ocean, and to the west by Cape Cod Bay, Eastham has a long history of dealing with the impacts of a dynamic coastal environment. These impacts will continue to be exacerbated by the effects of climate change. With 37.4 miles of tidal shoreline and natural resource areas, Eastham is highly susceptible to climate change and natural hazards such as coastal flooding, storm surge and erosion.

The Town is committed to taking a comprehensive approach to its planning efforts. A core component of the assigned duties of both the Town Planner and Conservation Agent is to oversee hazard mitigation planning and related efforts. With a $25,000 grant from the Massachusetts Executive Office of Energy and Environmental Affairs Municipal Vulnerability Preparedness ("MVP") Program, the Town of Eastham contracted with staff from the Cape Cod Commission and Woods Hole Sea Grant & Cape Cod Cooperative Extension, certified MVP providers, to conduct a "Community Resilience Building/MVP" workshop. Following completion of the workshop and submittal of a final report to EOEEA, the Town became an MVP certified community and is eligible for action grants to address coastal resiliency and hazards related to climate change.

The MVP workshop, through its community engagement and participation process, supports and informs the Hazard Mitigation Plan that advances the community's "conversation" around hazard impacts and climate change. The MVP workshop is referenced throughout the Hazard Mitigation Plan. See Appendix to view the full MVP Workshop Summary of Findings.

Planning Team

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Members and Responsibilities

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The Planning Team is an interdisciplinary group of town staff members with expertise to develop the plan and the authority and expertise to implement its action items. Staff members from the Cape Cod Commission (CCC) provided technical support to the Planning Team. ***Table 1.1*** lists the names, titles and affiliations of the Eastham Hazard Planning Team. These same town staff members served as the MVP Core Team and participated in the MVP workshop on January 7-8, 2019.

The Planning Team was responsible for developing and reviewing draft sections of the Hazard Mitigation Plan Update, creating the mitigation strategies and submitting the plan for adoption by the Federal Emergency Management Agency (FEMA) and the Eastham Board of Selectman. ***Table 1.2*** outlines the responsibilities of each member of the Planning Team (or department he/she represented).

Name	Title	Department	Responsibilities
Silvio Genao	Superintendent	Department of Public Works	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Tom Wingard	Building Commissioner	Building Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Jane Crowley	Director of Health & Environment	Health Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Shana Brogan	Natural Resource Manager/ Conservation Agent	Conservation Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Ed Kulhawik	Chief	Police Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Kent Farrenkopf	Chief	Fire Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Adam Bohannon	Deputy Chief (Chief as of February 2020)	Police Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Dorothy Burritt	Director	Council on Aging	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Dan Keane	Deputy Chief	Fire Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, attended team meetings.
Paul Lagg	Town Planner	Planning Department	Reviewed critical facilities list, developed capabilities assessment, developed mitigation actions, assisted with public outreach strategy, attended team meetings.
Martha Hevenor	Planner	Cape Cod Commission	Facilitated group meetings with Planning Team; coordinated the development of the hazard plan.
Gary Prahm	GIS Analyst	Cape Cod Commission	Prepared maps for the town hazard plan and MVP workshop; used GIS software to conduct a risk assessment

Table 1.1 | Eastham Hazard Planning Team Members and Responsibilities

The Town Planner led the local hazard planning team, providing a liaison to the Eastham Planning Board, which is the primary local agency for regulating development in Eastham. The Town Planner's participation on the planning team ensured feedback to the Planning Board. Planning Board members (as well as other regulatory board) were also targeted for participation in the MVP and Hazard Mitigation Plan processes as stakeholders. (See pages 15-17.)

Meeting Schedule and Involvement

The Planning Team worked together in a series of group meetings, beginning in November 2018 in preparation for the MVP workshop. Following completion of the workshop and MVP certification process, the Planning Team met regularly beginning in October 2019, to develop the Hazard Mitigation Plan Update. CCC staff also met and conferred with the Town Planner (the project lead) throughout the plan's development and sought input from Shannon Hulst, Floodplain Specialist & CRS Coordinator, on matters related to repetitive loss properties, CRS, and floodplain regulations.

Below is a list of dates and topics covered at each of these large group meetings.

- **November 9, 2018:** Planning for MVP workshop. Topics included MVP program overview, stakeholder identification, outreach strategy, workshop maps and materials.
- **January 7-8, 2019:** MVP Workshop. Members of the Planning Team joined with stakeholders and members of the public to identify priority hazards, strengths and vulnerabilities, and mitigation actions.
- **October 22, 2019:** Overview of the Hazard Mitigation Plan Update goals, purpose, and process; outreach strategy, review of relevant town plans, review of relevant hazards and critical facilities.
- **November 13, 2019:** Review of critical facilities, hazard profiles, outreach strategy, probability of future hazard events; and capabilities assessment.
- **December 3, 2019:** Vulnerability assessment, mitigation strategy - review of 2010 actions, MVP actions.
- **January 7, 2019:** Review of 2010 actions progress; new actions; priorities, implementation strategy, plan schedule

Outreach Strategy

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With the Public

The public was engaged at multiple times during the planning process: during the MVP workshop process, during hazard plan development, and just prior to submission of the draft hazard plan for MEMA/FEMA review.

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During MVP Process and Plan Development

The Town Planner (lead MVP core team member and Planning team member) created a Municipal Vulnerability Preparedness/Hazard Mitigation Planning web page on the Town website in November 2018 with information about the workshop, including a public invitation for interested people to participate. The website provided an interactive "story" map (produced by the Cape Cod Commission) with a data viewer that allowed users to review maps and data related to climate change and natural hazards, as well as post their own photos of hazard events/experiences. In addition, the website included a survey/questionnaire that provided an opportunity for the Planning Team to gather data on the significance/relevance of natural hazards identified in the

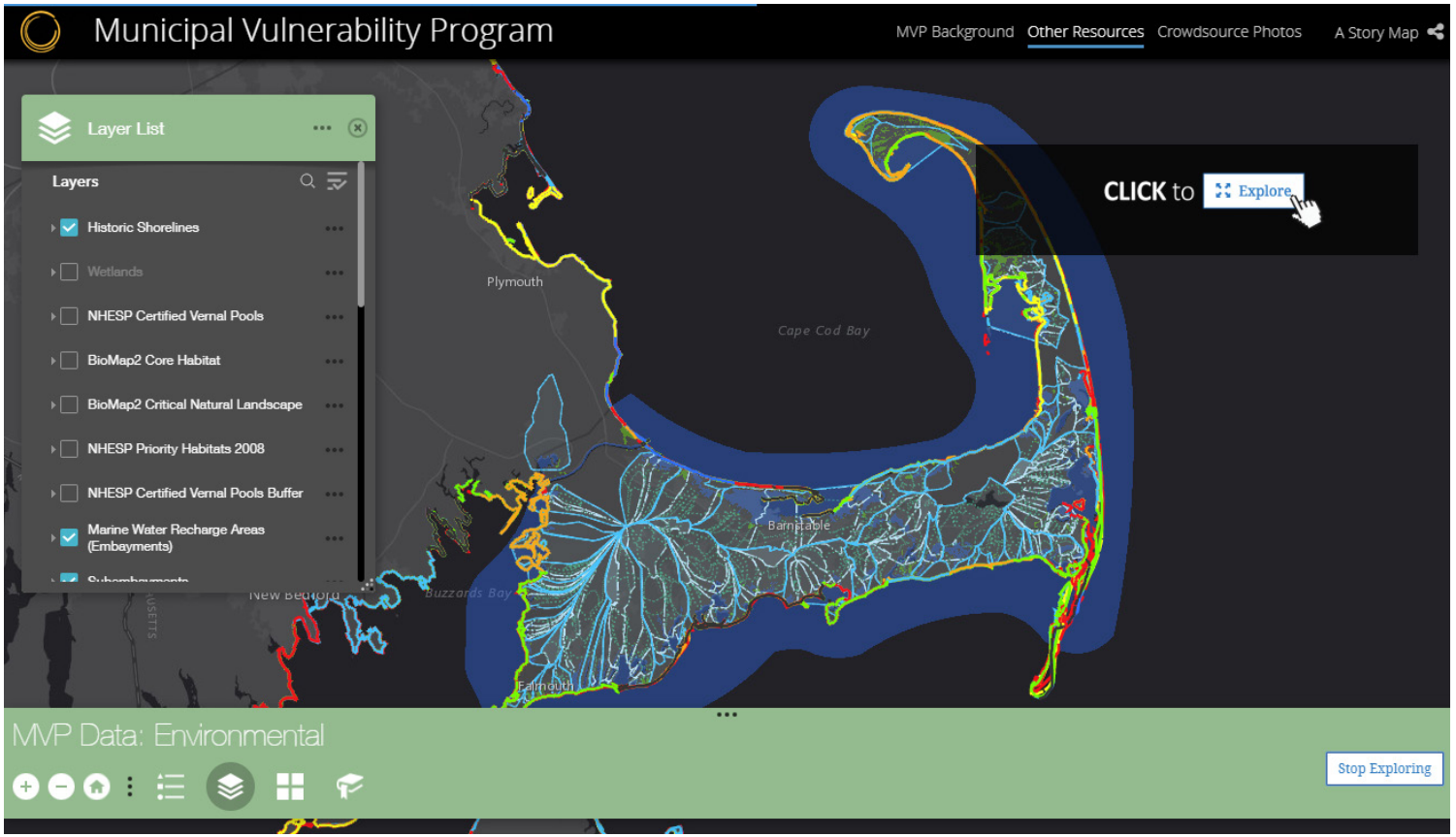

Figure 1.1 | Cape Cod Commission MVP Online StoryMap

Outreach Strategy

Massachusetts State Hazard Plan to Eastham; the impact of the hazards; and preparedness efforts in Eastham. The survey also gathered data on how residents would like to be engaged in hazard related issues in the future. (See Appendix for photo of webpage.).

After the MVP workshop, the Town posted a draft MVP Workshop Summary of Findings on the Town website and invited the public to attend a public listening session on May 29, 2020 in Eastham Town Hall, where the Town Planner presented the Summary and provided an opportunity for the public to comment. A copy of the final MVP Workshop Summary of Findings is provided in the Appendix. A newspaper article in the Cape Codder on June 19, 2019 provided information about the MVP program and Eastham's final report. The article also noted the town's efforts to update the Hazard Mitigation Plan.

The Town launched the public survey on the website again, in November 2019, prior to developing mitigation actions for the Hazard Mitigation Plan Update. An article in the Provincetown Independent noted the survey's availability. (See Appendix.) About 60 people responded to the public survey. For a copy of the survey, see "Public Survey on Hazard Mitigation" in the Appendix .

In addition to public outreach through the MVP workshop and public survey, the Town Planner attended an informal lunch session at the Council on Aging where he talked about the Hazard Mitigation Plan to a group of Eastham residents. The COA director (also a member of the Planning Team) suggested a lunchtime gathering as a convenient opportunity to spread the word in the community, about the hazard mitigation plan, the public survey, and how to participate.

The process for incorporating public input into the hazard plan was as follows:

1. Planning Team members reviewed public input from the MVP Workshop and hazard survey. At the October 22, 2019 Planning Team meeting, the members reviewed the top hazards the MVP workshop participants identified. At the December 3, 2019 Planning Team meeting, members reviewed the priority mitigation actions identified during the MVP workshop. The Town Planner distributed the results of the public survey to the Planning Team for review on January 16, 2020.
2. The Planning Team incorporated MVP workshop input and public survey responses/comments into the hazard plan in the following ways:

- The Planning team considered the top hazards identified in the MVP workshop and used that to help inform their determination of the hazards most relevant to the community.
- The Planning Team incorporated the top actions from the MVP workshop into the 2019 Hazard Mitigation Plan.

- The hazard survey asked people to identify specific hazards they experienced or are most concerned about while living or working in Eastham. These selections helped inform and confirm/support the Planning Team's determination whether a particular hazard is significant to the town (see ***Table 2.2***).
- The survey asked people to identify steps that the local government could take to reduce risk from natural hazards and protect the buildings and people of Eastham. It included a list of mitigation actions to reduce risk and loss plus an opportunity to suggest additional actions. The public responses helped indicate level of support and identify new actions where needed.

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Prior to Submission to MEMA/FEMA

- The Town of Eastham posted a link to the draft Eastham Hazard Mitigation Plan on the Town of Eastham website and on the Town of Eastham Facebook page. The page included information for providing comments on the plan. No comments were received from the public.
- The draft Eastham Hazard Mitigation Plan was presented at the Board of Selectmen meeting on May 18, 2020. During the meeting, the public had the opportunity to provide comments.

With Stakeholders

A stakeholder is someone who may be affected by or have an interest in the Eastham Hazard Mitigation Plan and its implications but did not participate in Planning Team meetings. Stakeholders for hazard planning efforts can be public officials, agency heads, members of neighborhood/civic organizations, business associations or staff from academic institutions.

Stakeholders were engaged in updating the Eastham Hazard Mitigation Plan. The stakeholder process involved three important steps:

1. Stakeholders were identified by the Planning Team prior to MVP workshop and again during the Hazard Mitigation Plan development.
2. The Planning Team designed a strategy to engage and gather input from stakeholders.
3. Stakeholders provided input during the planning process and just prior to plan approval

Identification of Stakeholders

Planning Team members first identified stakeholders in preparation for the MVP workshop. They included employees and volunteers from organizations and groups in Eastham and across Cape Cod, including:

- Eastham Chamber of Commerce

Outreach Strategy

- Eastham Council on Aging
- Community Development Partnership
- Association to Preserve Cape Cod
- Cape Cod Cooperative Extension/ Woods Hole Sea Grant
- Cape Cod National Seashore
- Eastham Planning Board
- Eastham Conservation Commission
- Eastham Zoning Board of Appeals
- Town of Orleans
- Town of Wellfleet

A2c

Stakeholder Participation

Stakeholders were engaged multiple times during the planning process – both during the MVP process and hazard mitigation plan development and again just prior to submission of the draft hazard mitigation plan to MEMA and FEMA.

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- Stakeholders were invited to take a hazard survey in November 2018 prior to the January 2019 MVP workshop (and again in November 2019). The survey provided an opportunity for the Planning Team to gather data on the significance/ relevance of natural hazards identified in the Massachusetts State Hazard Plan to Eastham; the impact of the hazards, and preparedness efforts in Eastham. The survey also gathered data on how stakeholders would like to be engaged in hazard related issues in the future.
- Stakeholders participated in the MVP workshop and identified top hazards of concern strengths and vulnerabilities related to hazards, and mitigation actions to increase the strengths or reduce the vulnerabilities. The top actions from the MVP workshop have been incorporated into the 2020 Hazard Mitigation Plan.

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- Stakeholders were invited to review and comment on the draft Municipal Vulnerability Workshop Summary of Findings which was posted on the Town website and presented at a public listening session on May 29, 2019.
- Prior to submission of the draft Hazard Mitigation Plan Update to MEMA, the Planning Team invited stakeholders to review and comment on the plan. The following comments were received:
  - Lauren McKean, Park Planner, Cape Cod National Seashore (CCNS) requested adding Cape Cod National Seashore to the list of stakeholders (it was accidentally omitted) and adding the Ranger Station on Nauset Road to the critical facilities list. She also added Town bayside beach restrooms and septic system as vulnerable to flooding and Coast Guard beach and Nauset Light beach facilities as vulnerable to coastal erosion. Additional CCNS facilities vulnerable to

flooding include the Cranberry Bog Bridge that crosses to the Coast Guard NEED facility, as well as the Nauset Bicycle Trail bridge nearby. She requested that the recently completed relocation of Nauset Light Road due to c A5a erosion be noted as a completed action.

- Shannon Hulst, Deputy Director, Cape Cod Cooperative Extension and Floodplain Specialist & CRS Coordinator, Cape Cod Cooperative Extension & Woods Hole Sea Grant suggested adding language about natural floodplain function in Eastham. She also suggested noting that impacts from flooding include mold which can affect human health.

A2b

With Neighboring Communities

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The draft Plan was sent to Town Planners in Orleans and Wellfleet for review and comment. A copy of the email sent to these neighboring towns and regional planning bodies soliciting their feedback on the Plan is provided in the Appendix.

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Continuing Outreach Efforts During Plan Maintenance

Once the 2020 Eastham Hazard Mitigation Plan Update is approved by MEMA and FEMA, it will be forwarded to the Eastham Board of Selectmen for adoption. Once adopted, the plan enters into the "Maintenance Period" and will be active for five years. During this maintenance period, FEMA requires the Planning Team to continue public engagement.

The following is a list of engagement activities that the Planning Team will complete during this five-year maintenance period:

- Online surveys to gather data on whether or not Eastham residents are prepared for nor'easters, hurricanes and severe winter weather.
- Presentations to community groups about the science of hazards and/or how to prepare for specific weather events. Press releases, social media, and public service announcements to inform the public of hazard related educational workshops and hazard planning information.

Incorporation with Other Town Plans and Reports

Technical Information Used in the Plan

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The 2020 Eastham Hazard Mitigation Plan Update was drafted using existing plans, studies, reports and technical information from local, county, state and federal agencies. Technical data used to formulate the Hazard Profile is cited under each Hazard Profile and is not explicitly cited in the list below.

Incorporation with Other Town Plans and Reports

Below is a list of the resources from Federal, State and Local agencies that were used and incorporated into the 2020 Eastham Hazard Mitigation Plan Update:

- Technical Information from Federal Agencies:
  - Local Mitigation Planning Handbook (2013) prepared by FEMA
  - How-To Guide: Getting Started – Building Support for Mitigation Planning (FEMA 386-1, 2002) prepared by FEMA
  - How-To Guide: Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA 386-2, 2001) prepared by FEMA
  - How-To Guide: Developing the Mitigation Plan (FEMA 386-3, 2003) prepared by FEMA
  - How-To Guide: Bringing the Plan to Life – Implementing the Hazard Mitigation Plan (FEMA 386-1, 2002) prepared by FEMA
  - Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (2013) prepared by FEMA
  - Hazard Mitigation Assistance Guidance (2015) prepared by FEMA
  - National Flood Insurance Program Community Rating System Coordinator's Manual (FIA-15/2013 prepared by FEMA
  - National Flood Insurance Program Floodplain Management Requirements: Study Guide and Desk Reference for Local Officials (FEMA 480, February 2005) prepared by FEMA
  - Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA 543, January 2007) prepared by FEMA
  - Mitigation Assessment Team Report Hurricane Ike in Texas and Louisiana: Building Performance Observations, Recommendations, and Technical Guidance (FEMA P-757, April 2009) prepared by FEMA
  - Recommended Residential Construction for Coastal Areas: Building Strong and Safe Foundations (FEMA P-550, 2nd Edition, December 2009) prepared by FEMA
  - Wind Retrofit Guide for Residential Buildings (FEMA P-804, December 2010) prepared by FEMA
  - Home Builder's Guide to Coastal Construction Technical Fact Sheets Series (FEMA P-499, December 2010) prepared by FEMA
  - Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining

Residential Buildings in Coastal Areas Volume I and II (4th edition, FEMA P-55, August 2011) prepared by FEMA

- Highways in the Coastal Environment: Assessing Extreme Events (2014) prepared by the U.S. Department of Transportation and the Federal Highway Administration
- National Climate Assessment (2014)

- Technical Information from State Agencies:
  - Massachusetts State Hazard Mitigation Plan (2013) prepared by Tetra Tech on behalf of the Massachusetts Emergency Management Agency and the Department of Conservation and Recreation
  - 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan
  - Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers, and Municipal Officials (2003) prepared by Franklin, Hampden, Hampshire Conservation Districts
  - Massachusetts Climate Change Adaptation Report (2011) prepared by Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee
  - .Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning (2013) prepared by the Massachusetts Office of Coastal Zone Management
  - Massachusetts Coastal Erosion Commission Report (draft released in 2015) prepared by Coastal Erosion Commission
  - Commonwealth of Massachusetts All Hazards Disaster Debris Management Plan (2010) prepared by the Massachusetts Emergency Management Agency
  - Massachusetts Homeowner's Handbook to Prepare for Coastal Hazards (2014) prepared by Barnstable County, Woods Hole Sea Grant and MIT Sea Grant
- Technical Information from County Agencies:
  - Barnstable County Multi-Hazard Mitigation Plan (2010) prepared by the Cape Cod Commission
  - Barnstable County Wildfire Preparedness Plan (2012) prepared by Barnstable County and the Cape Cod Cooperative Extension
  - Cape Cod Regional Policy Plan prepared by the Cape Cod Commission (2018)

Incorporation with Other Town Plans and Reports

- Technical Information from Eastham:
  - Eastham Multi Hazard Mitigation Plan (2010 draft)
  - Eastham Long Range Local Comprehensive Plan (2013)
  - Town of Eastham Zoning Bylaws
  - Eastham Five Year Strategic Plan (2019)
  - Eastham Complete Streets Prioritization Plan (2018)
  - Eastham Harbor & Waterways Management Plan (pending approval 2020)
  - Eastham Open Space & Recreation Plan (2007)
  - Eastham Community Resilience Building MVP Workshop Summary Report (2019)

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How Technical Information was Incorporated

The technical information listed above was incorporated into the 2020 Eastham Hazard Mitigation Plan Update in the following ways:

- Federal documents, especially FEMA documents, were used to:
  - Guide the activities of the planning process
  - Provide technical guidance on successful mitigation practices in coastal communities
  - Help the Planning Team develop mitigation actions
  - Provide current data on climate change and adaptation strategies
- State and County documents were used to:
  - Provide current data on hazard events affecting Massachusetts and Barnstable County especially climate change, sea level rise and coastal erosion
  - Guide the Planning Team on current state mitigation actions and plans; these documents were used as reference for the Planning Team
- Eastham-specific documents were used to:
  - Ensure that mitigation actions in the 2020 Hazard Mitigation Plan are consistent with current activities and plans already in place in Eastham
  - Provide technical data for the hazard profiles, risk assessment and mitigation actions

Integrating the Hazard Plan into other Town Plans

C6

The Mitigation Goals identified in the 2020 Eastham Hazard Mitigation Plan will be incorporated into the objectives and policies of the Eastham Local Comprehensive Plan (LCP).

Eastham Local Comprehensive Plan: The Eastham LCP describes the town's goals, policies and actions on land use, growth management, natural resources, open space and recreation, historic preservation and community character, economic development, affordable housing, and community facilities and services. Mitigation Goals and Actions will be incorporated into the next LCP update. Below are a few examples of Mitigation Goals that should be integrated in the update of the Eastham LCP:

- Reduce the potential for loss of life, property, infrastructure, and environmental, cultural and economic resources in Eastham from natural disasters.
- Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Eastham.

Eastham Open Space and Recreation Plan: The Town will incorporate Hazard Mitigation Plan actions regarding land acquisition and protection into the next OSRP.

C6

Plan Integration Status: New FEMA guidance requires that the 2020 Hazard Mitigation Plan Update describe how the plan was integrated with other plans over the last five years. This is a new requirement, and because the town did not formally adopt the 2010 Hazard Mitigation Plan, Eastham does not have a process in place to collect such information. Going forward, the town will maintain a list of the new and updated town plans on its website and the Town Planner will be responsible for ensuring that town planning efforts are consistent with the 2020 Eastham Hazard Mitigation Plan.

Contents of Chapter 1 Appendix

A1e

Contents in the appendix related to Chapter 1 include:

- Team Meeting attendance sheets
- Public Survey Documentation and Results
- Cape Codder newspaper article about the MVP Workshop and hazard planning
- Provincetown Independent newspaper article about Hazard Mitigation Plan and survey
- Eastham Community Resilience Building MVP Workshop Summary Report
- Emails sent to neighboring towns about the draft Eastham Hazard Mitigation Plan comment period

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Natural Hazards

CHAPTER TWO

Eastham is vulnerable to a range of natural hazards that threaten life and property. Current FEMA regulations and guidance under the Disaster Mitigation Act of 2000 require, at a minimum, an evaluation of a full range of natural hazards identified in the most recent Massachusetts State Hazard Plan. An evaluation of human-caused hazards (i.e. technological hazards, terrorism, etc.) is encouraged but not required for plan approval. The 2020 Eastham Hazard Mitigation Plan Update provides an assessment of only natural hazards. **Chapter 2 provides a detailed description of the natural hazards that could impact Eastham in the future or have impacted Eastham in the past.**

Hazard Identification

State Hazards

- The Massachusetts State Hazard Mitigation Plan[1] identifies the following 11 natural hazards that could have an impact or have a history of impacting communities in the Commonwealth of Massachusetts. These hazards are listed below:
- Coastal Erosion
- Dam Failure (including culverts)
- Earthquake
- Fire (urban and wildland)
- Flood
- Hurricane and Tropical Storms
- Landslide
- Nor'easters
- Severe Weather (includes high winds, thunderstorms, extreme temperatures, Tornadoes and drought)
- Severe Winter Weather (includes snow, blizzards and ice storms)
- Tsunami

Selection of Hazards that Affect Eastham

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As suggested under FEMA planning guidance, the Planning Team reviewed the full range of natural hazards identified in the Massachusetts State Hazard Plan and identified natural hazards that could impact Eastham in the future or that have impacted Eastham in the past (***Table 2.1***). The Planning Team members made this determination based on their own expertise and experience, input from the MVP workshop, data from the Massachusetts State Hazard Plans and other resources. All resources are referenced in the text of each hazard profile.

1 This report was prepared using information from both the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan the 2013 Massachusetts State Hazard Mitigation Plan.

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Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Eastham?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Eastham?	Why was this determination made?
Coastal Erosion/ Shoreline Change	Yes	▪ Massachusetts Coastal Zone Management ▪ MVP Workshop ▪ Local knowledge from Town Staff	Yes	There is a history of erosion and shoreline change in Eastham
Dam (culvert) Failure	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Massachusetts Department of Dam Safety ▪ Local knowledge from Town Staff	Yes	One dam and several culverts are located in Eastham.
Earthquake	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is no history of earthquakes in Eastham but there is a history of earthquakes in Massachusetts
Fire (urban and wild)	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff ▪ Barnstable County Wildfire Preparedness Plan	Yes	Fire-adapted vegetation puts the town at risk for wildfire and there is a history of wildfire in the region and in Cape Cod National Seashore.
Flood	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff ▪ MVP Workshop	Yes	There is a history of flooding in Eastham and the town's geographic location
Hurricanes and Tropical Storms	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ National Hurricane Center ▪ Local knowledge from Town Staff	Yes	There is a history of hurricanes and tropical storms in Eastham
Landslide	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	Lack of history of event and not included in previous hazard plan, but sandy soils could be destabilized from water saturation

Table 2.1 | List of relevant natural hazards for Eastham

Hazard Identification

Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Eastham?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Eastham?	Why was this determination made?
Nor'easters	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a strong history of nor'easters in Eastham and New England
High winds	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of high winds in Eastham
Thunderstorms	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ MVP Workshop ▪ Local knowledge from Town Staff	Yes	There is a history of thunderstorms in Eastham
Extreme temperatures	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of extreme cold and hot temperatures in Eastham
Tornadoes	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	Eastham does not have a history of Tornadoes, but a tornado occurred in the region in July 2019 and tornado warnings have been issued in Barnstable County in recent years
Drought	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of drought in Barnstable County
Severe winter weather	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of severe winter weather in Eastham
Tsunami	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	The probability of a damaging tsunami impacting Massachusetts is unknown
Sea Level Rise	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff ▪ MVP Workshop ▪ Cape Cod Commission Sea Level Rise Viewer	Yes	There is a history of sea level rise in Eastham

Table 2.1 | List of relevant natural hazards for Eastham (continued)

Hazard Profiles

Coastal Erosion and Shoreline Change

Overview

Coastal shorelines — especially beaches, dunes and banks — change constantly in response to wind, waves, tides and other factors including seasonal variation, sea level rise and human alterations to the shoreline system.[2] Every day, wind, waves and currents move sand, pebbles and other materials along the shore or out to sea. This dynamic and continuous process of erosion, transport and accretion shape the coastal shoreline. Shorelines change seasonally, tending to accrete gradually during the summer months when sediments are deposited by relatively low energy waves and erode dramatically during the winter when sediments are moved offshore by high energy storm waves, such as those generated by nor'easters.

B1c

Hazard Location

Through the Shoreline Change Project the Massachusetts Office of Coastal Zone Management (CZM) delineated and statistically analyzed the ocean-facing shorelines of Massachusetts to demonstrate trends from the mid-1800s to 2009. An update of the Shoreline Change Project was completed in 2001 using 1994 National Oceanic and Atmospheric Administration (NOAA) aerial photographs of the Massachusetts shoreline. CZM established an agreement with the U.S. Geological Survey (USGS), the Woods Hole Oceanographic Institution Sea Grant Program, and Cape Cod Cooperative Extension to produce the 1994 shoreline and calculate shoreline change rates. CZM then incorporated the shorelines and shore-perpendicular transects with shoreline change rates into MORIS, the Massachusetts Ocean Resource Information System, to provide better access to the shoreline change data and encourage the public to browse the data using this online mapping tool. To launch the MORIS tool, use the following link: http://www.mass.gov/eea/agencies/czm/program-areas/mapping-and-data-management/moris/

In addition to the CZM project, the Provincetown Center for Coastal Studies (PCCS) completed a report entitled *Assessment of the Century-Scale Sediment Budget for the Eastham and Wellfleet Coasts of Cape Cod Bay* for the Towns of Eastham and Wellfleet in 2018. Data from the 1930-40s and from 2010-2017 were used to develop historical and contemporary three-dimensional surface models of sediment transport on the bay side of Eastham. Using the data from both the CZM Shoreline Change Project and the PCCS Sediment Budget for Eastham and Wellfleet, the Planning Team concluded that the entire coastline of the planning area

2 Report of the Massachusetts Coastal Erosion Commission, December 2015

Hazard Profiles

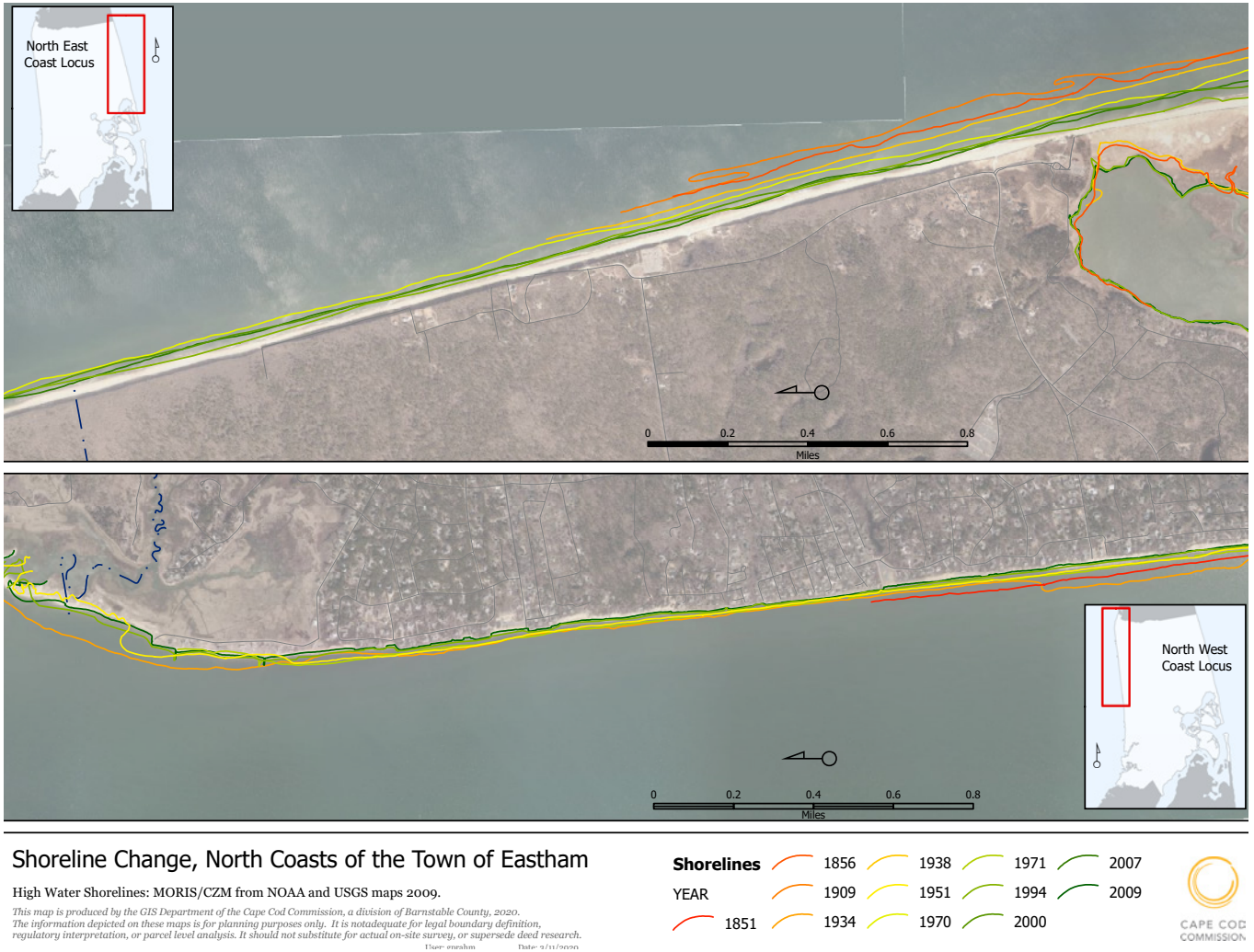


Figure 2.1a | Historic shoreline change along the northern coasts of Eastham. Map was created using data from the Massachusetts Ocean Resource Information System

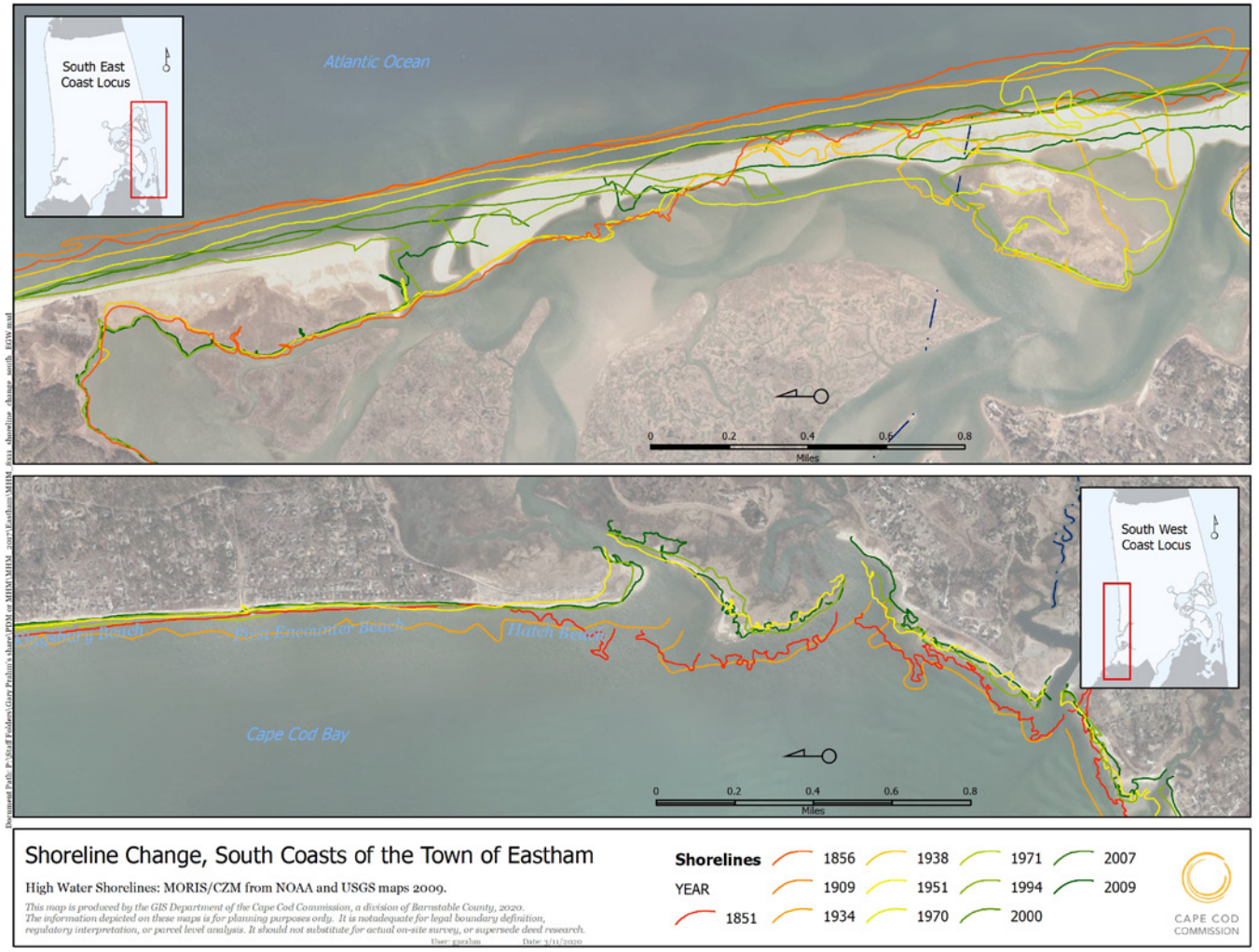


Figure 2.1b | Historic shoreline change along the southern coasts of Eastham. Map was created using data from the Massachusetts Ocean Resource Information System

is vulnerable to shoreline change. ***Figure 2.1*** is a series of maps of the planning area showing how the shoreline has changed from the mid- 1800s to 2009.

Previous Occurrences and Extent

Coastal erosion is measured as the horizontal displacement of a shoreline over a specific period of time, measured in units of feet or meters per year.[3] Shoreline change can be monitored over short-term and long-term time scales. Monitoring shoreline change on a relatively short period of record does not always reflect actual conditions and can misrepresent long-term erosion rates. However, long-term patterns of coastal erosion are difficult to detect because of substantial, rapid changes in coastlines over days or weeks from storms and natural tidal processes.

The Coastal Erosion Commission's 2015 Report states the average shoreline change rates for Eastham – for the entire town, the Cape Cod Bay, and the Outer Cape Coast - where positive values indicate accretion and negative values indicate erosion, as follows:

- Entire Town:
  - Short-Term Rate: -3.5 ± 5.4 ft/year
  - Long-Term Rate: -2.5 ± 1.7 ft/year
- Cape Cod Bay:
  - Short Term Rate: -1.7 ± 5.2 ft/year
  - Long Term Rate: -1.9 ± 2.0 ft/year
- Outer Cape Coast:
  - Short Term Rate: -5.7 ± 4.7 ft/year
  - Long Term Rate: -3.0 ± 0.7 ft/year

It is important to note that this data represents averages for shoreline change throughout Eastham, and that there might be areas with greater or lesser erosion and accretion rates.

Impact

B3a

While erosion is a natural process, it causes damage to coastal property and related infrastructure — particularly where development is close to the shoreline in unstable or low-lying areas. Below is a list of possible damages that could result from shoreline change[4]:

- **People:** public safety is jeopardized when buildings collapse or water supplies are contaminated; erosion can cause roadways to collapse which would reduce the response time of emergency vehicles
- **Infrastructure:** erosion can expose septic systems and sewer pipes risking contamination of shellfish

3 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan

4 Report of the Massachusetts Coastal Erosion Commission, December 2015

beds and other resources; accreting sand can block storm water pipes, causing urban drainage issues in town

- Buildings: erosion reduces the embedment of foundations in the soil, causing shallow foundations to collapse and making buildings on foundations more susceptible to settlement, lateral movement or overturning; once a building moves or is overturned, construction materials and other debris can be swept out to sea; seawalls and other hard structures open downdrift property owners to similar or greater losses
- Economy: if businesses are affected by coastal erosion, they could experience loss of function; damage to inventory; relocation costs; wage loss
- Natural Systems: where engineered structures are used to stabilize shorelines, the natural process of erosion is altered, changing the amount of sediment available and erosion rates at adjacent areas; the town's natural ecosystem attractions — beaches, dunes, barrier beaches, salt marshes and estuaries — would also be threatened and could slowly disappear as sand sources that supply and sustain them are eliminated; under conditions of reduced sediment supply, the ability of coastal landforms to provide storm damage and flooding protection would be diminished, increasing the vulnerability of infrastructure and development
- Transportation: roads and parking lots can become damaged due to shoreline recession

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that shoreline change will impact the planning area. High probability was defined based on the frequency of occurrence:

- Unlikely: less than a 1% probability over the next 100 years
- Possible: 1-10% probability in the next year or at least one chance in the next 100 years
- Likely: 10-100% probability in the next year or at least one chance in the next 10 years
- Highly Likely: near 100% probability in the next year

Data from the Shoreline Change Project, the "sediment budget," local knowledge, and the Report of the Massachusetts Coastal Erosion Commission were used to make this probability determination.

Dam and Culvert Failure

Overview

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material

for the purpose of storage or control of water.[5] Dam failure is a catastrophic type of failure characterized by a sudden, rapid and uncontrolled release of impounded water.[6]

A culvert is a structural opening under a roadway that allows water to pass from one side of a roadway to the other.[7,]

Water flowing under the road typically comes from two sources – streams and road runoff – and these water resources require different types of culverts:[8]

- A stream crossing culvert is located where the roadway crosses over a stream channel and the culvert allows water to pass downstream.
- A runoff management culvert is a strategically placed culvert to manage roadway runoff along, under and away from the roadway. These culverts are used to transport upland runoff that accumulated in ditches to the lower side of the roadway for disposal.

Culverts are typically made of concrete, steel or aluminum and can have various cross-sectional shapes (i.e. oval, circular, arched or rectangular). The size of the culvert opening is calculated using location-specific data on the amount of precipitation, snow accumulation and the probability of hurricanes impacting the area. The primary function of a culvert is to prevent flooding during normal and extreme weather conditions and provide proper road and highway drainage.

Culverts can fail and when failure occurs, it can be catastrophic. Culverts may fail for several reasons, including but not limited to:[9]

- Buildup of flood waters on the upstream side of the culvert that exceed the capacity of the culvert (video of a culvert failure in Maine, see: https://www.youtube.com/watch?v=NTbhyHNA1Vc)
- The pipe inside the culvert becomes occluded because of debris or improper maintenance.
- The pipe inside the culvert loses its structural integrity and begins to cave in.
- The culvert and road are washed out during a heavy rain event or from snowmelt runoff.
- The soil/material around the culvert pipe begins to move. Without support from such material, the culvert will buckle or sag and the culvert will collapse.

5 Massachusetts State Hazard Mitigation Plan, 2013

6 Ibid.

7 Massachusetts Highway Department: Project Development and Design Guide 2006

8 Failing culverts: Structural problems and economic considerations, Tenbusch, Inc, June 2013, www.tenbusch.com/underground_equipment/files/FailingCulvertsStructuralAndEconomicConsiderations.pdf

9 Ibid.

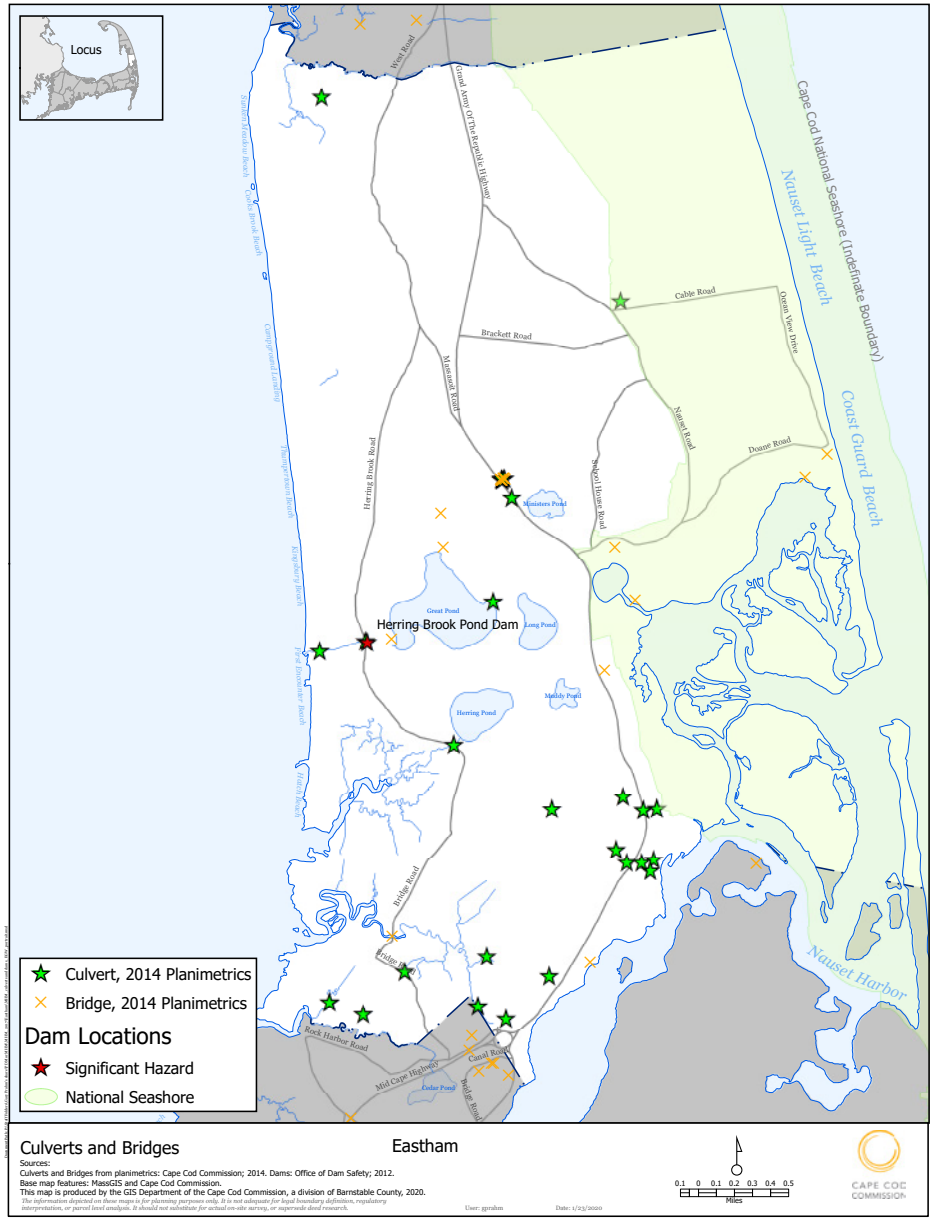


Figure 2.2 | Map of culverts and dams in Eastham

B1c

Hazard Location

One dam and 22 culverts are located in Eastham (locations shown in ***Figure 2.2***).

B1c, B2a,c

Previous Occurrences and Extent

Eastham has no record of dam or culvert failure. Since the town has not experienced dam or culvert failure, the following description of the extent of culvert failure comes from events that occurred in the state of Vermont during Tropical Storm Irene.[10] In August of 2011, Tropical Storm Irene brought heavy precipitation to New England and eastern New York. During Irene, the state of Vermont incurred significant damages to state and local infrastructure, including:

- Over 200 state road segments and 200 state-owned bridges were damaged
- 2,000 local road segments, 277 locally-owned bridges and nearly 1,000 locally-owned culverts were damaged

The extent of the culvert and bridge damage in Vermont was:

- Large river and stream bank failures delivered a tremendous amount of woody debris downstream and plugged bridges, causing streams to overtop the bridge and wash out the bridge approach
- Culverts became plugged with debris and redirected a large volume of water over areas of towns. In Rochester, NH water was redirected onto cemetery grounds, unearthing caskets and scattering human remains throughout the downtown area.

B3a

Impact

Below is a list of additional possible impacts from culvert failure:

- **People:** community isolation from impassable roads, often leaving residents without power and water.
- **Infrastructure:** power outages from disruption of underground utilities; no water due to disruption of pipes near the failed culvert; the high cost of relief and recovery may adversely affect investment in infrastructure or other development activities.
- **Economy:** impacted traffic flow and impassable roads may prevent people from returning to work and tourists from visiting the area; expensive infrastructure repairs, residents will bear the extra cost of circumventing damaged roads.

10 Gillespie et al., 2014, Flood effects on road-stream crossing infrastructure: economic and ecological benefits of stream simulation designs, Fisheries, volume 39 (2), page 62 - 76

- **Natural Systems:** bank erosion, debris in waterways and other natural systems.
- **Transportation:** impaired traffic flow and impassable roads.

B2b

Probability

The Planning Team determined that it is **POSSIBLE** that a culvert failure will impact the planning area. This determination was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used information from the Massachusetts Office of Dam Safety and knowledge of local conditions to make this determination. The Department of Dam Safety ranked the severity of the failure of the Herring Brook Pond dam as "significant."

Earthquake

Overview

An earthquake is movement or trembling of the ground produced by a sudden displacement of rock in the Earth's crust. Scientists have formulated several theories about the causes of earthquakes, but the theory of plate tectonics is commonly used to explain much of the earthquake activity in the world.[11]

The theory of plate tectonics postulates that, at one point, the earth was covered by a single crust, or plate, with no oceans. Over time, this plate started to split and drift into separate plates of land or ocean crusts. The earth's surface now looks much like a spherical jigsaw puzzle; all the plates fit together. The plates over the earth are in constant slow motion. They generally move in one of three ways—they collide, spread, or slide. Any one of these plate movements can cause an earthquake. Maps of earthquake activity throughout the world show that earthquakes most frequently occur at the boundaries of plates.

Plate movement or other forces create tremendous stress on rocks that make up the earth's outer shell. When rock is strained beyond its limit, it will fracture, and the rock mass on either side will move. This fracture

11 Earthquake Causes and Characteristics, FEMA Emergency Management Institute Training Guide, https://training.fema.gov/emiweb/is/is8a/is8a-unit3.pdf

is called a fault. Not all faults will cause earthquakes, but if there is a sudden rupture, energy is released that creates the motions associated with an earthquake. Once the sudden rupture occurs, the earth begins to shake. This shaking is caused by a series of waves known as seismic waves moving from the center of the earthquake outward to surrounding areas. Two scales are frequently used to measure earthquakes:

- THE MODIFIED MERCALLI INTENSITY SCALE measures the intensity or impact of an earthquake on people and the built environment. It measures the impact of an earthquake by sending out trained observers to look at the damage done to the built environment and the earth (landslides, etc.) and at the reaction of people to the event (***Table 2.2***).
- THE RICHTER SCALE measures the maximum recorded amplitude of a seismic wave. This measurement quantifies the ground motion and the energy released at the source of an earthquake, which is referred to as its magnitude.
  - Richter Magnitude of 3.5 -5.4: often felt but rarely causes damage
  - Richter Magnitude of 5.5 - 6.0: slight damage to well-designed buildings, major damage to poorly constructed buildings
  - Richter Magnitude of 6.1 – 6.9: destructive
  - Richter Magnitude of 7.0 – 7.9: major earthquake, causes serious damage over large areas
  - Richter Magnitude of 8.0 or higher: named Great Earthquakes, cause serious damage over extremely large areas

Both the Modified Mercalli Intensity Scale and Richter Scale are used to describe earthquakes because they utilize different data sets; the Richter Scale describes an earthquake's magnitude while the Modified Mercalli Intensity Scale describes the earthquake's impact on people and structures.

Hazard Location

B1c

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines in the central and western states. The eastern United States does experience earthquakes, but they are less frequent and less intense than those in the central and western U.S. ***Figure 2.3*** shows relative seismic risk for the United States.

Previous Occurrences and Extent

B1c, B2a,c

Although the zone of greatest seismic activity in the U.S. is along the Pacific Coast in Alaska and California, an average of six earthquakes a year are felt in the New England area. Historically, only 35 earthquakes

Level	Description
I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all, many frightened and run indoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rail bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen of ground surface. Lines of sight and level are distorted. Objects are thrown into the air.

Table 2.2 | Modified Mercalli scale, from Earthquake Causes and Characteristics, Chapter 3 of Emergency Management Institute Training Guide

Hazard Profiles

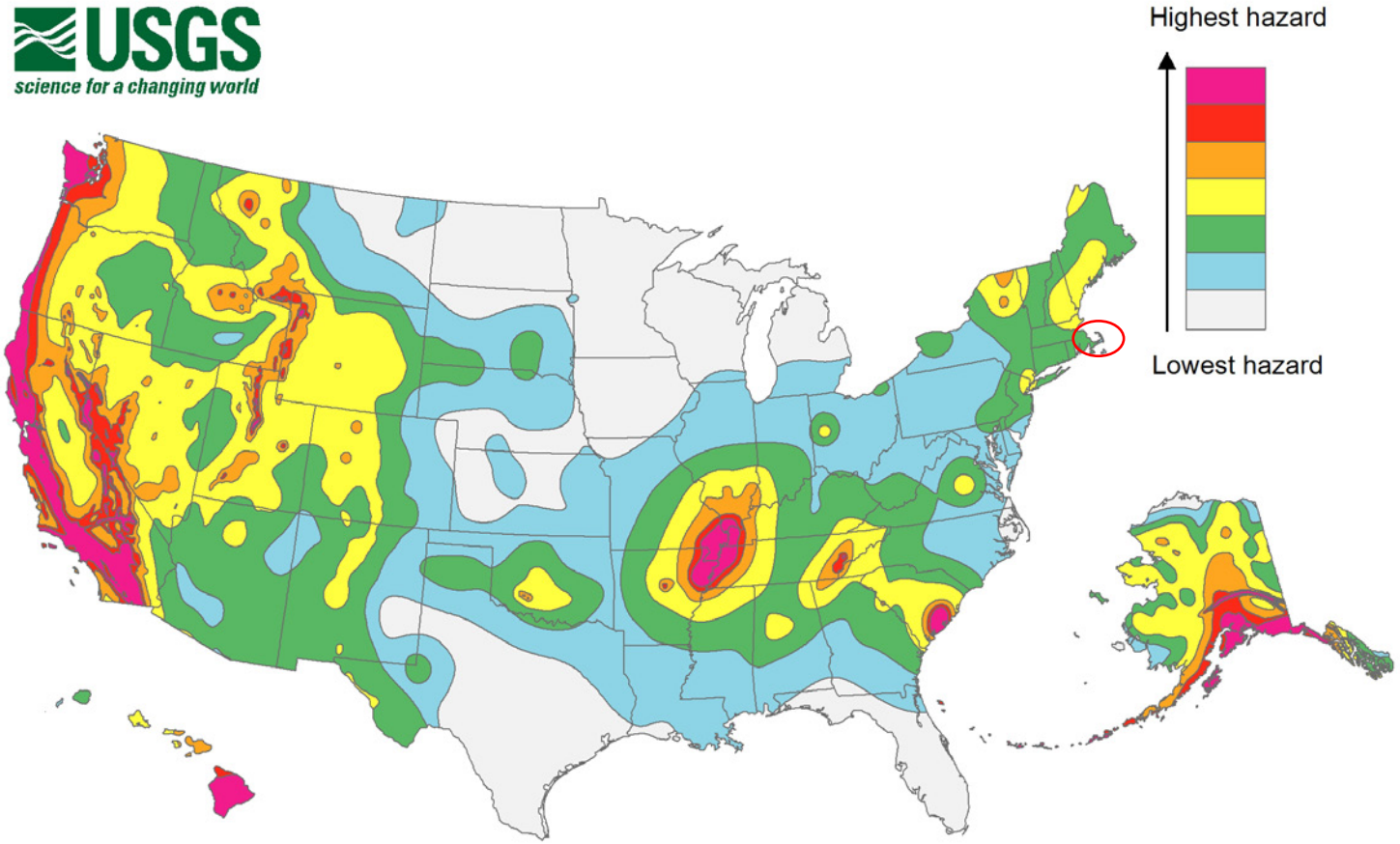


Figure 2.3 | 2014 simplified earthquake hazard risk map for the United States. A circle was used to identify the planning area on the map.

in New England were considered significant.[12] Most of Massachusetts' earthquakes have been small in magnitude and caused little damage; however, 104 earthquakes between 1924 and 2012 were measured at a magnitude of 4.5 or greater on the Richter scale. Due to the geologic composition and rock structure in the Northeast seismic shaking for many of these larger earthquakes were felt throughout all of New England.

B2c

Below is a list of earthquakes that affected eastern Massachusetts:[13]

- **August 8, 1847:** no data available on extent of hazard
- **November 27, 1852:** no data available on extent of hazard
- **December 10, 1854:** no data available on extent of hazard
- **September 21, 1876:** no data available on extent of hazard
- **May 12, 1880:** no data available on extent of hazard
- **January 21, 1903:** no data available on extent of hazard
- **April 24, 1903:** no data available on extent of hazard
- **October 15, 1907:** no data available on extent of hazard
- **January 7, 1925:** earthquake occurred off of Cape Ann and the reported felt area extended from Providence, RI to Kennebunk, ME
- **April 24, 1925:** no data available on extent of hazard
- **January 28, 1940:** no data available on extent of hazard
- **October 16, 1963:** intensity VI, caused plaster to fall in a house, a wall cracked, stones fell from a building foundation, dishes were broken, windows cracked
- **October 30, 1963:** no data available on extent of hazard
- **October 24, 1965:** slight damage to homes on Nantucket, house timbers creaked, doors, windows, and dishes rattled
- **December 30, 2012:** magnitude 1.2 earthquake about 7 miles south of Gardner, MA; no extent data available
- **April 2012:** a swarm of 12 or more earthquakes occurred off of the New England coast about 250 miles east of Boston. The largest of these earthquakes measured a magnitude of 4.4 on the Richter Scale. This swarm of earthquakes was of particular concern because of the major earthquake

12 Massachusetts State Hazard and Climate Adaptation Plan 2018

13 Massachusetts State Hazard Plan, 2013 and Weston Observatory website https://bcesp.org/

on the continental shelf further north in 1929 that produced a deadly and damaging tsunami in Nova Scotia.

- **December 22, 2018:** a small earthquake measured at 2.0 on the Richter scale occurred in the vicinity of Templeton and Gardner, Massachusetts

There have been no earthquake declared disasters for Massachusetts. No data is available on the history of earthquakes in Eastham.

B3a

Impact

Earthquakes can affect hundreds of thousands of square miles, cause damage to property, result in loss of life and injury and disrupt the social and economic functioning of the affected area. Most property damage and earthquake related deaths are caused by the failure and collapse of structures during ground shaking.

Earthquakes can also cause large and sometimes disastrous landslides. Sand dunes, like those in Eastham, are vulnerable to slope failure during an earthquake. This process, called sand liquefaction, occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and move freely, turning the ground into a liquid.[14]

B2b

Probability

Earthquakes cannot be predicted and may occur at any time of the day and any time of the year. The Planning Team determined that it is **POSSIBLE** that an earthquake will impact Eastham. Probabilities were defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used data collected from the 2013 Massachusetts State Hazard Plan and historical earthquake data in Massachusetts to make this probability determination.

14 Massachusetts State Hazard Mitigation Plan, 2013

Fire: Urban and Wildland

Overview

This portion of the Eastham Hazard Plan assesses two types of fire events: urban fires and wildfires.

Urban fires occur when buildings and structures catch fire, with potential for the fire to spread to adjoining structures. Urban fires are more common in areas where single family homes, multi-family homes and businesses are clustered closely together, thereby increasing the possibility of rapid spread to nearby structures. Urban fires occur more frequently than wildfires and often result from everyday activities such as cooking, smoking and appliance malfunction.

Wildfires are defined as any non-structural fire that occurs in a vegetative wildland including grass, shrub, leaf litter or forested area.[15] Wildfires often begin undetected and spread quickly when brush, trees and homes are ignited. In Massachusetts, wildfires are typically caused by lightning, human activity (i.e. smoking, unattended campfires) or prescribed burns (intentional, controlled burns that are started under the supervision of experienced fire personnel).[16]

In 2012, the Cape Cod Cooperative Extension and other regional partners developed the Barnstable County Wildfire Preparedness Plan. As stated in this document, Cape Cod is vulnerable to wildfires for several reasons:

The region has a long history of wildfires. As a result, most of Cape Cod has fire-adapted ecosystems that are prone to burning. Also pitch pine barrens are the dominant vegetative community on Cape Cod. These ecosystems contain several highly flammable plant species that are adapted to survive or regenerate post fire.

Many Cape residents live in the Wildland Urban Interface (WUI). This zone is defined as the line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel. Development in the WUI is dangerous because wildfires can move to surrounding developments and place homes and other buildings at risk for ignition.

Hazard Location

B1c

A team of fire professionals developed the Barnstable County Wildfire Preparedness Plan and conducted a town-wide risk assessment for wildfire in Eastham. This team identified three areas in Eastham that are at risk to wildland fires: (***Figure 2.4***). Cape Cod National Seashore forested/woodland areas north of Doane Road to

15 Massachusetts State Hazard and Climate Adaptation Plan 2018
16 Ibid.

Hazard Profiles

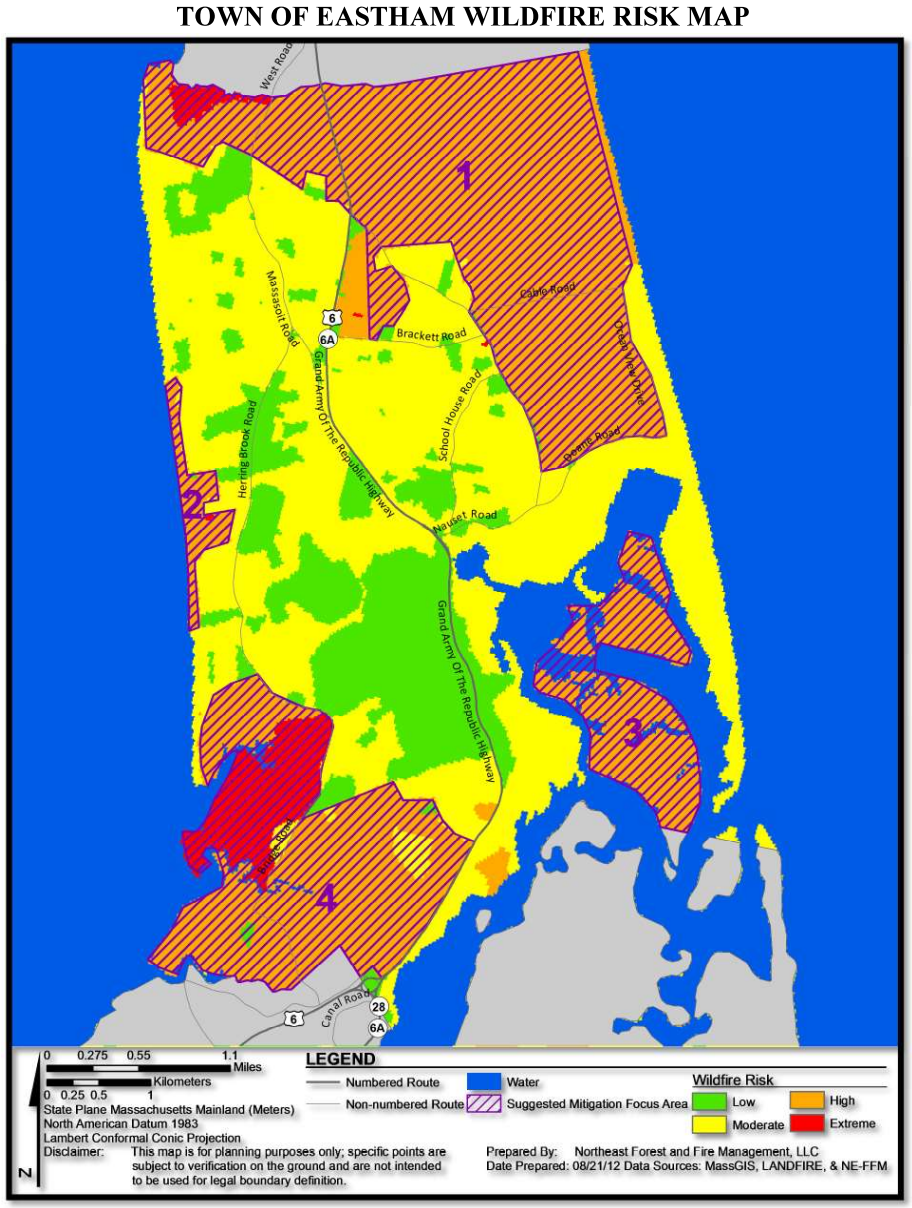


Figure 2.4 | Town of Eastham Wildfire Risk map from the Barnstable County Wildfire Preparedness Plan

Wellfleet (and beyond); bayside woodlands across from Wiley Park; bayside vegetated salt marsh areas between Bridge Road and the Eastham/Orleans rotary.

B1c, B2a,c

Previous Occurrences and Extent

The following is a list of notable wildland fires that occurred in Barnstable County since 1887:

- **1887:** A large forest fire burned over 25,000 acres from the Pocasset section of Bourne to Sandwich. This fire destroyed approximately 600 cords of stacked wood at the Sandwich Glass Company as well as several stands of oak and pine. The Sandwich Glass Company was forced to purchase and burn coal in its furnaces at a substantial financial cost. This, along with a labor union strike, ultimately contributed to the demise of the Sandwich Glass Company, one of the Cape's largest industrial businesses between 1825 and 1894. (www.capecodfd.com)
- **May 30, 1923:** A fire began in the woods of Pocasset village and burned through the day. It was under control by nightfall, only to flare up again and again for seven days. An area of approximately 25,000 acres, between Pocasset village, Sagamore, Sandwich, East Sandwich, and South Sandwich was left blackened. (www.capecodfd.com)
- **April 19, 20, 21, 1927:** 2,500 acres burned in Truro. (Barnstable Patriot, April 28, 1927)
- **1938:** 5,000-acre wildfire kills three Sandwich firefighters on Route 130 (https://www.mashpeema.gov/sites/mashpeema/files/uploads/mashpeewildlife.pdf)
- **April 1946:** Slash piles started by German prisoners of war at Camp Edwards blazed out of control and consumed 50,000 acres (https://www.mashpeema.gov/sites/mashpeema/files/uploads/mashpeewildlife.pdf)
- **June 1949:** 75 acres or more of brush and woodland burned after a fire started at the Truro Town Dump. Firefighters from Truro, Wellfleet, Brewster and Orleans helped bring it under control. (Provincetown Banner, June 16, 1949)

Wildland fires in Eastham are usually under an acre and located with the National Seashore forested areas. Seashore fire fighters works with the Town of Eastham Fire Department to control and manage fire in these locations. No significant urban fires have occurred in Eastham in recent years.

Impact

B3a

Destruction caused by urban fires and wildfires depends on the following factors:

- Size of the fire
- Landscape

Hazard Profiles

- Amount of fuel (i.e., vegetation and structures) in the path of the fire
- Direction and intensity of the wind
- Response time of fire personnel
- Number of firefighters able to respond to the fire
- Access to the fire once it starts

Below is a list of possible damages from urban and wildland fires.

- **People:** death or injury to people and animals, smoke can cause health issues for people, even for those far away from the fire.
- **Infrastructure:** gas, power and communications may be disrupted, flying embers can set fire to buildings more than one mile away from the initial fire.
- **Buildings:** structures can be damaged or destroyed, a large number of buildings can be burned.
- **Economy:** indirect economic losses in reduced tourism; as communication and infrastructure systems are damaged and disrupted, economic activities come to a standstill, often resulting in dislocation and dysfunction of normal business activities; when roadways are disrupted, it impacts the customer base for small businesses and leads to slow recovery times for these businesses; the high cost of relief and recovery may adversely affect investment in infrastructure or other development activities.
- **Natural Systems:** extensive acreage can be burned, damaging watersheds and critical natural areas, flash flooding and landslides can result from fire damage to the surrounding landscape; wildfires strip slopes of vegetation exposing them to greater runoff and erosion; this will weaken soils and cause failure on slopes, wildfires can affect the land for many years, including causing changes to the soil and therefore increasing the risk of future flooding, contamination of reservoirs, change the permeability of the ground. When fires burn hot and for long periods of time, the soil will bake and become impermeable. When this happens, runoff and the risk of flooding increases.
- **Transportation:** transportation may be temporarily disrupted.

Probability

B2b

The Planning Team determined that it is **LIKELY** that wild fire or urban fire will impact Eastham. Probabilities were defined based on the frequency of occurrence

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years

- **Highly Likely:** near 100% probability in the next year

The Planning Team used data collected from the 2013 Massachusetts State Hazard Mitigation Plan, the 2012 Barnstable County Wildfire Preparedness Plan and local knowledge of the town to make this probability determination.

Flood

Overview

Several types of flood hazards occur in and impact Eastham:

- **Flash flooding** occurs when a severe storm like a nor'easter or tropical storm causes a large amount of rain in a short period of time.[17]
- **Coastal flooding** occurs when persistent high wind and changes in air pressure during a hurricane or nor'easter push water towards the shore. This action causes storm surge which raises the level of the water by several feet. Waves can be highly destructive as they move inland, battering structures in its path. The magnitude of a flood varies with the tides; storm surge that occurs during high tide will flood larger areas than if the same surge occurred at low tide.[18]
- **Urban drainage** occurs in flat areas where runoff or rain collects and cannot drain out. Drainage systems are made up of ditches, storm sewers, retention ponds and other infrastructure that store runoff and carry it into a receiving stream, lake, or ocean. When most of these systems were built, they were designed to handle the amount of water expected during a 10-year storm event. Larger storms overload the system and result in back-ups. When this system is blocked, water forms temporary ponds. This water will remain in an area until it infiltrates into the soil, evaporates, the blockage is cleared or the water is actively pumped out.[19]

Hazard Location

B1c

Flooding in Eastham is also the direct result of coastal storms, nor'easters, heavy rains, tropical storms, and hurricanes. ***Figure 2.5*** shows the 2014 FEMA Flood Insurance Rate Map (FIRM) for Eastham. This map depicts areas of Eastham in V and A zones and the 2% annual flood areas.

Previous Occurrences and Extent

B1c, B2a,c

17 National Flood Insurance Program, Floodplain Management Requirements, FEMA 480

18 Ibid.

19 Ibid.

Hazard Profiles

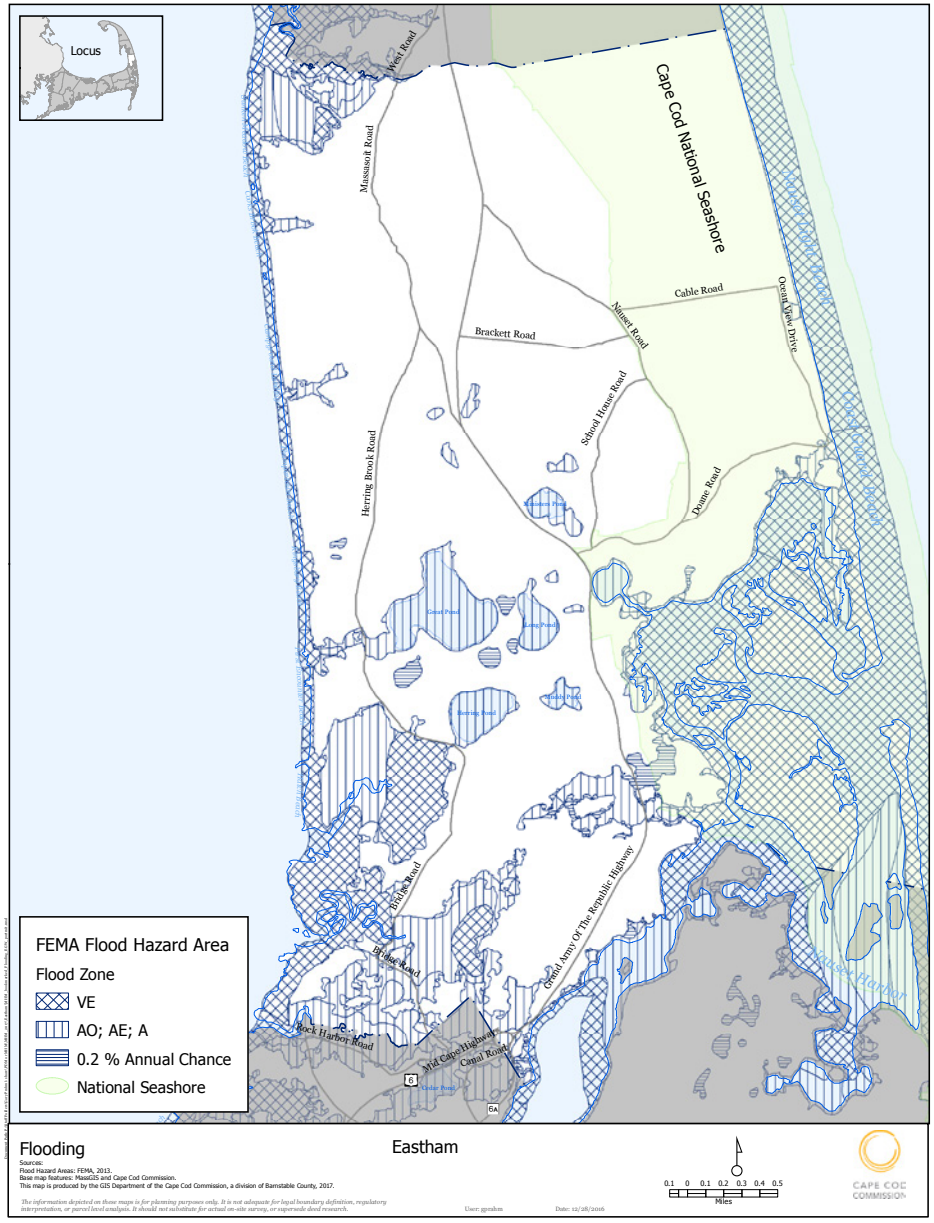


Figure 2.5 | 2014 FEMA Flood Hazard Area map for Eastham

Below is a list of notable rain, flooding and coastal flooding events experienced in Eastham and surrounding locations from 1970 - 2019. Data was collected from NOAA's National Climatic Data Center and local newspapers. It is not meant to be an exhaustive list of events but rather a representation of significant flooding occurrences.

- **December 17, 1970:** Lower/Outer Cape Cod: Rain closed schools, heavy rain and melting snow caused local flooding of roads and cellars, storm surge 3 ft above normal and eroded some coastal roads/ beaches, utility failures from flooded cable.
- **June 22, 2009:** An unusually strong coastal storm moved southeast of Nantucket, resulting in coastal flooding and strong winds across portions of coastal Massachusetts. Because of coastal erosion that began in 2007, the last 5 cottages of First Village (Chatham) on Nauset Beach, were lost in this storm.
- **March 7, 2013:** Minor coastal flooding occurred in Lower Cape communities, including Eastham, Harwich, Brewster, and Chatham.
- **January 3, 2014:** Moderate coastal flooding impacted portions of Cape Cod, creating flooded and impassable roads throughout the region. ¬
- **January 26-28, 2015:** Blizzard caused coastal flooding. Federal Declaration
- **January 4, 2018:** Blizzard caused coastal flooding at high tide
- **March 2-3, 2018:** Nor'easter caused erosion and extensive coastal flooding in Eastham and the surrounding region. The coastal flooding concern was centered around three high tides: midday Friday, midnight and midday Saturday. Wind gusts over 80 mph were recorded on Cape Cod. Bridge Road in Eastham flooded, as did nearby Rock Harbor Road in Orleans. This storm resulted in a Federal Disaster Declaration.
- **March 7, 2018:** Another Nor'easter struck the region, again bringing high winds, power outages and coastal flooding.
- **March 13, 2018:** High winds and heavy wet snow caused extensive power outages and coastal flooding the in third Nor'easter to strike the region in less than two weeks. The Town Cove area in Eastham flooded, with the Collins boathouse submerged beneath water.
- **August 9, 2018:** Heavy rain from a severe thunderstorm caused flooding and road closures. Bridge Road in Eastham was flooded and impassable.

B3a

Impact

Below is a list of the possible impacts for a flooding event in Eastham:

- People: people can be knocked down or washed off their feet while walking in floodwaters; injury and death for people who become trapped in their cars during a flood event; often people place themselves in harm's way by ignoring warning signs of water depth on roadways; people can be displaced from their homes because of post-flood safety and health hazards; mold, mildew and bacteria can cause health issues; flooding can cause drinking water to become contaminated.
- Infrastructure: flooding can leave large amount of debris and sediment on and around town infrastructure; floods can damage gas lines, utility poles, water infrastructure, wastewater treatment plants; cause sewage spills. Buildings: moving water can damage the walls of buildings; building foundations on the beach can be undermined by the velocity of floodwaters; floodwaters pick up anything that floats, including logs, lumber, propane tanks and vehicles – when this happens, these objects can act as battering rams and damage buildings; buildings can float off of their foundations if not anchored properly
- Economy: as communication and infrastructure systems are damaged and disrupted, economic activities come to a standstill, often resulting in dislocation and dysfunction of normal business activities; roadways disruptions affect the customer base and slow recovery times for small businesses; the high cost of relief and recovery may adversely affect investment in infrastructure or other development activities; there can be losses associated with decreased land value in floodplains
- Natural Systems: During flood events, storm water systems cannot handle the high water volume and oftentimes, untreated sewage can enter into the environment, floods can transfer sediment and debris into parks, beaches, estuaries, rivers, etc.
- Transportation: floods can wash out bridges and culverts, debris in floodwaters can occlude culverts so much that the culvert acts like a dam; roadways can be washed away in a flood event; there can be major disruptions to transit, train or ferry services.

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that flooding will impact the planning area. Probability was defined based on the frequency of occurrence:

- Unlikely: less than a 1% probability over the next 100 years
- Possible: 1-10% probability in the next year or at least one chance in the next 100 years

- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the history of hurricanes, tropical storms, nor'easters in Eastham to make this probability designation.

Hurricanes and Tropical Storms

Overview

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters.[20] In the Atlantic Basin, the hurricane season "officially" runs from June 1 to November 30; peak activity is in early to mid-September.[21]

There are four types of tropical cyclones that can occur in the Atlantic Basin:

- **Tropical Depression:** a tropical cyclone with maximum sustained winds of 38 mph or less
- **Tropical Storm:** a tropical cyclone with maximum sustained winds of 39 to 73 mph
- **Hurricane:** a tropical cyclone with maximum sustained winds of 74 mph or higher
- **Major Hurricane:** a tropical cyclone with maximum sustained winds of 111 mph winds or higher, corresponding to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale

Two data sets are used to classify tropical cyclones:

1. **Saffir-Simpson Hurricane Wind Scale** is a 1 to 5 rating based on a hurricane's sustained wind speed.[22] This scale estimates potential property damage (***Table 2.3***). Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.
2. **Amount and location of storm surge.** Storm surge is simply water that is pushed toward the shore by the force of the winds swirling around the storm.[23] This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase average water levels 15 feet (4.5 m) or more. In addition, wind-driven waves are superimposed on the storm tide. This

20 National Hurricane Center Outreach and Education, http://www.nhc.noaa.gov/climo/

21 National Hurricane Center Outreach and Education http://www.srh.noaa.gov/jetstream/tropics/tc_basins.htm

22 http://www.nhc.noaa.gov/aboutsshws.php

23 National Weather Service Jetstream – Online School for Weather, Tropical Weather, Tropical Hazards www.srh.noaa.gov/jetstream/tropics/tc_hazards.htm

Hazard Profiles

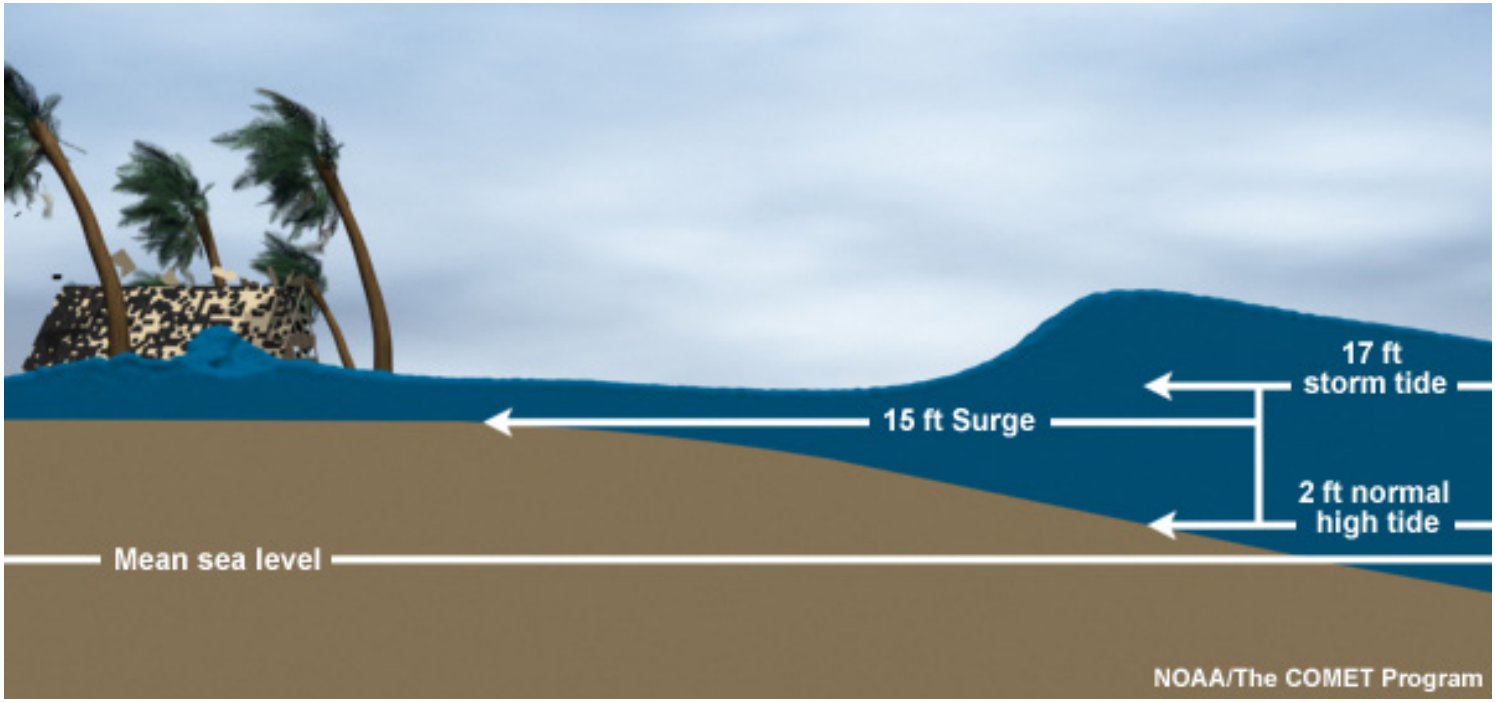


Figure 2.6 | Schematic of the generic differences between mean sea level, normal high tide, storm surge and storm tide. This graphic is for educational purposes only. The numbers shown (2, 15, 17 feet) are not specific to Eastham.

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Table 2.3 | Saffir-Simpson hurricane wind scale (National Hurricane Center)

rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides (***Figure 2.6***)

The US Army Corps of Engineers New England Division, in cooperation with FEMA, prepared Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation maps.[24] SLOSH mapping represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves. The mapping was developed for New England coastal communities using the computer model, Long Island Sound bathymetry, and New England coastline topography. The resulting inundation areas are grouped into Category 1 and 2, Category 3, and Category 4. The hurricane category refers to the Saffir-Simpson Hurricane Intensity Scale. The Army Corps of Engineers considered the highest wind speed for each category, the highest surge level, combined with worst-case forward motion and developed a model to depict areas that would be inundated under those combined conditions.

Hazard Location

B1c

The entire planning area is vulnerable to tropical cyclones. Coastal areas are extremely susceptible to damage because of wind and storm surge. Inland areas can also be affected by flooding, strong wind and heavy rain associated with tropical cyclones. ***Figure 2.7*** shows the predicted storm surge in the planning area for the Category 1-4 storms.

Previous Occurrences and Extent

B1c, B2a,c

The National Hurricane Center created maps showing the tracks of all known North Atlantic hurricanes and major hurricanes between the years 1851 and 2013 (***Figure 2.8***). These maps a strong history of hurricanes affecting the Atlantic Coast of the United States, including Barnstable County.

The Moris tool and data from NOAA was used to plot hurricane tracks making landfall in New England between 1851 and 2008 (***Figure 2.9***)

Data collected from the FEMA disaster declaration website, the 2013 MA State Hazard Plan, and local experts (including the Planning Team and the Barnstable County Emergency Planning Committee) was also used to document the previous occurrences of tropical cyclones that affected Cape Cod. ***Table 2.4*** describes the notable cyclones that affected Barnstable County and thus, the planning area.

24 Massachusetts State Hazard Mitigation Plan, 2013

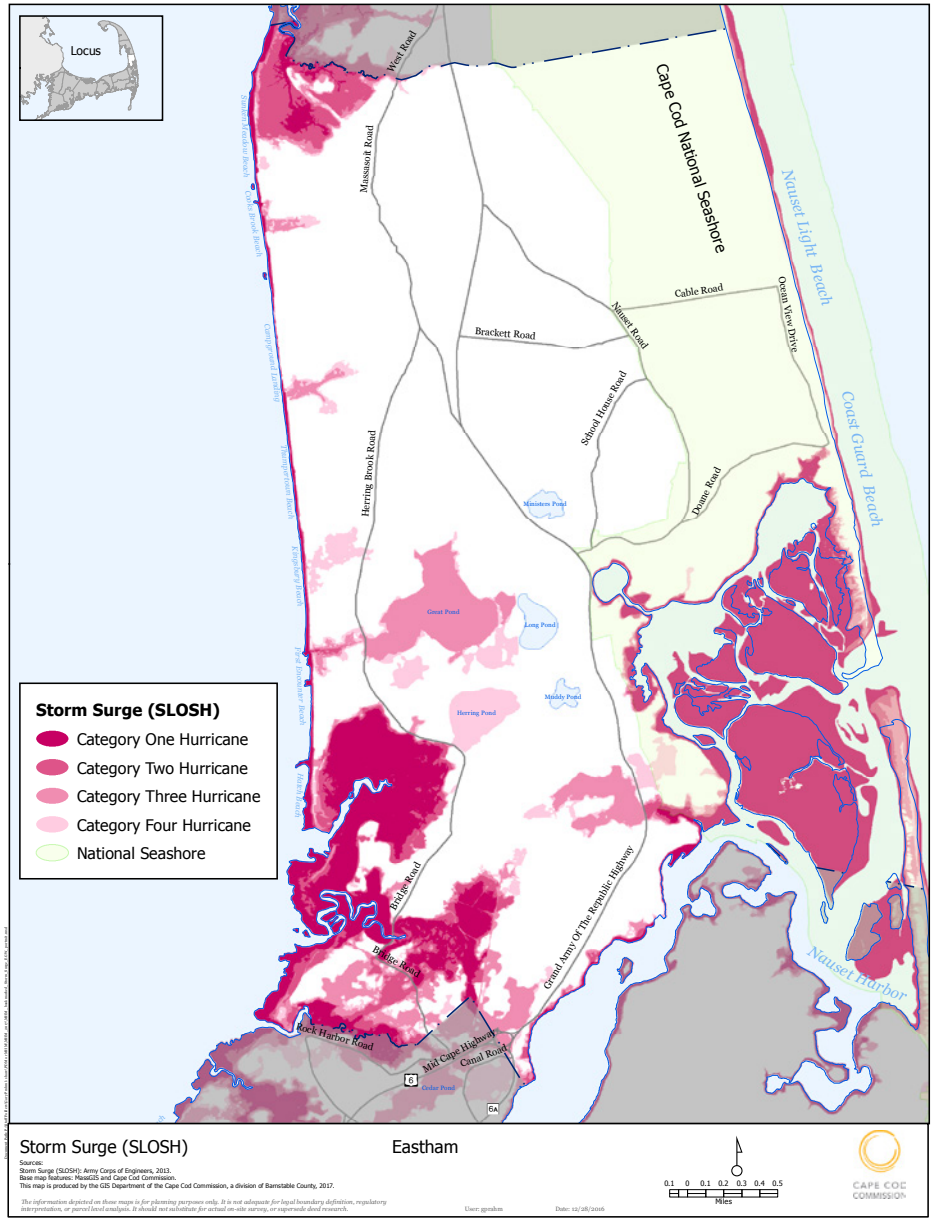


Figure 2.7 | SLOSH map for Eastham

Hazard Profiles

Notable Hurricanes and Tropical Cyclones for Barnstable County from 1954 - 2012							
Number	**Storm Name**	**Saffir-Simpson Classification**	**Landfall**	**Incident period**	**Declaration Date**	**Comments**	**References**
	Tropical Storm Arthur	TS		July 4, 2014			Barnstable County Regional Emergency Planning Committee
EM-3350	Tropical Storm Sandy	TS	Yes	October 27 to November 8, 2012	October 28, 2012	Barnstable County was designated for Category B Public Assistance	FEMA Disaster Declaration website
DR-4097	Tropical Storm Sandy	TS	Yes	October 27 to November 8, 2012	December 19, 2012	HMGP Assistance was provided for Barnstable County	FEMA Disaster Declaration website
EM-3330	Tropical Storm Irene	Category 2		August 26 to September 5, 2011	August 26, 2011	Barnstable County was designated for Category B Public Assistance	FEMA Disaster Declaration website
DR-4028	Tropical Storm Irene	Category 2		August 27 to August 29, 2011	September 3, 2011	HMGP Assistance was provided for Barnstable County	FEMA Disaster Declaration website
EM-3315	Hurricane Earl	Category 4		September 1 to September 4, 2010	September 2, 2010		FEMA Disaster Declaration website
DR-914	Hurricane Bob	Category 3	Yes	August 19, 1991	August 26, 1991		FEMA Disaster Declaration website
DR-751	Hurricane Gloria	Category 4		September 27, 1985	October 28, 1985		FEMA Disaster Declaration website
	Hurricane Donna	Category 5	Yes	September 12 to September 13, 1960	Not declared		FEMA Disaster Declaration website
	Hurricane Carol	Category 2-3		August 31, 1954	Not declared		Barnstable County Regional Emergency Planning Committee
	Hurricane Edna	Category 3	Yes	September 11, 1954	Not declared		Barnstable County Regional Emergency Planning Committee
	1938 Hurricane	Category 3	Yes	September 1938	Not declared		Barnstable County Regional Emergency Planning Committee
	1944 Hurricane	Category 4	Yes	September 1944	Not declared		Barnstable County Regional Emergency Planning Committee

Table 2.4 | History and extent of tropical storms and hurricanes for Barnstable County

B3a

Impact

The National Hurricane Center describes the types of damages that a community could experience during a Category 1-5 storm.[25]

CATEGORY 1: 74-95 mph 1 minute sustained winds

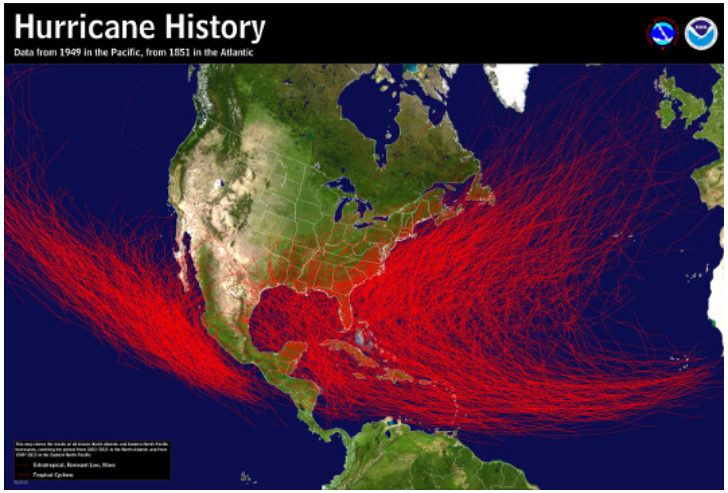
- Impacts to People, Pets, and Livestock:
  - Could result in injury or death from flying or falling debris
- Impacts to Frame Homes:
  - Some poorly constructed frame homes can experience major damage, involving loss of the roof covering, damage to gable ends, removal of porch coverings and awnings
  - Unprotected windows may break if struck by flying debris
  - Masonry chimneys can be toppled
  - Well-constructed frame homes could have damage to roof shingles, vinyl siding, soffit panels, and gutters
  - Failure of aluminum, screened-in, swimming pool enclosures can occur
- Impacts to Apartments, Shopping Centers, and Industrial Buildings
  - Some apartment building and shopping center roof coverings could be partially removed
  - Industrial buildings can lose roofing and siding especially from windward corners, rakes, and eaves
  - Failures to overhead doors and unprotected windows will be common
- Impacts to Signage, Fences, and Canopies:
  - There will be occasional damage to commercial signage, fences and canopies
- Impacts to Trees:
  - Large branches will snap
  - Shallow-rooted trees will be toppled
- Impacts to Power and Water Infrastructure:
  - Extensive damage to power lines and poles will likely result in power outages that could last up to several days

CATEGORY 2: 96-110 mph 1 minute sustained wind

- Impacts to People, Pets, and Livestock:
  - There is substantial risk of injury or death due to flying or falling debris
- Impacts to Frame Homes:

25 National Hurricane Center Outreach and Education, Saffir-Simpson Hurricane Wind Scale Extended Table, http://www.nhc.noaa.gov/aboutsshws.php

Hazard Profiles



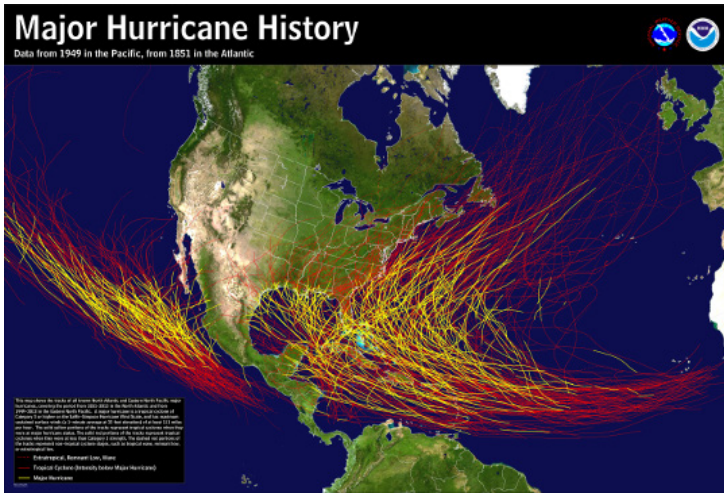


Figure 2.8 | Hurricanes and major hurricanes in the Atlantic Basin, National Hurricane Center.

- Poorly constructed frame homes have a high chance of having their roof structures removed, especially if they are not anchored properly
- Unprotected windows will have a high probability of being broken by flying debris
- Well-constructed frame homes could sustain major roof and siding damage
- Failure of aluminum, screened-in, swimming pool enclosures will be common

- Impacts to Apartments, Shopping Centers, and Industrial Buildings
  - There will be a substantial percentage of roof and siding damage to apartment buildings and industrial buildings
  - Unreinforced masonry walls can collapse
- Impacts to Signage, Fences, and Canopies:
  - Commercial signage, fences, and canopies will be damaged and often destroyed
- Impacts to Trees:
  - Many shallow-rooted trees will be snapped or uprooted
  - Roads will be blocked by toppled trees
- Impacts to Power and Water Infrastructure:

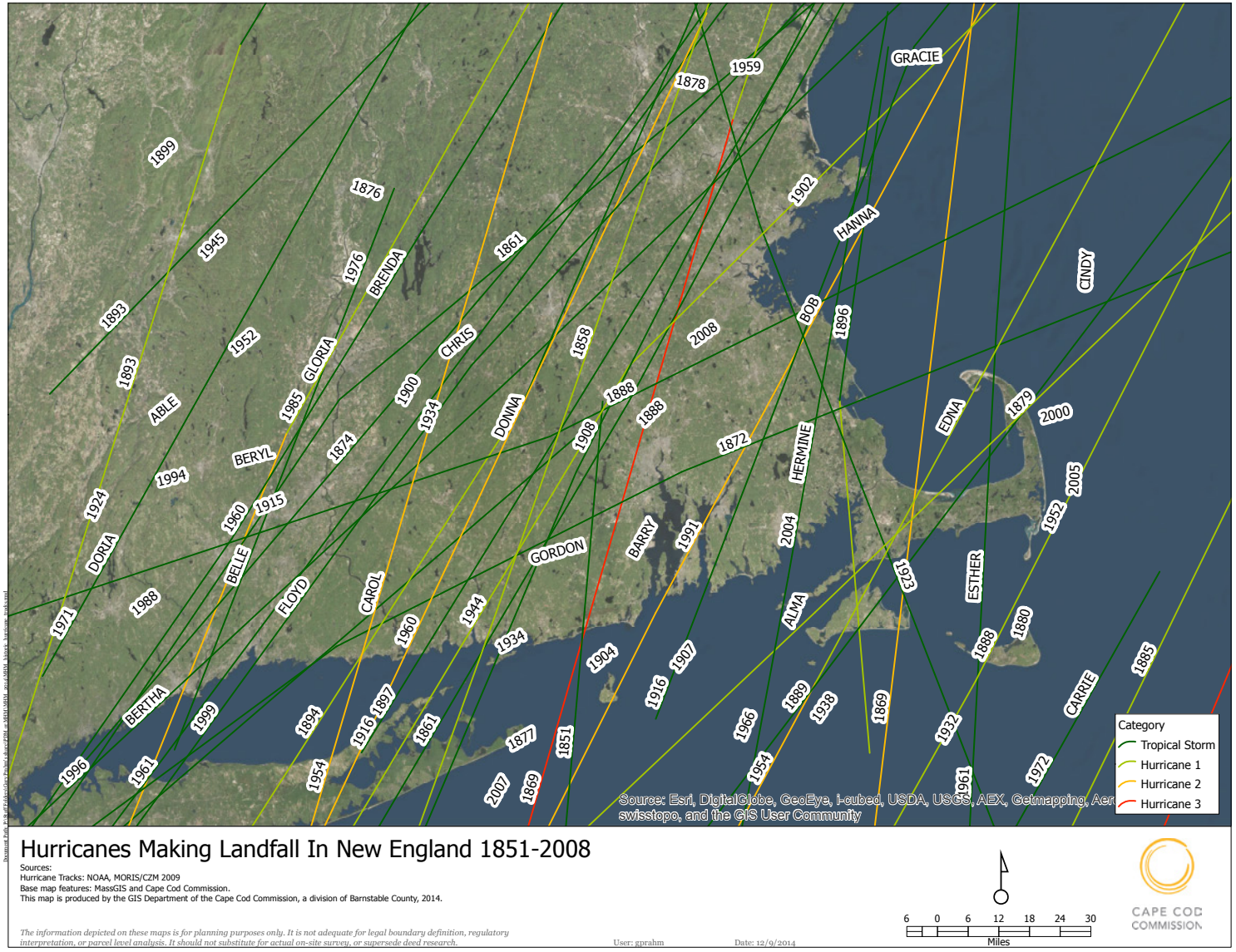


Figure 2.9 | Hurricanes making landfall in New England, 1851-2008

- Near total power loss is expected with outages that could last from several days to weeks
- Potable water could become scarce as filtration systems begin to fail

CATEGORY 3: 111-129 mph 1-minute sustained wind

- Impacts to People, Pets, and Livestock:
  - There is high risk of injury or death due to flying and falling debris
- Impacts to Frame Homes:
  - Poorly constructed frame homes can be destroyed by the removal of the roof and exterior walls
  - Unprotected windows will be broken by flying debris
  - Well-built frame homes can experience major damage involving the removal of roof decking and gable ends
- Impacts to Apartments, Shopping Centers, and Industrial Buildings
  - There will be a high percentage of roof coverings and siding damage to apartment and industrial buildings
  - Isolated structural damage to wood or steel framing can occur
  - Complete failure of older metal buildings is possible
  - Older unreinforced masonry buildings can collapse
- Impacts to Signage, Fences, and Canopies:
  - Most commercial signage, fences, and canopies will be destroyed
- Impacts to Trees:
  - Many trees will snap or become uprooted
  - Numerous roads will be blocked
- Impacts to Power and Water Infrastructure:
  - Electricity and water will be unavailable for several days to a few weeks after the storm passes

CATEGORY 4: 130-156 mph 1-minute sustained wind

- Impacts to People, Pets, and Livestock:
  - There is a very high risk of injury or death due to flying and falling debris
- Impacts to Frame Homes:
  - Poorly constructed homes can sustain complete collapse of all walls as well as the loss of the roof structure
  - Well-built homes also can sustain severe damage with loss of most of the roof structure and/or some exterior walls

- Extensive damage to roof coverings, windows, and doors will occur. Large amounts of wind-borne debris will be lofted into the air
- Wind-borne debris will break most unprotected windows and penetrate some protected windows

- Impacts to Apartments, Shopping Centers, and Industrial Buildings:
  - There will be a high percentage of structural damage to the top floors of apartment buildings
  - Steel frames in older industrial buildings can collapse
  - There will be a high percentage of collapse to older unreinforced masonry buildings
- Impacts to Signage, Fences, and Canopies:
  - Nearly all commercial signage, fences, and canopies will be destroyed
- Impacts to Trees:
  - Most trees will snap or become uprooted
  - Power poles will be downed
  - Numerous roads will be blocked
  - Fallen trees and power poles will isolate residential areas
- Impacts to Power and Water Infrastructure:
  - Power outages will last for weeks to possibly months
  - Long term shortages will increase human suffering
  - Most of the area will be uninhabitable for weeks to months

CATEGORY 5: 157 mph or higher 1-minute sustained wind

- Impacts to People, Pets, and Livestock:
  - There is a very high risk of injury or death due to flying and falling debris even if indoors in mobile or framed homes
- Impacts to Frame Homes:
  - A high percentage of frame homes will be destroyed, with total roof failure and wall collapse
  - Extensive damage to roof covers, windows, and doors will occur
  - Large amounts of wind-borne debris will be lofted into the air
  - Wind-borne debris damage will occur to nearly all unprotected windows and many protected windows
- Impacts to Apartments, Shopping Centers, and Industrial Buildings:
  - Significant damage to wood roof commercial buildings will occur due to loss of roof sheathing

- Complete collapse of many older metal buildings can occur
- Most unreinforced masonry walls will fail, which can lead to building collapse
- A high percentage of industrial buildings and low-rise apartment buildings will be destroyed

- **Impacts to Signage, Fences, and Canopies:**
  - Nearly all commercial signage, fences, and canopies will be destroyed
- **Impacts to Trees:**
  - All trees will snap or become uprooted
  - All power poles will be downed
  - Fallen trees and power poles will isolate residential areas
- **Impacts to Power and Water Infrastructure:**
  - Power outages will last for weeks to possibly months
  - Long-term shortages will increase human suffering
  - Most of the area will be uninhabitable for weeks to months

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that a hurricane or tropical storm will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the history of tropical storms and hurricanes in Barnstable County and local knowledge to make this probability designation.

Landslides

Overview

A landslide is a general term used to describe the downslope movement of soil, rock, and organic materials under the effect of gravity.[26]

Most landslides in Massachusetts are caused by a combination of unfavorable geologic conditions (silty clay or clay layers contained in glaciomarine, glaciolacustrine, or thick till deposits), steep slopes, and/or excessive wetness leading to excess pore pressures in the subsurface.[27] Conditions associated with landslides include the following:

- **Water saturation** on a slope occurs after intense rainfall, snow melt, changes in level of groundwater and water level changes along coasts and banks. Water from a rain event adds weight to the slope and reduces the strength of slope materials.
- **Undercutting of slopes by flooding and wave action** occurs when streams and waves erode the base of slopes, causing them to over-steepen and eventually collapse. Areas where this type of failure occurs includes Cape Cod, Nantucket and Martha's Vineyard.
- **Construction related failures** occur during construction activities such as cut and fill construction for highways and roads and when vegetation on a slope is removed during the construction of buildings. These activities can increase slope angle and decrease lateral support which can sometimes lead to landslide.[28]

Hazard Location

B1c

Landslides occur in every state in the U.S., but the majority of Massachusetts has a low incidence of landslides. In Eastham, the risk of flooding and loose soils could result in a landslide in the planning area.

Previous Occurrences and Extent

B1c, B2a,c

No federally declared landslide disasters occurred in Barnstable County between 1954 and 2020. To date, no significant landslides have occurred in Eastham.

Based on reports from the USGS website, the extent of a landslide is quantified as the estimated amount of material in cubic yards that was deposited from a higher elevation. Eastham has no history of landslide occurrence, so no data exists on landscape conditions and extent.

26 The Landslide Handbook – A Guide to Understanding Landslides USGS Circular 1325, 2008

27 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

28 Landslide Loss Reduction: A Guide for State and Local Government Planning, FEMA-182, 198

B3a

Impact

Below is a list of possible impacts that could result from a landslide.

- **People:** people, cars and homes can become buried, delays in emergency services, isolated residents
- **Infrastructure:** damaged power lines
- **Buildings:** unstable foundations of structures, damage and destruction to buildings because of the movement of sediment and flooding
- **Economy:** isolated businesses
- **Natural Systems:** downed trees, decreased water quality
- **Transportation:** road closures, damage to road segments and/or culverts, transportation delays because of blocked access to roadways

B2b

Probability

The Planning Team determined that it is **POSSIBLE** that a landslide will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the history of flooding and the presence of loose soils to make this probability determination.

Nor'easters

Overview

A nor'easter is a cyclonic storm that forms outside of the tropics and moves along the east coast of North America.[29] It is called a nor'easter because the winds over coastal areas blow from a northeasterly direction. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and then move north or northeastward. Once these storms reach New England, they usually become more intense. Nor'easters can occur at any time of year but are most frequent between September and April. The years with the most nor'easters tend to coincide with El Niño events.[30]

The east coast of North America provides an ideal breeding ground for nor'easters. During the winter, the

29 NOAA: Know the dangers of nor'easters, http://www.noaa.gov/features/03_protecting/noreasters.html

30 "Storm of the Century" by Susan Milton, Cape Cod Times, reported in the February 3, 2008 issue

polar jet stream transports cold Arctic air southeast across Canada, the United States and the Atlantic Ocean. In addition, warm air from the Gulf of Mexico and the Atlantic moves northward, keeping the coastal waters relatively mild during the winter. This difference in temperature between the warm air over the water and cold Arctic air over the land is the area where nor'easters are born.

Nor'easters bring heavy rain and snow, gale force winds, rough seas, coastal flooding and can cause beach erosion. Sustained wind speeds of 20-40 mph are common during a nor'easter with short-term wind speeds gusting up to 50-60 mph.[31] Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and producing extended periods of heavy precipitation. The level of damage in a strong hurricane is often more severe than a nor'easter, but historically Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (one or two per year).

Traditionally, nor'easters are not given names like hurricanes and tropical storms. This changed as a result of The Weather Channel's adopting a naming protocol in 2012 that gained popularity in defining storm systems. Nor'easters do not have their own categorization scheme; instead aspects of a nor'easter are categorized. For example, the Beaufort Scale is used to categorize the wind speed of a nor'easter (small craft advisory, gale warning, storm warning, hurricane force wind warning) and the Regional Snowfall Index is used to categorize snowfall during a nor'easter.

Hazard Location

B1c

Coastal areas of Eastham are the most susceptible to damages from wind, snow and surge during a nor'easter. However, it is also important to note that nor'easters can also bring heavy snow and flooding to the entire planning area.

Previous Occurrences and Extent

B1c, B2a,c

Since nor'easters are not categorized like hurricanes and tropical storms, it is difficult to track their history. Also, it is important to note that hurricanes and tropical storms can transform into nor'easters, making it especially difficult to track the history of nor'easters in a particular area.

The following is a list of some of the nor'easters that have affected Barnstable County, but it is not a complete list because of the reasons mentioned above:

:

31 Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

- **February 1978:** this blizzard/nor'easter produced 8-12 inches of snow as well as ice and flooding and 92 mph winds in Chatham. It damaged buildings and infrastructure across Barnstable County including battering the bathhouse and parking lot at Coast Guard Beach in Eastham; waves flooded and flattened dunes on barrier beaches in Chatham, Eastham and Orleans; Monomoy Island off of Chatham split in several places; homes were destroyed; the Outer Cape was an island for a few hours when a 16-foot storm tide flooded Route 6 at Fort Hill with three feet of water; Bridge Road flooded in Eastham.[32] This event resulted in a federal disaster declaration (FEMA DR-546).
- **October-November 1991:** This large nor'easter was an unusual event because it moved south and strengthened when it joined with Hurricane Grace – producing what some would call the "Perfect Storm." Winds measured over 80 mph with waves over 30 feet high in some parts of the coastline. This event resulted in a federal disaster declaration (FEMA DR-920).
- **December 1992:** A strong nor'easter affected the Commonwealth from December 11 to 13, 1992. Impacts included deep and intense snowfall, freezing rain, heavy rainfall near the coast, coastal flooding and damaging winds. The weight of the snow taxed snow removal equipment in many communities and caused roof damage. Precipitation totals for this storm were extraordinary. Much of southern New England received up to 5 inches of liquid equivalent precipitation during a 2 to 3 - day period, with locally close to 8 inches recorded in parts of southeast Massachusetts. Along coastal sections of Massachusetts, much of the precipitation fell as rain or rain/snow mix. This caused considerable ponding and localized flooding in poorly drained areas. The greatest damage from this storm was due to coastal flooding. Most east-facing shoreline communities from Chatham to Wellfleet and Plymouth to the North Shore, as well as Nantucket Island, experienced some level of coastal flood damage. As much as 20 feet of dune was lost in Sandwich. Many coastal roads were closed and docks and cottages were damaged.
- **March 1994:** A strong nor'easter passed to the southeast of Cape Cod, resulting in heavy snow and drifting snow. Over southeast Massachusetts, between three and six inches of snow fell before it changed to rain. Wind gusts of up to 40 and 60 mph resulted from this event and created snow drifts of up to three feet. Buildings were damaged, businesses and schools were closed, and road travel was disrupted.
- **January 22-23, 2005:** A major winter storm brought heavy snow, high winds, and coastal flooding to southern New England. In Massachusetts, blizzard conditions were reported on Nantucket. Near-

32 Ibid.

blizzard conditions were reported in areas and brought between one and three feet of snow and produced wind gusts of up to 65 mph. The highest snowfall totals were reported in eastern Massachusetts (between two and three feet). Minor to moderate coastal flooding was observed around high tide in eastern Massachusetts coast. Roads were inundated and evacuations occurred.

- **April 2007:** an intense coastal storm brought rain and coastal/inland flooding to eastern Massachusetts. The storm was primarily a rain event due to warmer temperatures. For this Patriot's Day Storm, the surge peaked on a high tide on April 16, 2007 and the time period of one-foot surge lasted more than four high tides (~47 hours). Major coastal flooding and storm damage resulted not only from the severity of the storm but also due to the timing of the Perigean spring tides. The 2007 nor'easter hit during highest predicted tide of the month which was also the top 0.2% of the year. This 2007 storm breached the barrier beaches at both Pleasant Bay on the Lower Cape and Katama Bay on Martha's Vineyard. While some breaches will close by themselves in a short amount of time, both of these 2007 breaches became new inlets for the bays. This event resulted in a federal disaster declaration (FEMA DR-1701). Counties included in this disaster received over $8 million in public assistance from FEMA.
- **January 2015:** Winter storm Juno was a powerful nor'easter that impacted the northeast and New England.[33] Governor Baker declared a state of Emergency and issued travel bans in preparation for this storm; all shelters in Barnstable County were opened; transit and ferry services were cancelled; winds gusted to 75 mph; rain/snow mix transitioning to 15-18 inches of snow; thundersnow occurred in various regions across Cape Cod; storm surge and coastal flooding caused erosion in many areas on Cape Cod; Pilgrim Nuclear Power Station shutdown in response to degrading offsite electrical grid conditions; dune break at Ballston Beach in Truro; significant damage to coastal areas in Cape Cod National Seashore. This event resulted in a Federal Disaster Declaration (FEMA DR-4214).
- **January 4, 2018:** A Nor'easter caused coastal flooding and power outages from downed wires in Eastham and the surrounding region, particularly low lying areas of the Lower and Outer Cape.
- **March 2-3, 2018:** Nor'easter caused erosion and extensive coastal flooding in Eastham and the surrounding region. The coastal flooding concern was centered around three high tides: midday Friday, midnight and midday Saturday. Boston saw a near record high tide around noon Friday, according to the National Weather Service. Boston's storm

33 http://capeandislands.org/post/blizzard-2015-delivers-high-wind-more-snow-forecast

surge was near 4 feet after 2 p.m. Wind gusts over 80 mph were recorded on Cape Cod. This storm resulted in a Federal Disaster Declaration.

- **March 7, 2018:** Another Nor'easter struck the region, again bringing high winds, power outages and coastal flooding.
- **March 13, 2018:** High winds and heavy wet snow caused extensive power outages and coastal flooding the in third Nor'easter to strike the region in less than two weeks. The Town Cove area in Eastham flooded, with the Collins boathouse submerged beneath water.

B3a

Impact

Below is a list of possible impacts that could occur in Eastham during a nor'easter:

- **People:** Longer response time for emergency personnel; see also impact on people in the Flood Hazard profile.
- **Infrastructure:** damages to water infrastructure; utility outages
- **Buildings:** wind damage to buildings, see also damages to buildings in the Flood Hazard Profile
- **Economy:** loss of business function; damage to inventory; relocation costs; wage loss
- **Natural Systems:** snow and ice accumulation can negatively impact vegetation and natural habitat, downed trees and fallen branches; coastal landscape can be reshaped by storm surge
- **Transportation:** roadways can become impassable from storm surge and debris; culverts damaged from storm surge

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that a nor'easter will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the history of nor'easters impacting Eastham to make this probability designation.

High Winds

Overview

Wind is air in motion relative to the ground surface.[34] High winds can occur as an isolated event or it can accompany other weather events such as:

- Before and after frontal systems
- Hurricanes and tropical storms
- Severe thunder and lightning storms
- Tornadoes
- Nor'easters

The National Weather Service issues warnings and advisories for high wind events as follows:

- **Wind Advisory:** for non-tropical events over land, sustained winds of 31-39 mph for at least one hour or any gusts up to 46-57 mph
- **High Wind Warning:** for non-tropical events over land, sustained winds of 40-73 mph or any gusts 58+ mph
- **Small Craft Advisory:** for non-tropical events over water, sustained winds of 29-38 mph
- **Gale Warning:** for non-tropical events over water, sustained winds of 39-54 mph
- **Storm Warning:** for non-tropical events over water, sustained winds of 55-73 mph
- **Hurricane Force Wind Warning:** for non-tropical events over water, sustained winds of 74+ mph
- **Tropical Storm Warning:** for tropical systems, any inland or coastal area with expected sustained winds from 39-73 mph
- **Hurricane Warning:** for tropical systems, any inland or coastal area with expected sustained winds of 74+ mph

Hazard Location

B1c

FEMA compiled 40 years of tornado history and 100 years of hurricane history to generate a map of the frequency and strength of windstorms in the United States (***Figure 2.10***).

The map shows that Eastham is located in Wind Zone II with maximum wind speeds of 160 mph. Since this map pertains to hurricane and tornado winds, it does not capture wind advisories, high wind warnings, small craft advisories, and gale warnings; it generalizes data at the local level. As a coastal location, Eastham experiences numerous high wind events other than hurricanes and Tornadoes.

34 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

Hazard Profiles

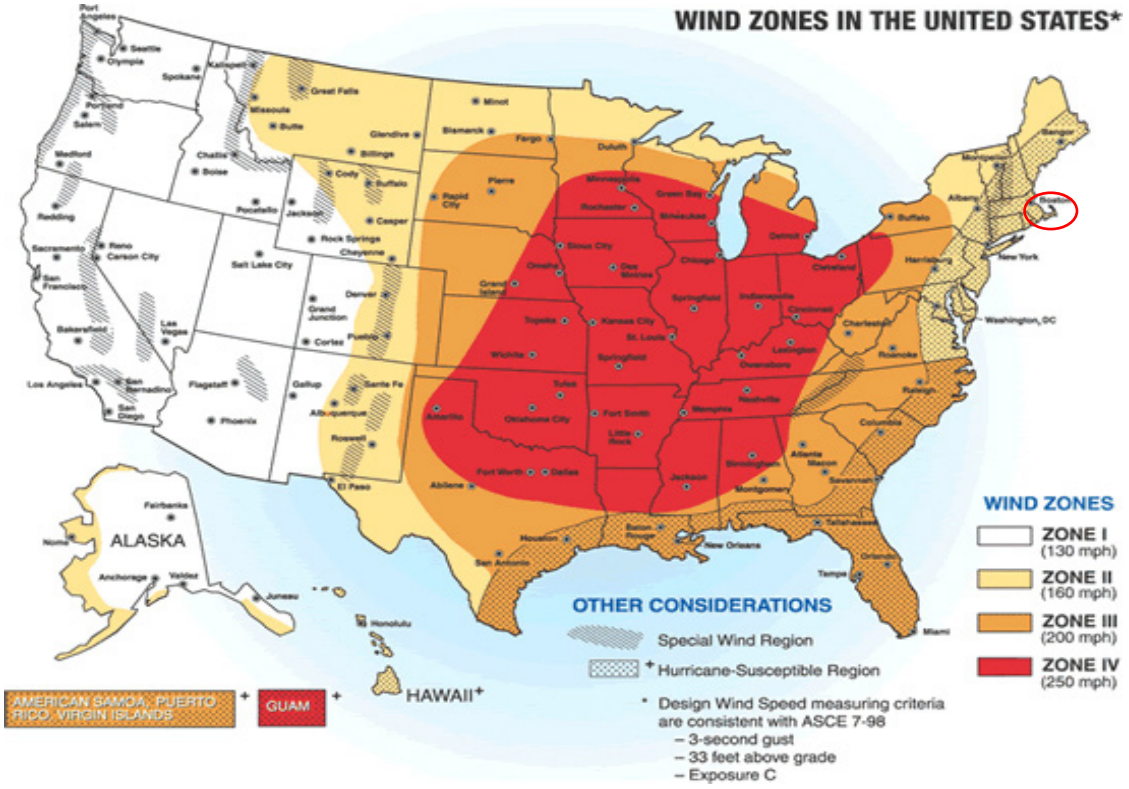


Figure 2.10 | Map of frequency and strength of windstorms in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan.

B1c, B2a,c

Previous Occurrences and Extent

Over the last 10 years (between December 1, 2009, and December 1, 2019), a total of 129 high wind events were recorded in Barnstable County on 63 days. High winds are defined by NWS 10-1605 as sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration.[35] The probability of future high wind events is expected to increase as a result of climate projections for the state that suggest a greater occurrence of severe weather events in the future. Specific information on the extent of these NCDC wind events in Eastham is not available.

B3a

Impact

Table 2.3 lists possible damages that can result from high wind events.

- **People:** power outages can affect vulnerable populations especially if outages occur during the winter months
- **Infrastructure:** downed power lines, power outages (wind gusts of only 40-45 mph have caused scattered power outages from downed trees and wires), high wind events can generate rough seas which can cause damage to coastal infrastructure
- **Buildings:** damage to roofs, windows; the roof on the Surfside Inn blew off in Hurricane Bob and damaged the houses across the street
- **Economy:** loss of power can cause businesses to close temporarily until power is restored
- **Natural Systems:** downed trees and branches

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that a high wind event will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used Eastham's history of high winds, hurricanes/tropical storms, and nor'easters as well as the town's proximity to the ocean to make this probability determination.

35 National Climate Data Center

Thunderstorms

Overview

A thunderstorm is a storm that produces lightning and thunder and is usually accompanied by gusty winds, heavy rain and sometimes hail.[36] The National Weather Service considers a thunderstorm to be severe if it produces any of the following: hail at least one inch in diameter, winds of 58+ mph, or a tornado.

The National Weather Service considers a thunderstorm to be severe if it produces any of the following: hail at least one inch in diameter, winds of 58+ mph or a tornado.

Three basic "ingredients" are required for the formation of a thunderstorm: moisture that forms clouds and rain, unstable air that rises rapidly and lift caused by cold or warm fronts, sea breezes or heat from the sun. The following is a description of the formation of thunderstorms.[37]

The rising air in a thunderstorm cloud causes various types of frozen precipitation to form within the cloud (i.e. small ice crystals, snow and ice pellets, and water pellets). The smaller ice crystals are carried upward toward the top of the clouds by the rising air while the denser ice pellets are either suspended by the rising air or start falling towards the ground. Collisions occur between the ice crystals and the pellets and these collisions serve as the charging mechanism for the thunderstorm. The small ice crystals become positively charged while the pellets become negatively charged. As a result, the top of the cloud becomes positively charged and the middle to lower part of the cloud becomes negatively charged. When the charge difference between the ground and the cloud becomes large, a charge starts moving toward the ground and a powerful discharge occurs between the cloud and the ground (***Figure 2.11***).

This discharge is seen as a bright, visible flash of lightning. The channel of air through which lightening passes can be heated to 50,000°F. The rapid heating and cooling of the air near this lightning channel causes a shock wave that results in the sound of thunder. Compared to hurricanes and winter storms, thunderstorms affect a relatively small area. The typical thunderstorm is 15 miles in diameter and lasts on average for 30 minutes.[38]

36 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

37 Thunderstorms, Tornadoes, Lightning: Nature's Most Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service

38 NOAA's National Weather Service, Storm Prediction Center: http://www.spc.noaa.gov/faq/tornado/f-scale.html

Figure 2.11 | Schematic of how lightning develops, from Thunderstorms, Tornadoes and Lightning: Nature's Most Violent Storms

B1c

Hazard Location

According to a map presented in the Massachusetts State Hazard Plan, Barnstable County experiences about approximately 20 thunderstorm days per year (see ***Figure 2.12***).

B1c, B2a,c

Previous Occurrences and Extent

Figure 2.12 indicates that Massachusetts experiences between 20 and 30 thunderstorm days. Using local knowledge, the Planning Team concluded that at least a few thunderstorms occur every year in Eastham, but data on these storm events is not consistently recorded at the local level. The thunderstorm profile relies on data from the NOAA National Climatic Data Center (NCDC) but this website does not have searchable data at the town level.

The following is a list of some historical thunderstorms that occurred on Cape Cod between July 2015 and August 2019; although it is not a complete list:

- **August 4, 2015:** A line of thunderstorms developed across Long Island, NY and moved quickly towards RI and southeastern MA. These storms caused significant wind damage knocking down a significant number of trees.
- **July 15, 2016:** A weak frontal boundary stalled across the I-95 corridor and was the focus for showers and thunderstorms to develop during the afternoon. A few of these storms produced damaging winds. The Automated Weather

Observation System at Provincetown Municipal Airport recorded a wind gust of 63 mph associated with the thunderstorm.

- **July 22, 2016:** A cold front moved through southern New England and when coupled with the existing heat and humidity, resulted in showers and thunderstorms developing over much of the area late in the day and continuing into the evening and overnight hours.
- **August 9, 2018:** A cold front moved across Massachusetts, bringing thunderstorms and downpours to Southeast Massachusetts and especially over Cape Cod. Up to 4.5 inches of rain fell on Cape Cod during the morning and early afternoon. Lightning struck a house on Mill Road in Eastham.
- **July 22, 2019:** A line of severe thunderstorms rolled across Cape Cod, leading the National Weather Service to issue a tornado warning. Lightning strikes together with high winds caused numerous power outages, fallen limbs, and downed trees that blocked roads. Flash flooding occurred in several locations.
- **July 23, 2019:** Thunderstorms brought heavy downpours and high winds to the region, again causing flash flooding, downed trees, and blocked roads. The storms brought one or more Tornadoes to the Cape, that caused extensive power outages, downed trees, building damage, including roof removal, and road blockages, with heavy dames in parts of Yarmouth, Dennis, Harwich, and Chatham.

Impact

B3a

Below is a list of impacts that could occur during a thunderstorm:

- **People:** power outages can affect vulnerable populations, especially if outages occur during the winter months; injury or death can occur because people are often caught outdoors during a thunderstorm and do not have enough time to run inside; people can become stuck if area flooding occurs
- **Infrastructure:** downed power lines and power outages; heavy rain associated with a thunderstorm can overwhelm drainage systems causing area flooding and property destruction
- **Buildings:** damage to roofs and windows; heavy rain associated with a thunderstorm can overwhelm drainage systems causing area flooding and property destruction; lightning strikes can cause buildings to catch on fire
- **Economy:** loss of power can cause businesses to close temporarily until power is restored; lightning strikes are possible during thunderstorm events which can cause economic loss to businesses

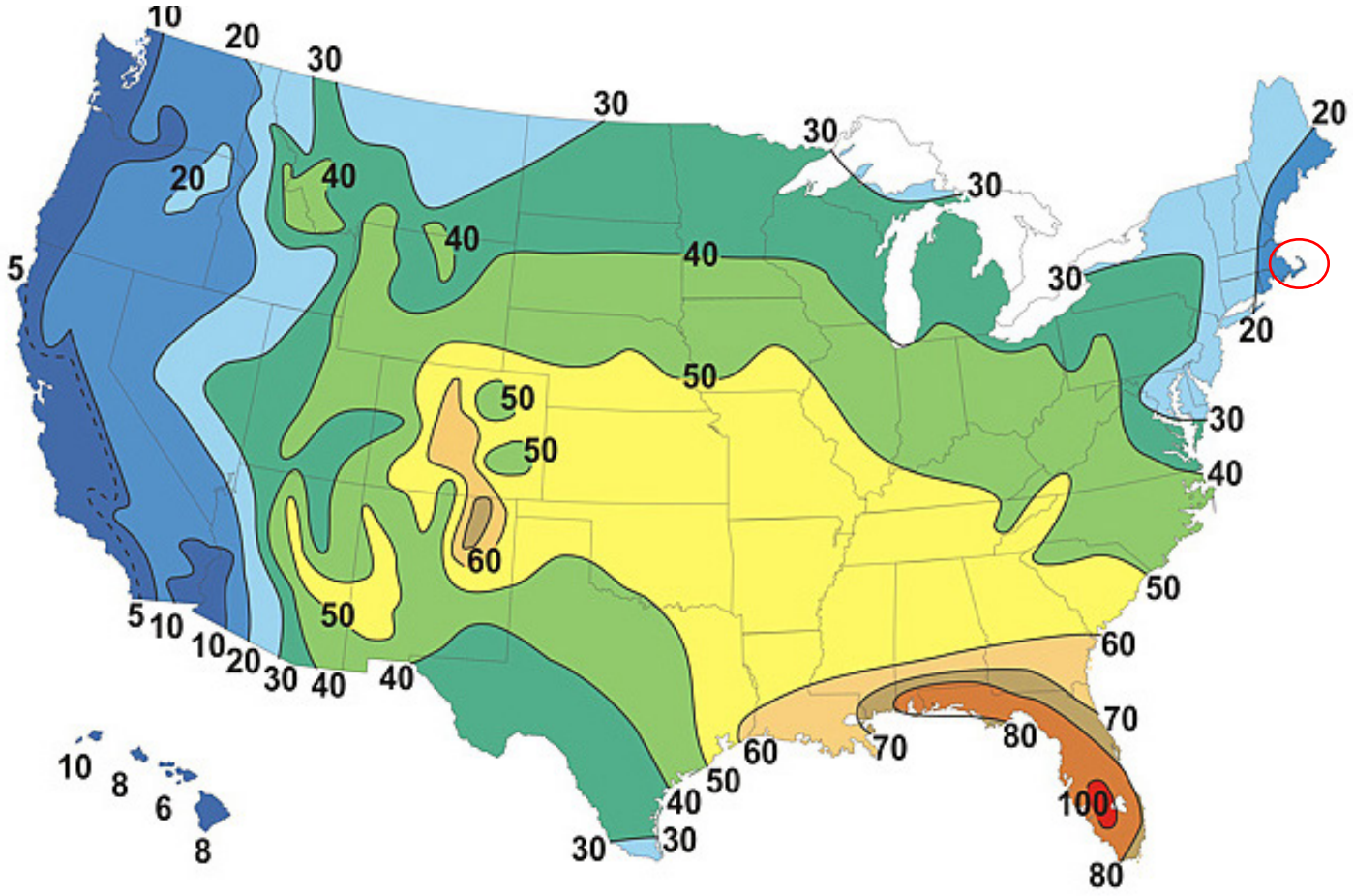


Figure 2.12 | Map of the average number of thunderstorms per year in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan

- **Natural Systems:** downed trees and branches

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that thunderstorms will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used Eastham's history of thunderstorms to make this probability determination.

Extreme Temperatures

Overview

Extreme temperatures are defined as temperatures that are far outside the normal ranges for the season in a specific area. Extreme cold events occur when temperatures drop well below normal in an area. Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0°F or below. Excessive summer temperatures are often identified as the number of days with maximum temperatures greater than or equal to 90°F and greater than or equal to 100°F.

B1c

Hazard Location

The entire planning area is vulnerable to extreme temperatures.

B1c, B2a,c

Previous Occurrences and Extent

According to NOAA's National Climatic Data Center (NCDC), the following extreme heat and extreme cold events were reported for Barnstable County between December 1, 2009 and December 1, 2019:

- **July 22, 2011:** Extreme heat event. A strong upper level ridge brought very hot temperatures to Southern New England and increased humidity levels such that heat index values rose above 105

degrees for a period of a few hours. The Automated Weather Observation System at Coast Guard Air Station Cape Cod (KFMH) near Falmouth, recorded heat indexes of 105 over a three-hour period. The Automated Weather Observation System at Provincetown Municipal Airport (KPVC) also recorded heat indexes of 105 during this time frame.

- **August 22, 2011:** Extreme heat event. A strong upper level ridge brought very hot temperatures to Southern New England and increased humidity levels such that heat index values rose above 105 degrees for a period of a few hours. The Automated Weather Observation System at Coast Guard Air Station Cape Cod (KFMH) near Falmouth, recorded heat indexes of 105 over a three hour period. The Automated Weather Observation System at Provincetown Municipal Airport (KPVC) also recorded heat indexes of 105 during this time frame.
- **February 14, 2016:** Arctic high pressure brought strong northwest winds and extremely cold wind chills to southern New England. Many locations reported wind chills between 25 and 35 degrees below zero. Wind chills as low as 32 below zero were reported in Falmouth and Hyannis

Impact

B3a

Below is a list of possible impacts that could occur during extreme temperature events[39]:

- **People:** children and elderly are particularly at risk to health problems associated with extreme temperature; heat-induced illness such as sunburn, heat cramps, heat exhaustion and heat stroke; cold-induced illness such as frost bite and hypothermia; air quality can be affected during extreme heat events which can cause health hazards; residents can be displaced if warming/cooling centers are opened during extreme temperature events
- **Infrastructure:** power failure; salt water freezes in bays/harbors and can damage coastal infrastructure; extreme temperatures can cause school closings
- **Buildings:** in extreme cold temperature, urban fire risk increases as people often use space heaters, generators and candles to stay warm
- **Economy:** extreme cold temperatures can inhibit fishing and other outdoor operations/work and the transport of goods and services
- **Natural Systems:** saltwater freezing can occur in coastal bays and harbors
- **Transportation:** icy roads make travel difficult

39 Massachusetts State Hazard Mitigation and Climate Adaption Plan, 2018

B2b

Probability

The Planning Team determined that it is **LIKELY** that extreme temperatures will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used Eastham's history of extreme temperatures in town to make this probability determination.

Tornadoes

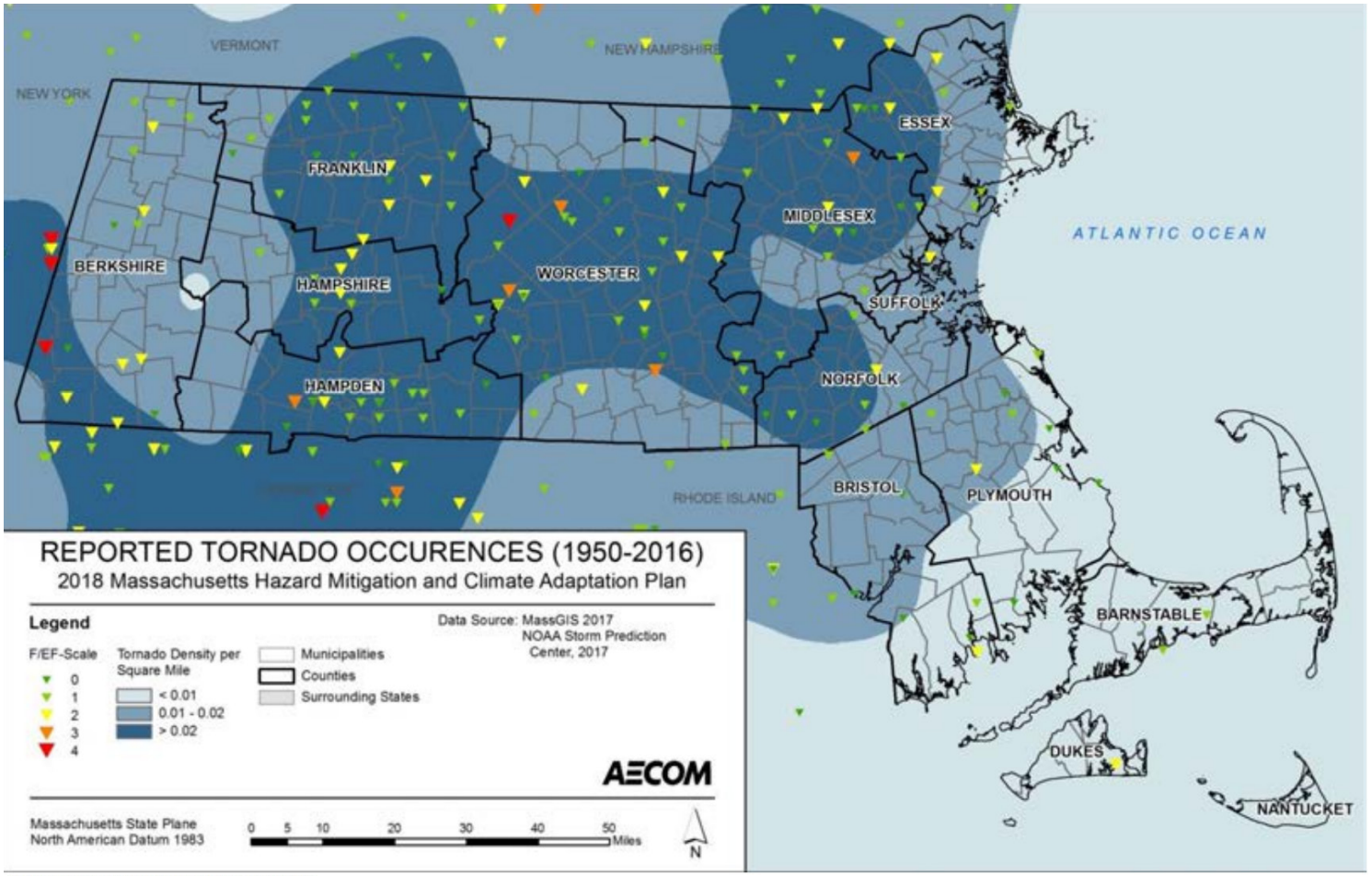
Overview

A tornado is a violently rotating column of air extending from a thunderstorm cloud to the ground.[40] Tornadoes are not always visible as funnel clouds because they are nearly translucent until they pick up dust and debris. The average tornado moves from southwest to northeast, but they can move in any direction and can suddenly change direction. The average speed of a tornado is 30 mph, but they can be stationary or move as fast as 70 mph. The strongest tornadoes have rotating winds of more than 200 mph.

Tornadoes can form from a variety of sources:

- Accompanying tropical storms and hurricanes as they move onto land
- From individual cells within severe thunderstorms squall lines
- From an isolated super-cell thunderstorm
- From tropical cyclones or even their remnants that are passing through
- Form when air converges and spins upward

40 NOAA's National Weather Service, Storm Prediction Center: http://www.spc.noaa.gov/faq/tornado/f-scale.html



Source: NOAA Storm Prediction Center (SPC)

Figure 2.13 | Tornado occurrence and density for Massachusetts. Map is from the Massachusetts State Hazard and Climate Adaptation Plan. (Note: map does not show the July 2019 tornado that occurred on Cape Cod.)

B1c

Hazard Location

The entire planning area is vulnerable to tornadoes, especially the coastline. Compared to the rest of Massachusetts, Barnstable County has a very low tornado density, defined as the number of tornadoes per 20 square miles (***Figure 2.13***).[41]

B1c, B2a,c

Previous Occurrences and Extent

According to the NOAA National Climatic Data Center, Barnstable County experienced the following tornado and waterspouts events between January 1, 1950 and July 21, 2015:

- **August 9, 1968:** F1 tornado was reported for Barnstable County. Many trees felled, destructive wind and hail, fruit and vegetable crops damaged, utility lines damaged, power outages, roof was lifted from a fruit stand (account taken from NCDC Storm data for August 1968)
- **August 22, 1977:** F1 tornado was reported for Barnstable County. A small tornado touched down in Yarmouth and destroyed an art gallery and signs on the street. It also picked up two buildings and two people were inside the building. Also, it spawned very large thunderstorm across Cape Cod.
- **August 20, 1997:** Showers developed during the afternoon in southeastern Massachusetts and these went on to produce three waterspouts, at least one confirmed weak tornado (F0), and numerous funnel clouds. The first waterspout occurred just east of the Sagamore Bridge, over Cape Cod Bay, at 1:30 p.m. Another waterspout was reported just west of Bourne, over Buzzards Bay, at 3:20 p.m. Throughout the afternoon, there were numerous reports of funnel clouds, some of which appeared in newspaper photos and documented via amateur radio operators' videos. Many of the funnels came as far as half-way down before retreating up into the cloud. There were no reports of damage or injury as a result of these events.
- **July 23, 2019:** A waterspout moved onshore just west of Kalmus Beach in Barnstable, MA at 1157 AM EDT (1057 AM EST). Winds gusted to 91 mph at a mesonet observation site at Kalmus. They had shifted from southeast to west-northwest with the passage of the tornado. The tornado continued moving northeastward at about 35 mph. The damage was discontinuous but where the tornado touched down, the damage was quite significant, with winds estimated as high as 110 mph. The roof of a motel on the south side of Main Street in West Yarmouth was completely peeled off. Additional significant tornado damage occurred just southwest of the Dennis-Yarmouth Regional High School. Dozens of large trees were uprooted and a few were snapped off. Another house had a hole in the roof from a fallen tree. The tornado then lifted. but

41 Massachusetts State Hazard Mitigation and Climate Adaption Plan, 2018

severe straight-line wind damage was observed from West Dennis eastward to West Harwich. Numerous large trees were uprooted, consistent with 90 mph gusts or greater. The same supercell storm that produced the Barnstable-Yarmouth tornado went on to touch down again near the center of Harwich at 1210 PM EDT. It moved northeast through Harwich Center. At least 150 hardwood trees were either uprooted or snapped. A few homes also had shingles that were ripped off. Wind gusts were estimated as high as 110 mph. The tornado then lifted, but severe straight-line wind damage was observed in Chatham.

B3a

Impact

Below is the Fujita Tornado Damage Scale developed in 1971 by T. Theodore Fujita[42]:

- **Scale F0, <73 mph winds, light damage:** some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged
- **Scale F1, 73- 112 mph winds, moderate damage:** surface peeled off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads
- **Scale F2, 113- 157 mph winds, considerable damage:** roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground
- **Scale F3, 158- 206 mph winds, severe damage:** roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown
- **Scale F4, 207-260 mph winds, devastating damage:** well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated
- **Scale F5, 261-318 mph winds, incredible damage:** strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; incredible phenomena will occur

Probability

B2b

The Planning Team determined that it is **POSSIBLE** that a tornado will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years

42 21 NOAA's National Weather Service, Storm Prediction Center: http://www.spc.noaa.gov/faq/tornado/f-scale.html

- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used Eastham's and the region's history of Tornadoes to make this probability determination.

Drought

Overview

Drought can be defined and characterized in numerous ways (e.g., meteorological, hydrological, agricultural, etc.), but the root cause is an extended period of deficient precipitation.[43] Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region.

Hazard Location

B1c

The entire planning area could be affected by drought.

Previous Occurrences and Extent

B1c, B2a,c

According to the Massachusetts Drought Management Plan, a determination of drought level is based on seven indices:

- **Standardized Precipitation Index (SPI)** reflects soil moisture and precipitation conditions and is calculated monthly using Massachusetts Rainfall Database at DCR, Office of Water Resources. SPI values are calculated for "look-back" periods of 1 month, 3 months, 6 months, and 12 months.
- **Crop Moisture Index (CMI)** reflects short-term soil moisture conditions as used for agriculture and is available from the National Climate Data Center.
- **Keetch-Byram Drought Index (KBDI)** is designed specifically for fire potential assessment. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity.
- **Precipitation Index** is a comparison of measured precipitation amounts (in inches) to historic normal precipitation. Cumulative amounts for 3-, 6-, and 12-month periods are factored into the drought determination.
- **Groundwater Level Index** is based on the number of consecutive months groundwater levels are

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below normal (lowest 25% of period of record for the respective months). The U.S. Geological Survey (USGS) monitors groundwater levels in a network of monitoring wells throughout Massachusetts.

- **Streamflows Index** is based on the number of consecutive months that streamflow levels are below normal (lowest 25% of period of record for the respective months). The USGS monitors streamflow in a network of gages throughout Massachusetts.
- **Reservoir Index** is based on the water levels of small, medium, and large index reservoirs across the state. The reservoir level relative to normal conditions for each month of the year will be considered. As part of its monthly conditions report, DCR, Office of Water Resources maintains a list of index water supply reservoirs and the percentage at which they are at capacity as well as non-water supply index reservoir levels, as available.

The 2019 Massachusetts Drought Management Plan uses five drought levels to provide information on the current status of water resources in distinct regions of Massachusetts (Western, Central, Connecticut River Valley, Northeast, Southeast and Cape and Islands). The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. For the purposes of the drought management plan, conditions are classified into five levels - a normal condition and four drought severity levels. These levels are based on the six drought indices, observed impacts to various resources and forecasts as described in detail in the plan. They provide distinction between different levels of drought severity and are used to provide adequate warning of worsening drought conditions.[44]

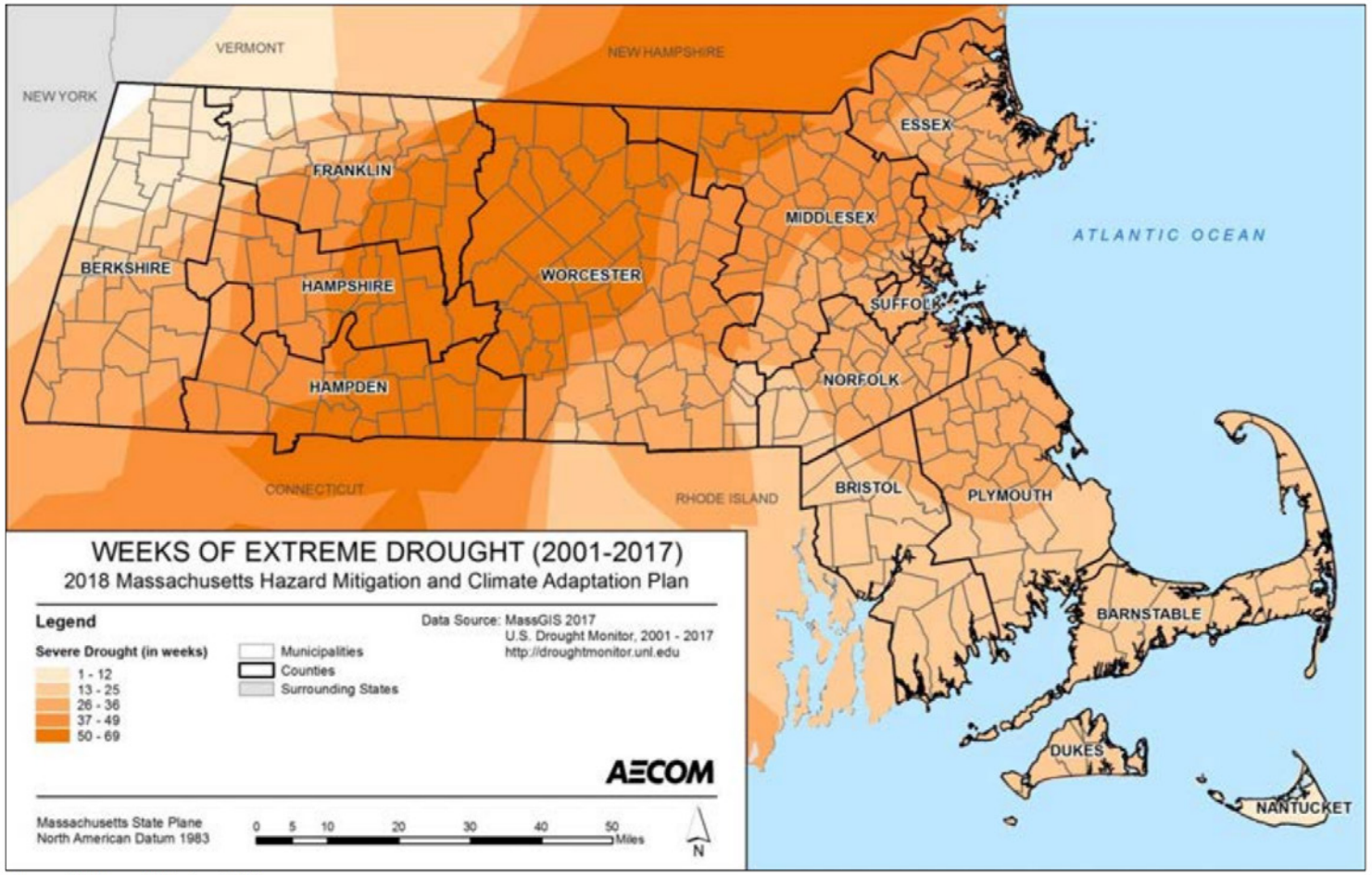
These drought levels are intended to provide information on the current status of water resources in distinct regions of Massachusetts (Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands). The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, and increased assessment and proactive education during a watch.

The condition levels are:

- **Level 0:** Normal i.e. No Drought
- **Level 1:** Mild Drought' (formerly "Advisory")
- **Level 2:** Significant Drought (formerly "Watch")
- **Level 3:** Critical Drought (formerly "Warning")
- **Level 4:** Emergency Drought (formerly "Emergency")

44 The drought levels, terminology, and indices were revised for the updated plan. Details about the changes are available in the 2019 plan: https://www.mass.gov/files/documents/2019/10/03/drought-plan.pdf

Hazard Profiles



Source: U.S. Drought Monitor, 2017

Figure 2.14 | Occurrence of extreme drought in Massachusetts 2001-2017 from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan 2018.

The U.S. Drought Monitor[45] started in 2000. Since 2000, the longest duration of drought (D1-D4) in Massachusetts lasted 48 weeks beginning on June 07, 2016 and ending on May 2, 2017. The most intense period of drought occurred the week of October 4, 2016 where D4 affected 52.13% of Massachusetts land. The following list of dates and drought levels/ descriptions for Barnstable County was compiled from data in the Massachusetts State Hazard Mitigation Plan, US Drought Monitor website, National Climate Data Center, and the Department of Conservation and Recreation Drought Management website:

- **1991:** Drought conditions in Barnstable County but no data is available on the drought level as described above. The observation well located in the vicinity of the Barnstable Airport set a record monthly low for two months. Local and state officials were concerned with water table levels primarily because of the impacts of low pond levels (i.e., Mary Dunn Pond) on wildlife and vegetation.
- **2001:** Drought Advisory in December
- **2002:** Drought Advisories and Watches from February to December
- **2012:** January to May of 2012 was the driest start to any year on record for the Commonwealth of Massachusetts, with only 6 inches of total precipitation. Most areas in southern New England were running 6-8 inches below normal. In April 2012, most of the Commonwealth was again under drought conditions that lasted until May 2012. Rivers and streams were most affected as most ran at record low levels during the spring run-off season. The main impact of the meteorological drought was periods of very high fire danger. In addition, small pond levels were reduced. While soil moisture was well below normal, this drought occurred prior to the beginning of the growing season so no agricultural impacts were realized.
- **2014:** Drought Advisory in October
- **2016:** Drought Advisories and Watches from July to December
- **2017:** Drought Advisory January to March

Impact

B3a

The following is a list of impacts that are possible with drought:[46]

- **People:** migration from a community, increased conflicts between water users, reduction in drinking water, food shortages
- **Infrastructure:** reduced water levels, soil erosion
- **Buildings:** soil erosion could cause damage to foundations and buildings

45 https://www.drought.gov/drought/data-gallery/us-drought-monitor

46 Massachusetts State Hazard Mitigation Plan, 2013

- **Economy:** reduced crop yield, increased prices for food
- **Natural Systems:** increased fire hazard, damage to water quality, damage to wildlife and fish habitat, degradation of landscape quality, loss of biodiversity, soil erosion, loss of wetlands

B2b

Probability

The Planning Team determined that it is **POSSIBLE** that a drought will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used Barnstable County's history of drought to make this probability designation.

Severe Winter Weather: Snow, Blizzards and Ice Storms

Overview

A winter storm occurs when there is significant precipitation during periods of low temperatures.[47] Winter storms typically occur from early autumn to late spring and can include any of the following events[48]:

- **Blizzards:** defined as winter storms with sustained or frequent wind gusts to 35 miles per hour or more, accompanied by falling or blowing snow that reduces visibility to or below one-quarter mile. Severe blizzards are defined as winter storms with temperatures near or below 10°F, winds exceeding 45 miles per hour and visibility near zero miles.
- **Blowing snow:** wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind.
- **Snow squalls:** brief, intense snow showers accompanied by strong gusty winds. Snow accumulation may be significant.
- **Snow showers:** snow falling at varying intensities for brief periods of time, some accumulation is possible

47 How to Prepare for a Winter Storm, www.ready.gov/prepare

48 Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008

- **Snow flurries:** light snow falling for short durations with little to no accumulation
- **Ice pellets and sleet:** composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. A Winter Storm Warning is issued for sleet or a combination of sleet and snow based on total accumulation, which is locally defined by area.
- **Icing:** occurs when liquid rain falls and freezes on contact with structures and objects on the ground, causing a coating of ice on a solid object or surface.
- **Coastal flooding:** winds generated from intense winter storms can cause widespread tidal flooding and severe beach erosion along coastal areas.
- **Ice jams and floes:** long cold spells can cause rivers and lakes to freeze. A rise in the water level or a thaw breaks the ice into large chunks which become jammed at man-made and natural obstructions. Ice jams act as a dam, resulting in severe flooding.
- **Snow melt:** sudden thaw of a heavy snow pack, often leads to flooding.

Hazard Location

B1c

The entire planning area is at risk for snow, blizzards, and ice storms.

Previous Occurrences and Extent

B1c, B2a,c

Snow and other forms of winter precipitation occur frequently in Eastham. The Northeast Regional Climate Center compiled normal 30-year average annual snow totals in New England and in the eastern U.S (***Figure 2.16***). These maps show normal snow totals for Eastham to be within 14-40 inches per year from 1981-2010.[49]

Table 2.5 is a list of federally-declared disasters from winter storm events in Barnstable County. The Blizzard of 1978 crippled most of the Commonwealth of Massachusetts, including Barnstable County. This event included blizzard conditions, extreme snowfall, high winds and devastating coastal flooding. As stated in the Massachusetts Hazard Mitigation Plan, the worst conditions in this storm event included:

- Snowfall rates of at least 3 inches per hour, 1-3 feet of snowfall, zero visibility
- Wind peaked at 93 mph in Chatham
- Major coastal flooding occurred over multiple high tide cycles

49 Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

Major Disaster Declarations for Winter Storms in Barnstable County from 1954 - 2019			
Number	**Disaster Type**	**Incident period**	**Declaration Date**
DR-546	Coastal storms, flood, ice, snow	February 6 - 8, 1978	February 10, 1978
DR-975	Winter coastal storm	December 11 - 13, 1992	December 21, 1992
EM-3103	Blizzards, high winds and record snowfall	March 13-17, 1993	March 16, 1993
DR-1090	Blizzard	January 7-13, 1996	January 24, 1996
EM-3175	Snowstorm	February 17 - 18, 2003	February 11, 2003
EM-3191	Snow	December 6 - 7, 2003	January 15, 2004
EM-3201	Snow	January 22-23, 2005	February 17, 2005
DR-1701	Severe storms, inland and coastal flooding	April 15 - 25, 2007	May 16, 2007
DR-4110	Severe winter storm, snowstorm, flooding	February 8-10, 2013	April 19, 2013
DR-4214	Severe winter storm, snowstorm, flooding	January 26 - 29, 2015	April 13, 2015
DR-4372	Severe winter storm and flooding	March 2-3, 2018	June 25, 2018

Table 2.5 | Major Disaster Declarations for Barnstable County for Winter Storms.
Data is from the FEMA Disaster Declaration website. It is important to note that Eastham has experienced more severe winter storms than those listed above, which includes only storms declared federal disasters.

B3a

Impact

Below is a list of impacts likely to occur during a winter storm event[50,51]:

- **People:** walking and driving can become extremely hazardous due to icy conditions, snow accumulation, low visibility, and extreme cold which causes people to shelter in place without utilities or other services until driving is safe or utilities are restored; injury from slipping and falling, overexertion during shoveling, frostbite; death from hypothermia, carbon monoxide poisoning (when gas powered furnaces and alternative heating sources are used inappropriately indoors during power outages); people become isolated in their homes
- **Infrastructure:** ice and heavy snowfall can knock out heating, power, and communication services for several hours or days; pipes and water mains may break due to extremely cold temperatures; large sections of ice can cause damage to floating docks
- **Buildings and Property:** structural failure of buildings due to heavy snow loads; roof failure; structural damage to buildings because of high wind; damage to fishing vessels, recreational boats and kayaks because of ice floes and coastal flooding
- **Economy:** as people are immobilized by the storm, they are unable to go to work, leading to economic losses; excessive costs to the town and residents because of increased plowing, snow removal, salting and sanding
- **Transportation:** roadways can become extremely hazardous due to icy conditions, snow accumulation, low visibility and extreme cold; car accidents can occur if people attempt to travel in unsafe conditions; transit and airport facilities will close temporarily because of severe winter weather; snow storms halt the transport of supplies, goods and services because of unsafe roadways

Probability

B2b

The Planning Team determined that it is **HIGHLY LIKELY** that a winter storm (snow and blizzard) will impact the planning area. High probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

50 Ibid.

51 Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008

The Planning Team used Eastham's history of snow storms and blizzards to make this probability designation.

Tsunami

Overview

A tsunami is a series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean flood, seismic or volcanic activity or underwater landslides. Tsunamis generate a devastating onshore surge of water.13 The waves associated with a tsunami move hundreds of miles per hour in the open ocean and can come ashore with wave heights of 100 feet or more.

B1c

Hazard Location

All of the coastal communities of Massachusetts are exposed to the threat of tsunamis, but at the present time, it is unknown what the probability is of a damaging tsunami along the Massachusetts coast.[52]

B1c, B2a,c

Previous Occurrences and Extent

According to the NOAA National Climatic Data Center, Barnstable County did not experience any tsunamis between January 1, 1950 and October 31, 2019.

The US Atlantic coast and Gulf Coast states have experienced six tsunamis in the last 200 years – only a total of six tsunamis have been reported:[53]

- Three tsunamis were generated in the Caribbean. Tsunamis are more likely to occur at convergent margins and there is a convergent plate in the Caribbean Sea. Thus, this area has a higher probability of generating earthquakes that could produce a tsunami.
- Two tsunamis were related to a magnitude 7+ earthquake along the Atlantic coast.
- One tsunami was reported off the mid-Atlantic states and may be associated with an underwater landslide.
- There is no data on the extent of these tsunamis for Barnstable County or Eastham.

Impact

B3a

Below is a list of potential impacts of a tsunami:

- **People:** hydraulic forces of the tsunami injure people or lead to death, floating debris can endanger human lives, people and businesses will be without fuel, food or employment
- **Infrastructure:** floating debris can batter infrastructure, breakwaters and piers collapse,

52 Massachusetts State Hazard Mitigation Plan, 2013

53 Ibid.

scouring actions sweep away infrastructure, oil fires often result because the waves carry away oil tanks therefore damaging infrastructure

- **Buildings:** hydraulic forces of the tsunami will destroy buildings, floating debris can batter inland structures, scouring actions sweep away buildings, oil fires often result because the waves carry away oil tanks therefore damaging buildings
- **Economy:** public utilities will be damaged and therefore the economy will suffer, especially for the fishing industry, disruption of coastal systems will have far-reaching economic effects
- **Natural Systems:** trees and plants are uprooted; animal habitats such as nesting sites for birds are destroyed. Land animals are killed by drowning and sea animals are killed by pollution if dangerous chemicals are washed away into the sea, thus poisoning marine life.
- **Transportation:** roads, bridges and culverts buckle or are swept away

Probability

B2b

The Planning Team determined that it is **unknown** and **UNLIKELY** that a tsunami will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the low frequency of tsunamis in Barnstable County to make this probability designation.

Sea Level Rise

Overview

Sea level rise refers to the increase in mean sea level over time.[54] Relative sea level rise is a combination of eustatic and isostatic contributions:

- **Eustatic contributions to sea level rise** are global-scale changes and include thermal expansion of seawater as it warms and the addition of water volume from melting land-based glacial ice sheets.
- **Isostatic contributions to sea level rise** are more localized changes in land surface elevations such as subsidence or sinking.

Sea level has been rising around the globe for thousands of years since the end of the last Ice Age. For a little over a century, tidal gauges and satellites have been measuring changes in sea level. Tide gauge stations measure the height of water referenced to a horizontal control point, or benchmark, and gauges are used to track and predict tide levels and longer-term sea level. Long-term data sets from tide stations have been used to understand local and global sea level trends. The National Oceanic and Atmospheric Administration's (NOAA) Center for Operational Oceanographic Products and Services maintains several tide gauge stations across coastal Massachusetts, including long-term stations at Boston, Woods Hole and Nantucket. The sea level data recorded by NOAA and other tide gauges produce trends in relation to fixed reference levels on land, and therefore the data from these stations includes variation in local land elevations.

There is high confidence that the warming atmosphere associated with global climate change is expected to accelerate both the thermal expansion of seawater and the melting of glaciers and ice sheets and will lead to increasing rates of sea level rise.[55]

Hazard Location

B1c

The entire coast of Eastham is vulnerable to sea level rise (***Figure 2.17***).

In 2014, the Cape Cod Commission developed a "bathtub" model to visualize Cape Cod's vulnerability to sea level rise (see Sea Level Rise Viewer at https://slrv.apps.capecodcommission.org/). The Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and Ranging (LiDAR) in 2011 by the USGS. The elevation data is accurate to 18 cm at a 95% confidence level with a 1 meter resolution. This elevation data was adjusted to Mean Higher High Water (MHHW) using the NOAA

54 Sea level rise: understanding and applying trends and future scenarios for analysis and planning, Massachusetts Office of Coastal Zone Management, December 2013

55 Ibid.

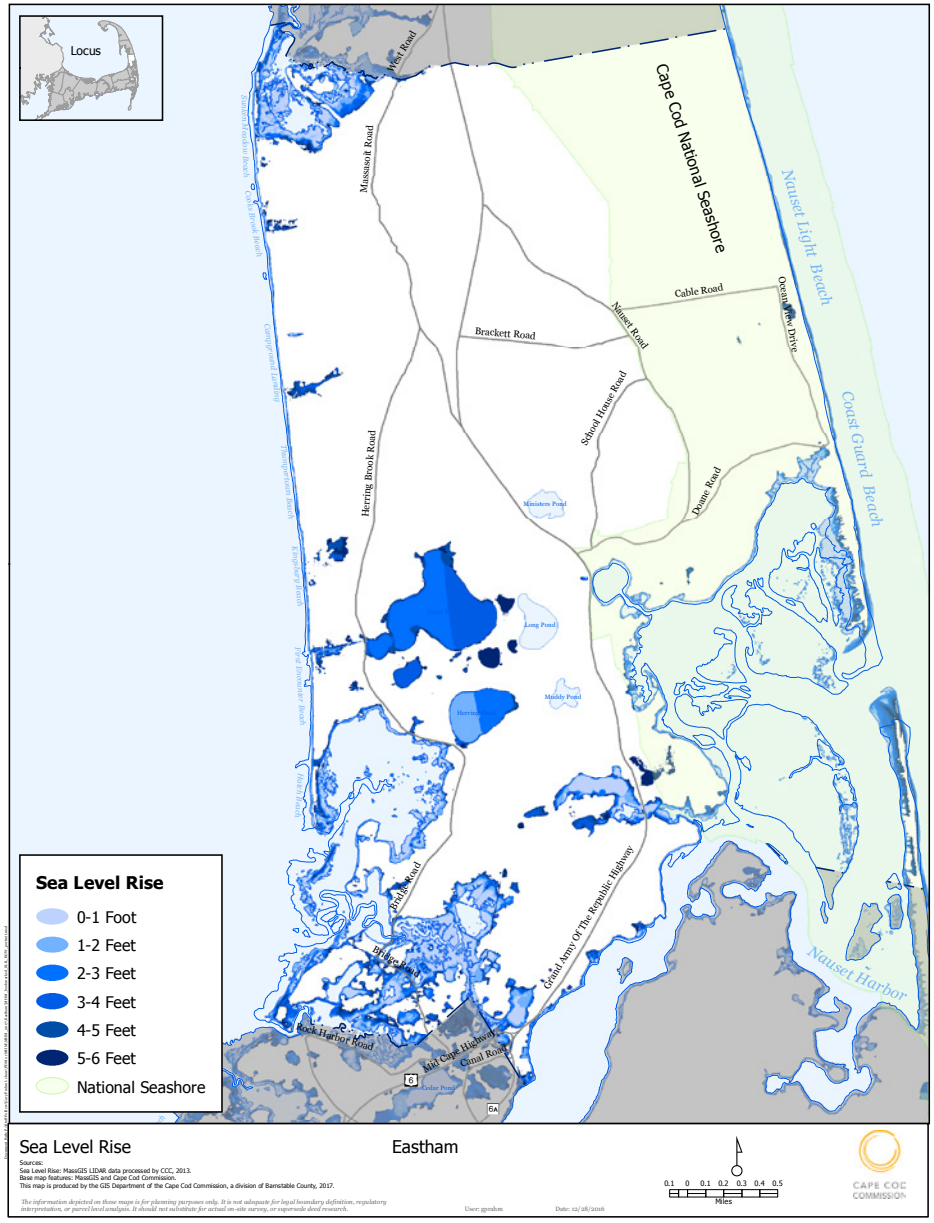


Figure 2.15 | Sea level rise map for Eastham

Datum Software. The Sea Level Rise is shown as a simple representation of a change in elevation, commonly referred to as a "bathtub" model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

B1c, B2a,c

Previous Occurrences and Extent

Mean sea level trends from the Boston, Woods Hole, and Nantucket long-term stations are listed below:[56]

- Boston, MA tide gauge station:
  - 0.11 ± 0.007 inches per year, measured over the period of 1921-2012
  - Century rate at the Boston tide gauge: 0.92 feet per 100 years
- Woods Hole, MA tide gauge station:
  - 0.11 ± 0.007 inches per year, measured over the period of 1932-2012
  - Century rate at the Woods Hole tide gauge: 0.92 feet 100 years
- Nantucket, MA tide gauge station:
  - 0.14 ± 0.017 inches per year, measured over the period of 1965-2012
  - Century rate at the Nantucket tide gauge: 1.15 feet per 100 years

B3a

Impact

As relative sea level rises, high water elevations will move landward, areas of coastal shorelines will retreat, and low-lying areas will be increasingly exposed to erosion, tidal inundation, and coastal storm flooding. Developed parts of the coast are especially vulnerable because of the presence of infrastructure, homes and businesses that can be damaged or destroyed by coastal storms. In addition, development often impedes the ability of natural coastal systems to buffer inland areas from storm damage, further exacerbating the problem. Many coastal habitats are also vulnerable to rising sea levels, including salt marshes, beaches and dune systems, and floodplains, because they are generally at or within a few feet of existing sea elevations. These areas provide significant environmental benefits, including habitat value, filtering of pollutants for improved water quality, protection of inland areas from flooding and storm surge, and extensive recreational opportunities.[57]

56 Ibid.

57 Ibid.

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that sea level rise will impact the planning area. Probability was defined based on the frequency of occurrence:

- **Unlikely:** less than a 1% probability over the next 100 years
- **Possible:** 1-10% probability in the next year or at least one chance in the next 100 years
- **Likely:** 10-100% probability in the next year or at least one chance in the next 10 years
- **Highly Likely:** near 100% probability in the next year

The Planning Team used the history of sea level rise in Massachusetts to make this probability designation.

Climate Change

Climate is defined as average temperature and precipitation and it also includes the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as storms, including those which may bring precipitation, high winds, and tornado events. While predicting changes of storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment.[58]

The following changes in hazard frequency and intensity are expected to occur with changes in climate[59]:

- **Coastal Erosion:** Climatic trends can change a beach from naturally accreting to eroding due to increased episodic erosion events caused by waves from an above-average number of storms and high tides, or from the long-term effects of fluctuations in sea or lake level. The coastal zone is being severely impacted by erosion and flooding due in part to climate change and sea-level rise. It is likely that the impact will increase in the future as sea levels continue to rise at the current rate or rises at an accelerated rate.

58 United States Environmental Protection Agency, 2006
59 Massachusetts State Hazard Mitigation Plan, 2013

Climate Change

- **Earthquakes:** The impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes.
- **Fire:** Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.
- **Flooding:** While it is not known if the number of storms will increase in the future as the result of climate changes, it is anticipated that the intensity of tropical and extra-tropical storms may increase as the storm intensity is a function of sea surface temperature, which continue to rise. Thus, we may experience more intense storms with greater rainfall in the future.
- **Tropical Cyclones:** Although there is still some level of uncertainty, research indicates the warming climate may double the frequency of Category 4 and 5 hurricanes by the end of the century and decrease the frequency of less severe hurricane events.
- **Nor'easters and Winter Storms:** Weather extremes are likely to become more frequent and cause more damage under a changing climate. Although no specific storm is directly linked to climate change, an increasing number of events could become more common. New England is expected to experience changes in the amount, frequency, and timing of precipitation. Along with rising temperatures, it is expected that annual precipitation will increase by 14%, with a slight decrease in summer totals and a 30% increase in winter totals. Winter precipitation is predicted to be in the form of rain rather than snow. This change in precipitation will have significant effects on the amount of snow cover, winter recreation, spring snowmelt and peak stream flows, water supply, aquifer recharge, and water quality. Snow is also predicted to fall later in the winter and cease falling earlier in the spring.

- **Severe Weather (wind, extreme temperature, thunderstorms, tornadoes, drought):** Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data show that the probability for severe weather events increases in a warmer climate. With a warmer climate, droughts could become more frequent, more severe, and longer-lasting.

Hazards Selected for Risk Assessment

After profiling the hazards in the 2013 Massachusetts Hazard Mitigation Plan and assigning a probability to each hazard, the Planning Team reviewed the top hazards selected during the MVP workshop and determined which were significant for Eastham. They also reviewed the public and stakeholder input provided in the hazard survey.

Table 2.6 documents the evaluation process used for determining which of the 11 Massachusetts State hazards are considered significant enough to warrant further evaluation in the risk assessment. A hazard was further evaluated for a risk assessment if the following criteria were met:

- the Planning Team determined that the probability of the hazard was highly likely
- the hazard was identified as a top concern at the MVP workshop

Using the process described above, the following hazards were selected for risk assessment in Chapter 4:

- Coastal Erosion/Shoreline Change
- Flood
- Hurricanes and Tropical Storms
- Nor'easters
- High Winds
- Severe Winter Weather
- Sea Level Rise

Hazards Selected for Risk Assessment

Type of Natural Hazard	What is the future probability of the hazard as determined by the Planning Team?	Was the hazard identified as a top concern at the MVP Workshop?	Was the hazard further evaluated in the risk assessment in Chapter 4?
Coastal Erosion and Shoreline Change	HIGHLY LIKELY	Yes	Yes
Dam (Culvert) Failure	POSSIBLE	No	No
Earthquake	POSSIBLE	No	No
Urban Fire	POSSIBLE	No	No
Wildfire	LIKELY	No	No
Flood	HIGHLY LIKELY	Yes	Yes
Hurricane and Tropical Storms	HIGHLY LIKELY	Yes	Yes
Landslide	POSSIBLE	No	No
Nor'easters	HIGHLY LIKELY	Yes	Yes
High Winds	HIGHLY LIKELY	Yes	Yes
Thunderstorms	HIGHLY LIKELY	Yes	YES
Extreme Temperatures	POSSIBLE	Yes	No
Tornadoes	POSSIBLE	No	No
Drought	POSSIBLE	No	No
Severe Winter Weather	HIGHLY LIKELY	Yes	Yes
Tsunami	UNLIKELY	No	No
Sea Level Rise	HIGHLY LIKELY	Yes	Yes

Table 2.6 | List of hazards selected for a risk assessment

Asset Inventory

CHAPTER THREE

Chapter 2 profiles natural hazards that have affected Eastham in the past or could affect the town in the future. The next step in the hazard planning process is to determine the types of assets and people that are located in Eastham. Once this asset inventory in complete, the Planning Team can determine which of these assets and populations are vulnerable to the impacts of natural hazards. **Chapter 3 is an inventory of the people and natural and built environments in Eastham.**

People

Population: Year-round and Seasonal

Approximately 4,900 year-round residents live in Eastham (according to the 2013-2017 U.S. Census American Community Survey estimate). The median household income for this population is $62,452 and the average household income is $79,094.

Like other Cape Cod towns, Eastham's population grows significantly from winter to summer. The seasonal population includes year round household occupants, second home owners or residents, and transient renters of hotels/motel rooms. There is no singular numeric estimate of Eastham's seasonal population because this statistic is difficult to determine. For the purposes of this plan, seasonal population seeks to address and reflect how many individuals may need to be accounted for within the town, regardless of resident, visitor or transient status. Estimates and projections for total summer population range from 27,500 to 30,000, according to the 2010 Eastham Hazard Mitigation Plan; the 2019 MVP Summary of Findings provides a "conservative" summer population estimate of 22, 000. Regardless of the variation in estimates, the substantial seasonal population boom puts a strain on Town services and affects long-range planning.

Base Map of Eastham

Figure 3.1 is a base map for the Town of Eastham; it is a map showing the geographic area of Eastham and includes features such as roads, rivers, coastlines, and critical facilities. The base map acts as a frame of reference for the reader and reviewer of the Eastham Hazard Mitigation Plan Update.

Base Map of Eastham

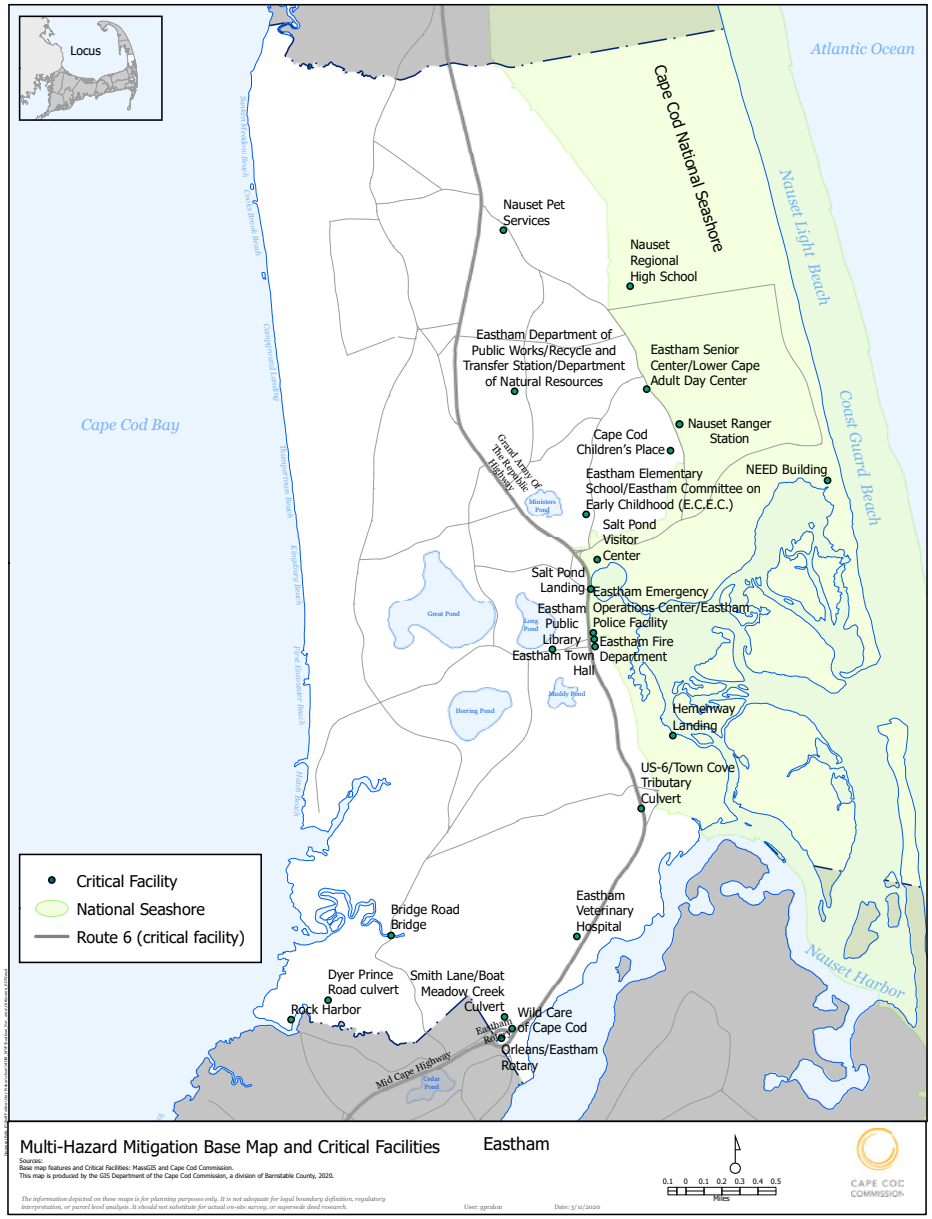


Figure 3.1 | Base map of Eastham with critical facilities

Natural Environment

The Town of Eastham is located on a strip of land lying across the base of the "outer arm" of Cape Cod in Massachusetts. Eastham is approximately three (3) miles wide from east to west and approximately seven (7) miles long from north to south. The Town is bounded to the north by the Town of Wellfleet, on the south by the Town of Orleans, on the west by Cape Cod Bay and on the east by the Atlantic Ocean. Eastham encompasses a total area of approximately 27 square miles, an upland area of approximately 14 square miles and has over 37 miles of tidal shoreline. The Town is located approximately 99 miles southeast of Boston, 96 miles east of Providence, Rhode Island and 25 miles east of Hyannis. Cape Cod National Seashore, authorized by Congress in 1961, comprises one-third of Eastham's area (3,000 acres), including most of its six and one-half (6½) mile Atlantic Ocean shoreline, stretching from Orleans to Wellfleet.

Geology

Cape Cod and Eastham owes its existence to glacial deposits derived from the last ice sheet which moved over southeastern New England. Glauconite, fossil material, and the sparsity of feldspar in the glacial sand suggest that the ice sheet overrode coastal plain and shelf sediments of Pleistocene and pre-Pleistocene age before reaching Cape Cod. During deglaciation of southern New England, the topography of the continental shelf played a major role in determining the pattern of ice retreat. Major lobes formed in the relatively shallow basins on the shelf. Soils The climatically associated soils on Cape Cod are podzols. Their existence in this less than normal hostile climate is due to the porosity of the glacial material and the rapid leaching associated with it. The remaining sediments that are characteristic of the Eastham area are interior and coastal sands deposited by wind actions either along the present coast and associated with wave action or those sands associated with direct glacial deposition. Wet sediments found in and near salt marshes and freshwater swamps are also quite prevalent, particularly in southern and coastal Eastham areas. Eastham's natural floodplain provides important functions. The dunes protect areas behind them from floodwater, and the vast expanse of healthy marsh also provides protection to neighboring structures.

Topography

Like most of Cape Cod, Eastham's terrain is level to gently rolling with land mass elevations generally from sea level to sixty feet above sea level. Perhaps the most significant feature of the topography is the nearly one half of the Town covered by water. Eastham might be considered the "low country" of the Cape, with many points of saltwater infiltration occurring at elevations below sea level. The most dramatic topographical

features occur along the Atlantic Ocean coast where steep cliffs or bluffs are formed by the erosion of sand dunes

Built Environment

Homes

According to US Census American Community Survey (ACS) 2012-2017 estimates, Eastham has approximately 6,143 total housing units, with 60% occupied only seasonally and 40% occupied year round. ***Table 3.1*** provides a list of the type and number of housing units in Eastham.

About 88 percent of the town's housing units were built after 1950, with over 50% built between 1970 and 2000. The median number of rooms in Eastham residences is 5.5.

Over 60% of housing units in Eastham are seasonal or second homes, similar to other Outer and Lower Cape communities. Eastham, like its neighboring communities, continues to lose year-round population. The high cost of housing, lack of affordable units, dependence of a tourist economy and limited higher wage employment opportunities, are factors in the population decline. Eastham's housing units increased 4.4% between 2000 and 2014, with many of the new homes seasonally occupied.

UNITS IN STRUCTURE	Estimate*
1-unit, detached	5751
1-unit, attached	126
2 units	191
3 or 4 units	50
5 to 9 units	0
10 to 19 units	0
20 or more units	25
Mobile home	0
Boat, RV, van, etc.	0
Total Housing Units	6143

Table 3.1 | Number and type of housing units in Eastham
Source: U.S. Census American Community Survey, 2013-2017 5-year estimate.
*Note: The ACS housing units data estimates contain a margin of error between +/- 0.6% - +/- 2.2 % and may not reflect actual number of existing units

Businesses and Employment

Eastham's business landscape is dominated by service industries, primarily Retail and Accommodations/Food Service (*Table 3.2*).

Industry	Number	Values (Thousands of dollars)
Wholesale trade	2	D
Retail trade	24	37,389
Transportation and warehousing(104)	7	D
Information	1	N
Finance and insurance	4	N
Real estate and rental and leasing	6	D
Professional, scientific, and technical services	17	D
Administrative and support and waste management and remediation services	13	
Health care and social assistance	12	4882
Arts, entertainment, and recreation	2	D
Accommodation and food services	34	20,872
Other services (except public administration)	10	3564

Table 3.2 | Estimated number and value of Eastham businesses by industry
Source: 2012 Economic Census of the United States013
D=Withheld to avoid disclosing data for individual companies
N=Data not available or not comparable

Industry	Number Employed
Civilian employed population 16 years and over	2226
Agriculture, forestry, fishing and hunting, and mining	20
Construction	239
Manufacturing	20
Wholesale trade	6
Retail trade	418
Transportation and warehousing, and utilities	65
Information	54
Finance and insurance, and real estate and rental and leasing	113
Professional, scientific, and management, and administrative and waste management services	263
Educational services, and health care and social assistance	443
Arts, entertainment, and recreation, and accommodation and food services	320
Other services, except public administration	65

Table 3.3 | Town of Eastham Number of Employees by Industry
Source: ACS 2017 5-Year Estimates

Critical Facilities

Table 3.4 is a list of the Critical Facilities in Eastham.

Type of Critical Facility		Name of Critical Facility
Essential Facilities	Assets that are essential to the health and welfare of the whole population and are especially important following hazard events. The potential consequence of losing these assets is so great that they were carefully inventoried. The building, contents and function/services provided to the community are significant. Source: FEMA How-to Guide 2/ FEMA 386-2	Eastham Town Hall
		Eastham Police Department
		Department of Public Works/Recycle & Transfer Station
		Eastham Public Library
		Eastham Fire Department
		Eastham Senior Center
		Cape Cod Children's Place
		Nauset Ranger Station
		Nauset Regional High School
		Salt Pond Visitor Center
		Veterinary Hospital
		Nauset Pet Services
		Eastham Elementary School
		Wildcare Cape Cod
		NEED building
Lifeline Utilities	Includes wastewater, water, oil, natural gas, electric power, and communication systems	Eastham municipal water system
Transportation Systems	Critical assets in all 5 modes of transportation (air, road, transit, rail, sea). Source: FEMA How-to Guide2/ FEMA 386-2	Route 6/Town Cove Tributary Culvert
		Smith Lane/Boat Meadow Creek Culvert
		Bridge Road bridge
		Dyer Prince Road Culvert
		Salt Pond landing
		Hemenway Landing
		Route 6
		Orleans/Eastham Rotary
		Rock Harbor

Table 3.4 | List of critical facilities in Eastham (See Figure 3.1 for a map of critical facilities)

B4a

Repetitive Loss Properties

Repetitive Loss Properties are those for which two or Repetitive Loss Properties are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any ten-year period since 1978.

Eastham has one repetitive loss area containing unmitigated properties. It is located in the southeastern part of town, near the Orleans rotary on Route 6, which is a known flooding choke point. The waterfront area is low-lying on the western side of Town Cove, which is hydrologically connected to Nauset Marsh. While the properties are not oceanfront at this location, Town Cove can act as a funnel to intensify storm surge. During the Perfect Storm in 1991 the dunes on the barrier beach protecting Pleasant Bay were levelled and took a few years to regenerate, allowing more damage in 1992 and 1993. (They have since regenerated and offer now additional protection to the area.)

Two other areas in Eastham have experienced repetitive loss flooding, but mitigation actions have since been implemented to reduce their vulnerability. One area is near Kingsbury Beach (bayside) and the other near Coast Guard Beach (oceanside).

The Town has implemented several actions to help reduce future impacts from floods, wind, sea level rise, and erosion in the repetitive loss locations (as described above) that also help residents and properties located in other vulnerable areas, including the following: the town has provided and continues to provide educational materials to residents and property owners on preparedness and hazard mitigation and; the Town participates in the NFIP and reviews the zoning bylaw to ensure it is as protective as possible and reflects current floodplain science and policy; the Town participates in NFIP's Community Rating System (CRS) through enhanced floodplain management. The 2020 Hazard Mitigation Plan update includes the following new actions to reduce loss from flooding and wind:

- Continue participation and maintain standing in the NFIP's Community Rating System (CRS) program through enhanced floodplain management activities.
- Conduct a feasibility study to understand potential impacts, costs, and other considerations of elevating the roads as well as identifying other alternatives for mitigating the flooding.
- Create a task force responsible for public education on local emergency preparedness

Figure 3.2 | Repetitive loss map for Eastham from FEMA

D1

New Developments in Eastham

- The number of building permits for new construction has steadily increased since 2010, peaking at 793 permits issued in 2018. Residential construction and renovation comprised the majority of the construction activity. The seasonal and second home market continues to make up the majority of the housing stock. The number of retirees converting their seasonal homes to year round use also continues to increase which accounts for the majority of the residential construction activity over the past several years. Construction of a new 65-unit affordable housing development (started 2019) located on town owned property accounted for the single largest residential construction project since the last HMP plan update. Final construction is scheduled to be completed in 2020.

The Town issued four building permits for new construction in the flood zone between 2010-2020, as follows:

- **New Construction - 145 Cole Road (11/05/2015):** New two-car garage addition with room above.
- **New Construction - 5 Ben's Way (02/16/2016):** New barn studio
- **New Construction - 20 Keene Way (12/01/2016):** Construction of new three bedroom single family residence with garage.
- **New Construction- 245 Harmes Way (06/12/2017):** Demolish existing three bedroom single family residence and build a new single family residence ,decks and storage building

The Town undertook several public building and infrastructure improvement projects since 2010 including:

- **Eastham Public Library:** 190 Samoset Road
  - Opened in 2016
- **Village at Nauset Green:** Nauset Green Way 65 Unit Affordable Housing Development Initial occupancy 2020

Name of Development	Special Flood Hazard Area	SLOSH zone	Sea Level Rise
Eastham Public Library	NO	NO	NO
Village at Nauset Green	NO	NO	
Municipal Water System (Wells and Pump Stations)	NO	NO	NO
Harbormaster Building	YES	YES	YES

Table 3.5 | Exposure assessment of new developments in Eastham

- **Municipal Water System:** Town-wide system
  - Phase 1 water mains and storage tank 2016 – 2018
  - Phase 2 water mains 2019 – 2023
- **Rock Harbor Dock Replacement:** 631 Dyer Prence Road
  - Replace docks and float system (completed 2019)
    Construct new harbormaster building (anticipated completion 2020)
  - Install new septic system (anticipated completion 2020)

Neither the new public library nor the new housing development are located within any areas susceptible to flooding or sea level rise. The new library facility has been used as a local "warming station" during winter storms and power outages. This facility allows emergency services to provide an alternative option to activating the larger regional shelter located at the Nauset High School facility. The new municipal water system will provide residents connected to the system with a reliable source of safe drinking water as opposed to relying on private wells susceptible to power outages. Although the new Harbormaster building will be located in the flood zone. This building will be constructed to meet all applicable state and federal flood zone construction standards. The building will be used primarily as a field office.

Vulnerability Assessment

CHAPTER FOUR

Chapter 2 of the Eastham Hazard Mitigation Plan Update profiles natural hazards that could impact the town in the future or have impacted Eastham in the past. Chapter 3 inventories the assets that could be damaged during a hazard event, such as buildings, infrastructure, and critical facilities. Chapter 4 ties together the hazard profiles and asset inventories to estimate the potential losses that Eastham could experience during a natural hazard event. **Chapter 4 answers the question: How will assets in Eastham be affected by hazard events?**

Methodology: Vulnerability Assessments

Chapter 4 of the 2020 Eastham Hazard Mitigation Plan Update includes the following two assessments:

- **Vulnerability Assessment of Parcels and Buildings:** this assessment was completed by the Cape Cod Commission using data from the Town Assessor's office and reviewed by the Planning Team.
- **Exposure Assessment of Critical Facilities:** the Planning Team used Geographic Information System (GIS) analysis to identify whether critical facilities could be exposed to flooding, storm surge, sea level rise and coastal erosion.

The methods of both assessments are provided in the remaining part of this section.

Methods of the Vulnerability Assessment of Parcels and Buildings:

To estimate the total number of parcels and value of buildings located in Eastham, the Planning Team used Town Assessing data from 2019. This 2019 data set contains information about parcels such as use codes, building characteristics and assessed values. The 2019 parcel data is also linked to geometry data for specific parcels on the ground. The 2019 data is the most current data set that contains both the parcel and the geometry data. This large data set was grouped into categories using Massachusetts Property Type Classification Codes. Parcel numbers and building values were totaled for each category.[1] It is important to note that the category titles are based on the State's Classification Code designations and not selected by members of the Planning Team. Below is a list of examples of asset types in each category.

- **Agriculture:** agricultural land/farms, greenhouses, farm buildings
- **Banks:** bank buildings
- **Entertainment and Recreation:** includes eating and drinking establishments, indoor recreation, recreational land
- **General Services:** includes warehouses and distributional facilities, post office, housing authority, municipal property
- **Medical Office/Clinics:** includes medical office buildings
- **Multi-Family Dwelling:** includes condos, 2-3 family homes, multiple houses on a single property, 4-8 unit homes and 8+ units
- **Non-Profit/Municipal:** government or town owned properties, public parking lots, libraries, museums, fraternal offices

1 Property Type Classification Codes, Non-arm's Length Codes and Sales Report Spreadsheet Specifications, prepared by the Bureau of Local Assessment, revised June 2016

- **Parking:** commercial parking lots
- **Personal/Repair Services:** includes buses and funeral homes
- **Retail Trade:** includes hardware stores, shopping malls, supermarkets, small retail
- **Single Family Dwelling:** single family homes
- **Temporary Lodging:** includes motels, inns, resorts
- **Theaters:** includes theaters and stadiums
- **Vacant:** includes developable land, undevelopable land, residential open land, underwater land or marshes not under public ownership
- **Wholesale Trade:** includes tanks holding fuel and oil products for retail distribution, bottled gas and propane tanks, lumber yards

Next, Commission staff used GIS to overlay maps of hazard areas onto parcel and value data. Only a subset of natural hazards was identified for further vulnerability assessment (see ***Table 2.6*** for rationale). Below is a list of hazards selected for the vulnerability assessment and a description of the available data used for the assessment.

- **Flooding:** FEMA flood hazard maps, adopted by Eastham in 2014
- **Hurricanes and Tropical Storms:** The storm surge that occurs during tropical cyclones is assessed using the SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model. Currently, there is no model available for the impact of wind from tropical cyclones. ***Figure 2.14*** in Chapter 2 shows a SLOSH map for the Town of Eastham.
- **Sea Level Rise:** Bathtub model developed by the Cape Cod Commission was used to model the impacts of sea level rise on Eastham. ***Figure 2.23*** in Chapter 2 shows a Sea Level Rise map for the Town of Eastham.
- **Coastal Erosion/Shoreline Change:** GIS was used to identify which properties had a physical connection to saltwater. A property that shares a boundary with saltwater was identified as "coastal property." Parcel and building values were identified. The Planning Team recognizes that this method is imperfect.
- **Nor'easters:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **High Winds:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **Severe Winter Weather:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **Sea, Lake and Overland Surges from Hurricanes (SLOSH) model:** SLOSH is a computerized numerical model developed by the National Weather Service (NWS) to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes

Methodology: Vulnerability Assessments

in consideration of atmospheric pressure, size, forward speed, and track data2. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features. However, the SLOSH model does not explicitly model the impacts of waves on top of the surge nor does it account for normal river flow or rain flooding. Future advancements in the SLOSH model will allow for the resolution of some of these limitations.[2]

- **Cape Cod Commission's Sea Level Rise model:** Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and Ranging (LiDAR) in 2011 by the United States Geological Society (USGS). The elevation data is accurate to 18 cm at a 95% confidence level with a 1 meter resolution. This elevation data was adjusted to Mean Higher High Water (MHHW) using the NOAA VDatum Software. The Sea Level Rise is shown as a simple representation of a change in elevation, commonly referred to as a "Bathtub" model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

It is important to note that SLOSH and Sea Level Rise models are coarse models to illustrate vulnerability to storm surge and sea level rise using the best available data. Both of these models have their strengths and their weaknesses.

Methods of Exposure Assessment of Critical Facilities:

For this exposure assessment, the Team compiled a list of critical facilities and mapped them in GIS. Sea level rise, flooding, storm surge maps were overlaid on the map of critical facilities. If a critical facility was located in a hazard area, the Planning Team determined that it was exposed and therefore vulnerable. To assess exposure to coastal shoreline change, the Planning Team determined whether the parcel boundary of the critical facility was adjacent to saltwater. As mentioned in the previous section, maps for nor'easters, high winds, severe winter weather and are not available and therefore their impact on critical facilities was not determined.

2 http://www.nhc.noaa.gov/surge/slosh.php

Results: Vulnerability Assessment
Parcels and Buildings in Hazard Areas

Parcels and Buildings Vulnerable to Flooding

Flooding (A, AE, V Zones)

Type of Use	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	2	0	0%			0%
Banks	2	0	0%	$1,280,600		0%
Church/Non-Profit Offices	83	55	66%	$3,964,400	$1,084,100	27%
Emergency Response	7	1	14%	$6,328,400	$2,368,900	37%
Entertainment and Recreation	12	4	33%	$1,172,900	$714,830	61%
General Services	64	21	33%	$16,314,900	$2,336,900	14%
Heavy Industrial	3	0	0%			0%
Light Industrial	11	0	0%	$2,115,600		0%
Medical Office/Clinic	7	1	14%	$4,165,300	$1,179,800	28%
Metals/Minerals Processing	2	0	0%	$72,200		0%
Multi-family Dwelling	299	69	23%	$129,028,300	$37,408,800	29%
Personal/repair services	2	0	0%	$332,100		0%
Professional/tech services	1	0	0%			0%
Retail Trade	20	1	5%	$4,667,600	$327,800	7%
Schools	3	1	33%	$21,843,100	$4,869,700	22%
Single Family Dwelling	5192	758	15%	$1,132,589,000	$211,820,800	19%
Temporary Lodging	12	3	25%	$13,107,000	$3,587,900	27%
Vacant	749	248	33%	$1,565,700	$801,300	51%
Wholesale trade	5	0	0%	$1,888,200		0%
COLUMN TOTAL	6,476	1,162		$1,340,435,300	$266,500,830	

Table 4.1 | The proportion of buildings and value of buildings located in an A, AE, or V zone. Table generated using 2019 Eastham Assessing Data.

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Sea Level Rise

Sea Level Rise						
	1 foot		2 feet		3 feet	
Type of Use	# of parcels	Value of Buildings	# of parcels	Value of Buildings	# of parcels	Value of Buildings
Agriculture	2	$0	2	$0	2	$0
Banks	2	$1,280,600	2	$1,280,600	2	$1,280,600
Church/Non-Profit Offices	49	$214,700	49	$214,700	49	$214,700
Emergency Response	7	$6,328,400	7	$6,328,400	7	$6,328,400
Entertainment and Recreation	4	$0	4	$0	4	$0
General Services	19	$3,155,700	20	$3,155,700	20	$3,155,700
Heavy Industrial	3	$0	3	$0	3	$0
Light Industrial	11	$2,115,600	11	$2,115,600	11	$2,115,600
Medical Office/Clinic	7	$4,165,300	7	$4,165,300	7	$4,165,300
Metals/Minerals Processing	2	$72,200	2	$72,200	2	$72,200
Multi-family Dwelling	32	$19,071,500	35	$19,891,600	42	$23,730,200
Personal/Repair Services	2	$332,100	2	$332,100	2	$332,100
Professional/Tech. Services	1	$0	1	$0	1	$0
Retail Trade	20	$4,667,600	20	$4,667,600	20	$4,667,600
Schools	3	$21,843,100	3	$21,843,100	3	$21,843,100
Single Family Dwelling	330	$102,553,200	397	$121,370,100	468	$140,694,500
Temporary Lodging	1	$308,500	1	$308,500	2	$2,031,700
Vacant	158	$763,700	172	$763,700	187	$801,300
Wholesale Trade	6	$1,888,200	6	$1,888,200	6	$1,888,200
COLUMN TOTAL	659	$168,760,400	744	$188,397,400	838	$213,321,200

Table 4.2 | The number of parcels and value of buildings exposed to sea level rise. Table generated using 2019 Eastham Assessing Data.

Sea Level Rise						
	4 feet		5 feet		6 feet	
Type of Use	# of parcels	Value of Buildings	# of parcels	Value of Buildings	# of parcels	Value of Buildings
Agriculture	2	$0	2	$0	2	$0
Banks	2	$1,280,600	2	$1,280,600	2	$1,280,600
Church/Non-Profit Offices	50	$329,300	50	$329,300	52	$329,300
Emergency Response	7	$6,328,400	7	$6,328,400	7	$6,328,400
Entertainment and Recreation	4	$0	4	$0	4	$0
General Services	21	$3,155,700	24	$3,252,300	24	$3,252,300
Heavy Industrial	3	$0	3	$0	3	$0
Light Industrial	11	$2,115,600	11	$2,115,600	11	$2,115,600
Medical Office/Clinic	7	$4,165,300	7	$4,165,300	7	$4,165,300
Metals/Minerals Processing	2	$72,200	2	$72,200	2	$72,200
Multi-family Dwelling	51	$28,687,900	53	$29,842,900	58	$31,765,600
Personal/Repair Services	2	$332,100	2	$332,100	2	$332,100
Professional/Tech. Services	1	$0	1	$0	1	$0
Retail Trade	20	$4,667,600	20	$4,667,600	20	$4,667,600
Schools	3	$21,843,100	3	$21,843,100	3	$21,843,100
Single Family Dwelling	542	$159,823,900	620	$179,240,600	701	$197,782,400
Temporary Lodging	2	$2,031,700	2	$2,031,700	2	$2,031,700
Vacant	206	$801,300	222	$801,300	233	$801,300
Wholesale Trade	6	$1,888,200	6	$1,888,200	6	$1,888,200
COLUMN TOTAL	942	$237,522,900	1,041	$258,191,200	1,140	$278,655,700

Table 4.2 | The number of parcels and value of buildings exposed to sea level rise (cont.). Table generated using 2019 Eastham Assessing Data.

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Hurricanes

SLOSH

Type of Use	Category 1 Storm		Category 2 Storm		Category 3 Storm		Category 4 Storm	
	# of Parcels	Building values*	# of Parcels	Building values	# of Parcels	Building values	# of Parcels	Building values
Agriculture	0	$0	0	$0	0	$0	0	$0
Banks	0	$0	0	$0	0	$0	0	$0
Church/Non-Profit Offices	38	NA	44	NA	50	$329,300	53	$329,300
Emergency Response	0	$0	0	$0	0	$0	0	$0
Entertainment and Recreation	2	$0	4	$0	4	$0	5	$0
General Services	17	$1,642,000	17	$1,642,000	19	$1,707,500	23	$1,976,600
Heavy Industrial	0	$0	0	$0	0	$0	0	$0
Light Industrial	0	$0	0	$0	0	$0	0	$0
Medical Office	0	$0	0	$0	0	$0	0	$0
Metal/Mineral Processing	0	$0	0	$0	0	$0	0	$0
Multi-family Dwelling	22	$14,695,800	28	$17,932,300	51	$26,867,200	72	$34,940,800
Personal/repair services	0	$0	0	$0	0	$0	0	$0
Professional/tech services	0	$0	0	$0	0	$0	0	$0
Retail Trade	0	$0	0	$0	0	$0	0	$0
Schools	0	$0	0	$0	0	$0	0	$0
Single Family Dwelling	253	$79,707,600	360	$112,567,700	611	$177,748,100	880	$236,396,600
Temporary Lodging	1	$308,500	1	$308,500	2	$2,031,700	2	$2,031,700
Vacant	116	$763,700	142	$763,700	207	$801,300	233	$801,300
Wholesale Trade	0	$0	0	$0	0	$0	0	$0
COLUMN TOTAL	449	$97,117,600	596	$133,214,200	944	209485,100	1268	276476300

Table 4.3 | The number of parcels and value of buildings vulnerable to hurricanes. Table generated using 2019 Eastham Assessing Data.

Exposure Assessment of Critical Facilities by the Planning Team

Critical Facilities			
Name of Facility	Hurricane Category for Flooding (SLOSH)	Located in Flood Zone?	Sea Rise Level (feet) for Flooding
Nauset Regional High School	None	No	N
Nauset Pet Services	None	No	N
Eastham DPW/Natural Resources Office/Recycling & Transfer Station	None	No	N
Eastham Senior Center/COA	None	No	N
Cape Cod Children's Place	None	No	N
Nauset Ranger Station	None	No	N
Eastham Elementary School	None	No	N
Eastham Police Facility/Emergency Operations	None	No	N
Eastham Fire Department	None	No	N
Eastham Public Library	None	No	N
Eastham Town Hall	None	No	N
Eastham Veterinary Hospital	None	No	N
NEED Building	None	No	N
Salt Pond Visitor Center	None	No	N
Wild Care of Cape Cod	None	No	N
Orleans/Eastham Rotary	3	AE	2
Rock Harbor	2	AE	1
Hemenway Landing	2	VE	1
US-6/Town Cove Tributary Culvert	3	AE	1
Smith Lane/Boat Meadow Creek Culvert	3	AE	1
Salt Pond Landing	2	AE	3
Bridge Road bridge	1	AE	1
Dyer Prince Road culvert	3	AE	1
District G Well	None	No	N
NRHS Well	None	No	N
Eastham Water Tower	None	No	N

Table 4.4 | The vulnerability of the critical facilities identified by the Planning Team. Table generated using 2019 Eastham Assessing Data.

B3b

Vulnerable Populations

Below is a description of segments of the population who are vulnerable to the impacts of natural hazard events:[3]

- **Coastal Erosion:** Coastal erosion is not generally considered an imminent threat to public safety because shoreline changes are gradual over many years. However, drastic changes to the shoreline may occur in a single storm event which can threaten homes and public safety.
- **Culvert Failure:** All populations in a culvert failure inundation zone would be exposed to the risk of culvert failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.
- **Earthquake:** All of Eastham is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of dwelling structures, soil types in which homes are constructed, proximity to fault locations, etc. Further, the time of day also exposes different sectors of the community to the hazard.
- **Wildland and Urban Fire:** As demonstrated by historical urban and wildfire events, potential losses include human health and life of residents and responders. The most vulnerable populations include the elderly, children, and disabled as well as emergency responders and those within a short distance of the interface between the built environment and the wildland environment.
- **Flooding:** The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure includes the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by a hazard event (e.g., risk while traveling in flooded areas, or compromised access to emergency services during an event). The degree of such impacts will vary and is not strictly measurable.2 Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating. People living in homes that have been flooded can suffer from serious illness and adverse mental health impacts from mold.

3 Massachusetts State Hazard Mitigation Plan, 2013

- **Hurricanes and Tropical Storms:** The impact of a hurricane or tropical storm on life, health and safety is dependent upon several factors including the severity of the event and whether or not residents receive adequate warning time. It is assumed that the entire population of Barnstable County is exposed to this hazard. Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.2 Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.
- **Landslides:** It is difficult to determine demographics of populations vulnerable to landslides.
- **Nor'easters:** The impact of a nor'easter on life, health and safety is dependent upon several factors including the severity of the event and whether residents received adequate warning time. It is assumed that the entire town's population is exposed to this hazard (wind and rain/snow). The most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.
- **Severe Weather (wind, thunderstorms, tornadoes, extreme temperatures, drought):** For the purposes of this plan, the entire population of Eastham is exposed to severe weather events. Residents may be displaced or require temporary to long-term sheltering due to severe weather events. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. In general, vulnerable populations include the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

Vulnerable Populations

- **Severe Winter Weather (snow, blizzards and ice):** According to NOAA's National Severe Storms Laboratory, winter weather indirectly and deceptively kills hundreds of people in the U.S. every year, primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures with dangerous wind chills. These storms are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. Injuries and fatalities may occur due to traffic accidents on icy roads, heart attacks while shoveling snow or hypothermia from prolonged exposure to cold.

  Heavy snow can immobilize a region and paralyze a town, shutting down its transportation network, stopping the flow of supplies, and disrupting medical and emergency services. The elderly are considered most susceptible due to their increased risk of injury and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice, or related to power failures. In addition, severe winter weather events can reduce the ability of these populations to access emergency services. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

- **Tsunami:** It is difficult to determine demographics of populations vulnerable to tsunamis.

B3b

Summary of Vulnerable Infrastructure

The following infrastructure is vulnerable to the impacts of natural hazards events:

- The Orleans/Eastham rotary is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- The Bridge Road bridge is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- The Route 6 Town Cove tributary culvert is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- Smith Lane/Boat Meadow Creek Culvert is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- Dyer Prince Road is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- Hemenway Landing is vulnerable to flooding (located in flood hazard zone).
- Salt Pond Landing is vulnerable to flooding (located in flood hazard zone).
- Rock Harbor is vulnerable to flooding (located in flood hazard zone) and sea level rise.
- Bayside beach restrooms and septic systems are vulnerable to flooding.
- Cape Cod National Seashore facilities at Nauset Light beach and Coast Guard beach are vulnerable to coastal erosion. Seashore facilities vulnerable to flooding include the Cranberry Bog Bridge that crosses to the Coast Guard NEED facility, as well as the Nauset Bicycle Trail bridge.

Mitigation Strategy

CHAPTER FIVE

Chapter 2 profiles specific hazards that could affect Eastham and Chapter 4 assesses the losses that could result from hazard events. The next step in the hazard planning process is to identify actions to reduce risk and loss of life and to develop ways to implement these actions. This so-called “Mitigation Strategy” determines broad goals and objectives and outlines specific actions for the next five years. **Chapter 5 outlines a hazard mitigation strategy for the Town of Eastham for the next five years.**

C3a,b

Mitigation Goals

Mitigation goals are broad guidelines that articulate Eastham's desire to protect people and structures, reduce the cost of disaster response and recovery, and minimize disruption to the community following a disaster.

Mitigation Goals for the 2020 Eastham Hazard Mitigation Plan Update are:

1. Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.
2. Coordinate local hazard mitigation planning activities with those of Barnstable County and neighboring towns.
3. Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan.
4. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.
5. Ensure that mitigation measures are context sensitive to natural features, historic resources, and community character.
6. Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Mitigation Actions

Mitigation actions are any action, process or project designed to reduce or eliminate long term risk from natural hazards. These mitigation actions are developed by the Planning Team and they must be consistent with the vulnerability and risk assessment performed in Chapter 4 and with the priorities of the Town of Eastham.

Below is a description of how the Planning Team developed the Mitigation Action section of the 2020 Eastham Hazard Mitigation Plan Update:

1. **A Progress Determination on Mitigation Actions in 2010:** the Planning Team assigned a status to each mitigation action identified in the 2010 Hazard Mitigation Plan and explained whether the action was completed, an existing capability, in progress, deferred or deleted (See ***Table 5.1***).
2. **2.Future Mitigation Actions for the 2020 Hazard Mitigation Plan Update:** the list contains:
   - New mitigation actions based on the Vulnerability and Risk Assessment in Chapter 4
   - "In Progress" and continued actions identified in ***Table 5.1*** were carried forward into the Future Mitigation Action List

3. **Capability Assessment:** The Team reviewed and revised the Capability Assessment from the 2010 Hazard Mitigation Plan. Also, any action designated as an "existing capability" in ***Table 5.1*** was carried over to the Capability Assessment. (***Table 5.2***).

Progress Determination on 2010 Mitigation Actions

D2a

Before identifying new Mitigation Actions for the 2020 Hazard Plan, the Planning Team discussed the status of the mitigation actions identified in 2010 Eastham Hazard Mitigation Plan. One of the following status determinations was given to each mitigation action identified from the 2011 plan:

- **Complete:** The project was implemented and completed in 2010 – 2020.
- **Existing Capability:** The project was implemented and completed in 2010 – 2020, and it will continue to be implemented on an annual basis in the future. These action items are also identified in the capability assessment (***Table 5.2***).
- **In Progress:** The project was started in the 2010 – 2020 timeframe and it is still in progress.
- **Deferred:** The project is important, but it was deferred because there was no funding available or it is not feasible to complete the project.
- **Deleted:** The project is no longer relevant to the community.

Progress Determination on 2010 Mitigation Actions

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flood	Action Item #G1: Increase protection of the floodplain by enhancing floodplain management activities within the Town of Eastham. Adopt Floodplain regulations that are consistent with updated FIRM maps.	Building, Planning	Existing Capability	The town adopted floodplain regulations in 2014 but will continue to update.
Flood	Action Item #G2: Become a participant in the National Flood Insurance Program (NFIP) Community Rating System (CRS) program through enhanced floodplain management activities. Explore opportunities to join with Barnstable County as a whole.	BOS, Planning, Building	Complete	The Town joined CRS in 2018. New action for 2019 to improve CRS rating. The Town currently has two certified flood managers (CFM) on staff accredited through the Association of State Floodplain Managers (ASFPM)
Flood	"Action Item #G3: Advertise and promote the availability of flood insurance to Town property owners by direct mail yearly."	Planning Department, Board of Selectmen	Existing Capability	The Town joined Community Rating System in 2018, and this action occurs through that program. The Town uses the website and email rather than direct mail. Town does annual direct mailing to all properties in the flood plain
All	Action Item #G4: Use the Town's emerging Geographic Information System (GIS) to maintain current building and parcel data for the purposes of conducting more detailed hazard risk assessments and for tracking permitting / land use analysis	Planning, MIS, Assessing	Existing Capability	The Town has purchased and uses upgraded GIS software and added an online permitting system, which is integrated into the Town's GIS mapping software

Table 5.1 | Progress determination on 2010 Mitigation Actions

Progress Determination on 2010 Mitigation Actions

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flood, Erosion, Sea Level Rise	Action Item #5: Continue to acquire and preserve parcels of land subject to repetitive flooding from willing and voluntary property owners	Planning, Natural Resources, BOS, Town Meeting	Existing Capability	The town continues to acquire properties in the flood zone but no repetitive loss properties were purchased.
All	Action #6: Conduct a thorough evaluation of the Town's most at-risk locations identified in the Vulnerability Analysis, and evaluate the potential mitigation techniques for protecting each location to the maximum extent possible.	DPW, Natural Resources, Health, Building, Planning	In progress	The town is conducting an analysis of four low lying roads currently. It is using coastal inundation model and Storm Pathways to evaluate locations. The Town is working with CCNS to relocate Nauset Light Beach Road due to coastal erosion, to be completed in 2020.
All	Action Item #7: Monitor the Town's emergency response services to identify needs or shortfalls in terms of personnel, equipment or required resources.	Police, Fire, Health	Existing Capability	Town departments monitor emergency response services. The town is upgrading its communications center to improve response capabilities.
Flood, Erosion, Sea Level Rise	Action Item #8: Revise the Town's Flood Plain Zoning (Section IV) to incorporate cumulative substantial damage or improvement requirements.	Planning, Building, Town Meeting	Deleted	This action was deleted because using a cumulative substantial damage/ improvements is stricter than what the state building code requires.

Table 5.1 | Progress determination on 2010 Mitigation Actions (continued)

Progress Determination on 2010 Mitigation Actions

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Wind, snow & ice	"Action Item #9: Incorporate the inspection and management of hazardous trees/limbs into the Town's routine monitoring process."	DPW, Fire	Existing Capability	Town does this on a regular basis and also coordinates with Eversource on tree trimming.
Wind	"Action Item #10: Augment the enforcement the State Building Code and related Town Bylaws by encouraging wind resistant design techniques for new residential construction and reconstruction during the Town's permit process. Follow 2007 State Building Code to improve safety of structures. "	Town Planner, Building Department, Conservation Commission.	Existing Capability	Town does this. Also note 2015 wind resistant design changes in state building code.
All	Action #11: Conduct a quantification of potential losses by estimating potential losses at varying degrees of storm surge, wind, and stormwater hazard severity, as well as specific impacts on critical facilities for the MHM five (5) year update.	Planning	Completed	This analysis was done for the 2019 Hazard Mitigation Plan. See Chapter 4. The Town obtained Planimetrics data from the Cape Cod Commission and partners with Commission GIS staff to conduct vulnerability assessments for the Hazard Mitigation Plan.
All	Action G #12: Develop a map indicating hazard sensitive parcels acquired by Eastham	Planning, Natural Resources, BOS	Deferred	This action is a fairly simple task for the Planning Department but was not completed.
Erosion, sea level rise	Action IM #1 Regular maintenance dredging of Rock Harbor Creek	Natural Resources	Existing Capability	Rock Harbor was dredged in 2014. A consultant is looking at additional dredging work on a regular basis.

Table 5.1 | Progress determination on 2010 Mitigation Actions (continued)

Progress Determination on 2010 Mitigation Actions

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flood	"Action IM #2 Reconstruction of infrastructure identified by NPDES Phase II Annual Permitting"	DPW	In progress	The town completed year one mapping of stormwater infrastructure and submitted a stormwater management plan under MS4 permit.
Flood, fire, erosion, sea level rise	"Action IM #3 Continue to participate in marsh restoration project that improve tidal flushing"	Natural Resources, Planning, DPW	In progress	The town has replaced culverts on Dyer Prence Road and Great Pond.
Fire	Action IM #4 Participate in Barnstable County's Cooperative Extension Service's grant program for wildfire fuel reduction programs.	Fire	Existing Capability	Barnstable County wildfire plan completed in 2012. The town continues to address wildfire control through partnerships with DCR and the National Park Service.
Fire	Action #5: Coordination with National Seashore on fuel reduction programs and response	Fire	Existing Capability	The Park Service/CCNS maintains its own burning/ trimming program and keeps the Town informed of burning activities.
All	"Action E #1: Continue to collect educational materials on preparedness/mitigation measures for individual property owners, for display and distribution at Town Hall, Natural Resources Office, Library and Council on Aging offices."	Building, Planning	Existing Capability	The Town provides hazard information to the general public on the website and provides written materials at the COA and other locations. The CRS program provides information to property owners.

Table 5.1 | Progress determination on 2010 Mitigation Actions (continued)

Progress Determination on 2010 Mitigation Actions

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flood	"Action E #2 Develop an educational flyer targeting NFIP policyholders on the Increased Costs of Compliance (ICC) coverage, to be disseminated following a flood event that results in substantial damage determinations by the Town."	Building	Existing Capability	An ICC flyer is available through the Town's webpage: https://www.capecodextension.org/project/national-flood-insurance-program/
Flood	"Action E #3 On an annual basis, contact all owners of FEMA- identified repetitive loss properties and inform them of the assistance available through the federal Flood Mitigation Assistance (FMA) program, in addition to other flood protection measures."	Building, Planning	Existing Capability	Town sends annual mailing to all rep Loss properties
All	"Action E #4 Annually host a public hazards display for the residents of Eastham, in combination with the "Windmill Weekend" festival or another appropriate community event."	Planning, Building	Deleted	Staffing limitations hindered execution of this action item. The Town will continue to provide such information through the website and as noted above but hosting public displays at annual events/festivals is not a priority given staffing limitations.
Flood, wind, erosion, sea level rise	"Action E #5: Conduct an educational workshop targeting Cape Cod Bay coastal area land owners and contractors on hazard mitigation."	Planning, Building, Natural Resources	Deferred	Staffing limitations hindered execution of this action item.
Wildfire	"Action #6 : Enhance promotion of concepts developed as part of National Fire Protection Association's FIREWISE program (www.firewise.org) beyond National Seashore residents."	Fire	Existing Capability	Town continues to partner with Americorps and DCR on wildfire education efforts.

Table 5.1 | Progress determination on 2010 Mitigation Actions (continued)

C5a

Mitigation Actions for the 2020 Hazard Plan

This section of the plan is the most dynamic because it is heavily influenced by factors such as grant funding and staff capability. The Mitigation Actions section will be updated to ensure that it remains consistent with current Town priorities. The mitigation actions are in no particular order.

The Planning Team created a prioritization ranking for the Mitigation Actions. Several variables factored into the priority designation:

Life Safety/Social:

- How effective is the action at protecting lives and preventing injuries?
- If the action is to improve structures/infrastructure, will it also protect lives and prevent injury?
- Will the action affect one segment of the population more than another?
- Will the action disrupt the community in any way? (i.e., impact emergency service routes, break up neighborhoods)

Property Protection:

- Will the action eliminate or reduce damage to structures and infrastructure? If so, how?
- What are the secondary impacts of the mitigation action?
- Does it solve a problem or a symptom of the problem?

Technical/Legal/Environmental/ Administrative:

- Is the mitigation action technically feasible based on Eastham's current capabilities?
- Is the action a long or short-term solution?
- What are the benefits of the project? What are the costs?
- Does the action support Eastham's Mitigation Goals?
- Does Eastham have the authority to implement the action? If not, who does?
- Is the action consistent with town values and other planning projects?
- What are the environmental impacts of the action?
- Does it comply with environmental regulations?

Political/Local Champion:

- Is there political support to implement and maintain the action?
- Does the public support the mitigation action?
- Is there a strong advocate for the action?

Mitigation Actions for the 2020 Hazard Plan

The Priority designations for 2020 Mitigation Actions (high, medium, low) were based on the following factors:

- High Priority: The town will begin or complete these projects within three years.
- Medium Priority: The town will begin or complete these projects within four years.
- Low Priority: The town will begin or complete these projects within five years

Flood

Mitigation Action #1

FROM 2010

Increase protection of the floodplain by enhancing floodplain management activities within the Town of Eastham. Adopt Floodplain regulations that are consistent with updated FIRM maps.

Project Type:

Planning

Responsible Dept.:

Planning, Conservation

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP

High

Flood

Mitigation Action #2

NEW

Continue participation and maintain standing in the NFIP's Community Rating System (CRS) program through enhanced floodplain management activities.

Project Type:

Planning

Responsible Dept.:

Planning, Conservation

Funding Sources:

Operating budget, grants

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters. Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency with Other Town Plans:

LCP

High

Flood

Mitigation Action #3

FROM 2010

Advertise and promote the availability of flood insurance to Town property owners.

Project Type:

Education & Awareness

Responsible Dept.:

Planning

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP

High

Mitigation Actions for the 2020 Hazard Plan

All Hazards

Mitigation Action #4

FROM 2010

Use the Town's Geographic Information System (GIS) to maintain current building and parcel data for the purposes of conducting more detailed hazard risk assessments and for tracking permitting / land use analysis

Project Type:
Planning

Responsible Dept.:
Planning, Assessing

Funding Sources:
Operating budget, grants

Timeframe:
Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP

High Priority

Flood

Mitigation Action #5

FROM 2010

Continue to acquire and preserve parcels of land subject to repetitive flooding from willing and voluntary property owners

Project Type:
Planning

Responsible Dept.:
Planning, Conservation

Funding Sources:
CPA, grants, donations

Timeframe:
Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP, OSRP

Medium Priority

All Hazards

Mitigation Action #6

FROM 2010

Monitor the Town's emergency response services to identify needs or shortfalls in terms of personnel, equipment or required resources.

Project Type:

Preparedness

Responsible Dept.:

Police, Fire

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

High Priority

All Hazards

Mitigation Action #7

FROM 2010

Incorporate the inspection and management of hazardous trees/limbs into the Town's routine monitoring process.

Project Type:

Planning

Responsible Dept.:

DPW

Funding Sources:

Operating budget, grants

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP

Medium Priority

Mitigation Actions for the 2020 Hazard Plan

Wind

Mitigation Action #8

FROM 2010

Augment the enforcement the State Building Code and related Town Bylaws by encouraging wind resistant design techniques for new residential construction and reconstruction during the Town's permit process. Follow the current 9th edition State Building Code to improve safety of structures.

Project Type:
Mitigation

Responsible Dept.:
Building

Funding Sources:
Operating budget

Timeframe:
Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP

High Priority

All Hazards

Mitigation Action #9

FROM 2010

Develop a map indicating hazard sensitive parcels acquired by Eastham

Project Type:
Education & Awareness

Responsible Dept.:
Planning

Funding Sources:
Operating budget

Timeframe:
1 -year

Consistency with Mitigation Goals:

Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency with Other Town Plans:

OSRP, LCP

Low Priority

Erosion, Sea Level Rise

Mitigation Action #10

FROM 2010

Conduct regular maintenance and improvement dredging of Rock Harbor Creek.

Project Type:

Natural systems protection

Responsible Dept.:

DPW

Funding Sources:

Grants

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

Harbor Management Plan

High Priority

Flood

Mitigation Action #11

FROM 2010

Reconstruction of infrastructure identified by NPDES Phase II Annual Permitting

Project Type:

Infrastructure

Responsible Dept.:

DPW

Funding Sources:

Chapter 90 funds, grants

Timeframe:

Annually, Ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

Stormwater Management Plan

High Priority

Mitigation Actions for the 2020 Hazard Plan

Flood, fire, sea level rise

Mitigation Action #12

FROM 2010

Continue to participate in marsh restoration projects that improve tidal flushing.

Project Type:

Natural systems protection

Responsible Dept.:

Planning, DPW, Conservation

Funding Sources:

Grants

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

LCP, Harbor Management Plan

Medium Priority

Fire

Mitigation Action #13

FROM 2010

Continue to participate in Barnstable County's Cooperative Extension Service grant program for wildfire fuel reduction programs.

Project Type:

Preparedness

Responsible Dept.:

Fire

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

Regional Fire Management Plan

Medium Priority

Fire

Mitigation Action #14

FROM 2010

Continue coordination with Cape Cod National Seashore and DCR on fuel reduction programs and response.

Project Type:

Preparedness

Responsible Dept.:

Fire

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

Regional Fire Management Plan

Medium Priority

All Hazards

Mitigation Action #15

FROM 2010

Continue to collect educational materials on preparedness/ mitigation measures for individual property owners, for display and distribution at Town Hall, Natural Resources office, library and Council on Aging offices.

Project Type:

Outreach

Responsible Dept.:

Planning, Building

Funding Sources:

Operating budget

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process. Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

CRS Program, LEMP

Medium Priority

Mitigation Actions for the 2020 Hazard Plan

Flood

Mitigation Action #16

FROM 2010

Continue to provide information to NFIP policyholders on the Increased Costs of Compliance (ICC) coverage.

Project Type:
Education & Awareness

Responsible Dept.:
Building

Funding Sources:
Operating budget, grants

Timeframe:
Annually, ongoing

Consistency with Mitigation Goals:

Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

CRS Program

Medium Priority

Flood

Mitigation Action #17

FROM 2010

On an annual basis, contact all owners of FEMA- identified repetitive loss properties and inform them of the assistance available through the federal Flood Mitigation Assistance (FMA) program, in addition to other flood protection measures.

Project Type:
Education & Awareness

Responsible Dept.:
Building

Funding Sources:
Operating budget, grants

Timeframe:
Annually, ongoing

Consistency with Mitigation Goals:

Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

CRS Program

High Priority

All Hazards

Mitigation Action #18

FROM 2010

Continue to provide information on natural hazards to Eastham residents on the town website.

Project Type:

Education & Awareness

Responsible Dept.:

Planning, Building

Funding Sources:

Operating budget, grants

Timeframe:

Annually, ongoing

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

CRS Program

Medium Priority

Flood, Sea Level Rise, Erosion, Wind

Mitigation Action #19

FROM 2010

Conduct an educational workshop targeting Cape Cod Bay coastal area land owners and contractors on hazard mitigation.

Project Type:

Education & Awareness

Responsible Dept.:

Planning, Building, Conservation

Funding Sources:

Operating budget, grants

Timeframe:

1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters. Ensure that mitigation measures are context sensitive to natural features, historic resources, and community character.

Consistency with Other Town Plans:

LCP

Low Priority

Mitigation Actions for the 2020 Hazard Plan

Fire

Mitigation Action #20

FROM 2010

Enhance promotion of concepts developed as part of National Fire Protection Association's FIREWISE program (www.firewise.org) through Americorps and DCR partnerships

Project Type:
Education & Awareness

Responsible Dept.:
Fire

Funding Sources:
Operating budget

Timeframe:
Annually

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters. Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency with Other Town Plans:

LCP

Medium Priority

All Hazards

Mitigation Action #21

NEW

Expand town-wide communications equipment, including radios for inter-department communication, and additional message boards for public communications.

Project Type:
Preparedness

Responsible Dept.:
Police, Fire

Funding Sources:
Operating budget, grants

Timeframe:
1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

High Priority

Flooding

Mitigation Action #22

NEW

Improve resiliency of Bridge Road/Route 6. Conduct a feasibility study to understand potential impacts, costs, and other considerations of elevating the roads as well as identifying other alternatives for mitigating the flooding.

Project Type:

Mitigation

Responsible Dept.:

Conservation, DPW

Funding Sources:

Grants

Timeframe:

1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

MVP Findings

High Priority

All Hazards

Mitigation Action #23

NEW

Create a task force responsible for public education on local emergency preparedness

Project Type:

Education & Awareness

Responsible Dept.:

Police, Fire

Funding Sources:

Operating budget

Timeframe:

1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters. Increase public awareness of existing hazards and encourage hazard mitigation planning as part of the overall municipal planning process.

Consistency with Other Town Plans:

MVP Findings

Medium Priority

Mitigation Actions for the 2020 Hazard Plan

Flooding

Mitigation Action #24

Develop conservation commission regulations that address Lands Subject to Coastal Storm Flowage (LSCSF).

Project Type:
Planning and regulation

Responsible Dept.:
Conservation

Funding Sources:
Operating budget, grants

Timeframe:
1-2 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

MVP Findings

Medium Priority

All Hazards

Mitigation Action #25

Develop a Memorandum of Understanding with the water system operator for maintenance/repair (during storm events)

Project Type:
Preparedness

Responsible Dept.:
DPW

Funding Sources:
Operating budget

Timeframe:
1-year

Consistency with Mitigation Goals:

Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to disasters.

Consistency with Other Town Plans:

MVP Findings

High Priority

Flooding

Mitigation Action #26

Purchase diesel pumps for use in low-lying areas for emergency egress

Project Type:
Preparedness

Responsible Dept.:
DPW

Funding Sources:
Grants

Timeframe:
1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

High Priority

All Hazards

Mitigation Action #27

Upgrade Route 6 signals at Brackett Road and Samoset Road to receive external generators

Project Type:
Infrastructure

Responsible Dept.:
DPW

Funding Sources:
Grants

Timeframe:
1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

Medium Priority

Mitigation Actions for the 2020 Hazard Plan

All Hazards

Mitigation Action #28

Install mobile traffic control devices for temporary traffic control during Route 6 closures.

Project Type:
Infrastructure

Responsible Dept.:
Police

Funding Sources:
Grants

Timeframe:
1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

Medium Priority

All Hazards

Mitigation Action #29 NEW

Purchase roving generator that could be moved to buildings in need during power outages

Project Type:
Preparedness

Responsible Dept.:
DPW

Funding Sources:
Grants

Timeframe:
1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

High Priority

All Hazards

Mitigation Action #30

NEW

Seek funding for transfer switches to accommodate portable generators at tie-in points.

Project Type:

Preparedness

Responsible Dept.:

DPW

Funding Sources:

Grants/Local Capital Plan Funds

Timeframe:

1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

Medium Priority

All Hazards

Mitigation Action #31

NEW

Evaluate the needs/upgrades/improvements to shelters and warming stations.

Project Type:

Preparedness

Responsible Dept.:

Police/Fire

Funding Sources:

Grants/Operating Budget

Timeframe:

1-year

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

LEMP

High Priority

Mitigation Actions for the 2020 Hazard Plan

Flooding

Mitigation Action #32

NEW

Improve the resilience of Route 6/Bridge Road to flooding

Project Type:

Infrastructure

Responsible Dept.:

DPW/Planning/ Conservation

Funding Sources:

Grants/State/Federal

Timeframe:

2 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life, property, infrastructure, and environmental and cultural resources in Eastham from natural disasters.

Consistency with Other Town Plans:

MVP Report/5 Year Strategic Plan

High Priority

Flooding

Mitigation Action #33

NEW

Continue to work with MassDOT to mitigate flood risks along Route 6 (including the Eastham Rotary) which serves as the primary evacuation route for Eastham and the entire Outer Cape region.

Project Type:

Infrastructure

Responsible Dept.:

DPW/Planning/ Conservation

Funding Sources:

Grants/State/Federal

Timeframe:

2 years

Consistency with Mitigation Goals:

Reduce loss of life from natural disasters.

Consistency with Other Town Plans:

LEMP/5-Year Strategic Plan/Harbor and Waterways Management Plan

High Priority

All Hazards

Mitigation Action #34

NEW

Work with DCR and MassDOT to identify opportunities to utilize the Cape Cod Rail Trail as a backup evacuation route. Identify and upgrade areas along Rail Trail to enable access to the facility.

Project Type:
Planning

Responsible Dept.:
Planning/DPW

Funding Sources:
State/local funding/Grants

Timeframe:
1-5 years

Consistency with Mitigation Goals:
Reduce the potential for loss of life from natural hazards.

Consistency with Other Town Plans:
LEMP

Medium Priority

Participation in NFIP

A6c

Repetitive Loss Properties

B4a

Repetitive Loss Properties are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any ten year period since 1978. Seven Repetitive Loss Properties (single-family residential dwellings or cottages) are located in Eastham. Three have been mitigated.

Continued compliance with NFIP

C2a

To be approved by the Federal Emergency Management Agency (FEMA), the Eastham Hazard Mitigation Plan Update must describe the Town's participation in the National Flood Insurance Program (NFIP). The NFIP is based on a mutual agreement between the Federal government and the Town of Eastham. Federally backed flood insurance is available in Eastham as long as the Town agrees to regulate development in their mapped floodplain. To remain compliant with the NFIP, Eastham is committed to the following activities:

- Issue or deny floodplain development/ building permits.
- Inspect all developments to ensure compliance with local bylaws.
- Maintain records of floodplain development.

- Assist with floodplain identification and mapping as well as any revision of floodplain maps, including local requests for map updates.
- Help residents obtain information on flood hazards, floodplain map data, flood insurance and proper construction practices.

C1

Existing Capabilities Assessment

During the development of the 2020 Eastham Hazard Mitigation plan, members of the Planning Team reviewed the capabilities of each town department (***Table 5.2***).

D3

An Assessment of the Changes in Priorities from 2010 to 2020

The Mitigation Actions described in the 2010 Eastham Hazard Mitigation Plan were prioritized based on their feasibility using the STAPLEE method. The Mitigation Actions in the 2020 Eastham Hazard Mitigation Plan Update were prioritized as high, medium, low.

Below is a list of activities that remain a priority for the Town of Eastham in 2020:

- Eastham remains dedicated to public outreach on emergency preparedness, communication with residents and visitors before, during and after a hazard event, and communicating with the public about the impact of natural hazards.
- Eastham remains committed to assessing local infrastructure for damage to coastal hazards such as storm surge, flooding and shoreline change in the National Flood Insurance Program.
- Eastham remains dedicated to reducing the potential for life, property, infrastructure, and environmental, cultural, and economic resources in the Town from natural hazards.

Since the 2010 Eastham Hazard Mitigation Plan, the Town has developed a greater sense of urgency in addressing hazards and climate change impacts. Eastham has increased its efforts to engage with stakeholders and the public on issues related to hazard mitigation and climate change. Completion of the MVP workshop in 2019 reflects the Town's expanded interest in both educating the public on hazard and climate change issues and seeking community input on mitigation actions. The Town has taken additional steps since to address hazards and climate change impacts by joining the CRS program as well as joining together with neighboring communities to understand and address issues related to shoreline change. In addition, since receipt of its MVP Community certification, the Town has pursued additional actions related to mitigating flooding impacts to low-lying roads.

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
PLANNING AND REGULATORY: Plans			
Local Comprehensive Plan 2012	The LCP addresses issues related to hazard mitigation including land use and growth management, open space protection, natural resources, capital facilities, economic development, and transportation.	**Planning**	**All Hazards**
Capital Improvement Plan	The CIP funds identifies and funds future municipal projects and is a potential funding source for infrastructure and building upgrades that would reduce impacts from hazards	**Finance, Town Administration**	**All Hazards**
Strategic Plan 2020-2024	Eastham's Strategic Plan provides actions and strategies to support and advance community goals	**Town Administration, Planning**	**All Hazards**
Local Emergency Operations Plan	Eastham has a local emergency operations and shelter plan administered by the police department.	**Police and Fire**	**All Hazards**
Regional Transportation Plan	The Regional Transportation Plan identifies priority transportation projects across Cape Cod, which may include projects related to road flooding and culvert repair.	**DPW, Planning**	**Flooding**
Stormwater Management Plan	Eastham completed a stormwater management plan under its MS4 permit.	**DPW**	**Flooding, sea level rise, severe winter storms, nor'easters, hurricane/ tropical storms,**
Open Space Plan	Eastham's open space plan addresses open space protection needs and acquisition strategies, including parcels in coastal hazard areas.	**Conservation, Planning**	**All Hazards**
County Wildfire Protection Plan 2012	The Barnstable County Wildfire Management Plan identifies priority areas in each community for wildfire management/ risk reduction.	**Fire**	**Fire**

Table 5.2 | Existing capabilities assessment

Existing Capabilities Assessment

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Municipal Vulnerability Preparedness Plan 2019	The MVP plan/Summary of Findings identifies priority projects/actions related to natural hazard mitigation and climate change adaptation. As an MVP-certified community, Eastham is eligible to receive action grants to address vulnerability.	**Planning**	**All Hazards**
Sediment Assessment Study	The town partnered with the Center for Coastal Studies to conduct a study on bayside sediment transport in 2018.	**Conservation**	
PLANNING AND REGULATORY: Building Code, Permitting			
State Building Code	Eastham's Building Commissioner enforces the state building code, which contains building standards/requirements related to wind-resistant design, flood protection, snow loading, and earthquakes.	**Building**	**All Hazards**
Fire Code	Town observes State, Federal and local fire codes. New sprinkler system laws are continually enforced.	**Fire Department, Building Commissioner**	**Fire**
PLANNING AND REGULATORY: Land Use Planning and Bylaws:			
Eastham Zoning Bylaw	The Eastham Zoning Bylaw contains regulations for development in the floodplain.	**Planning**	**Flooding**
Flood Insurance Rate Maps	Voters amended the zoning bylaw to make it consistent with the newly updated FIRM maps.	**Planning**	**Flooding**
ADMINISTRATIVE AND TECHNICAL			
Community Rating System	Eastham participates and maintains standing in NFIP's Community Rating System (CRS) program through enhanced floodplain management activities.	**Planning**	**Flooding**
Geographic Information System	The town maintains current building and parcel data using GIS for the purpose of conducting more detailed hazard risk management assessments and for tracking permitting/land use.	**Planner**	**All**

Table 5.2 | Existing capabilities assessment (continued)

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Essential Records and Cultural Items	Building files are backed up and stored in a building outside of flood hazard area.	**Building, Town Clerk**	**All**
Generators	Town staff reviews and monitors an inventory of town-owned generators	**Police and Fire, DPW**	**All**
Shelter	Equipment inventories and needs for the regional shelter are assessed during monthly meetings of the Barnstable County Regional Emergency Planning Committee. Town staff also assesses needs for the local shelters and warming stations.	**Police and Fire**	**All**
Mutual Aid	Eastham has mutual aid agreements with neighboring communities to respond to fire and other emergencies requiring emergency response assistance.	**Police and Fire Departments**	**All Hazards**
Emergency Communication	The town owns large variable message boards which displays 3-4 lines of text. They are usually placed on roadways to notify residents of hazards, lane closures and parking instructions.	**Police and Fire**	**All Hazards**
Emergency Planning	Town staff determine supplies, equipment and communications needs and prioritize purchases so that Eastham is prepared for any needed emergency response to any natural hazard event. Town officials attend the regular Barnstable County Regional Emergency Planning Committee meetings.	**Police and Fire**	**All Hazards**
Sheltering Education/ Outreach	The Eastham Police and Fire Departments collaborate with other Departments to send out press releases about the locations of regional shelter and natural hazards	**Police and Fire**	**All Hazards**

Table 5.2 | Existing capabilities assessment (continued)

Existing Capabilities Assessment

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Eversource	In 2012, an Act Relative to Emergency Response of Public Utility Companies was signed into law, requiring a more robust response to emergencies from power companies. Additionally, Eversource has MOUs with private companies to provide accommodations during all but the summer seasons.	**Police and Fire Departments, DPW**	**All Hazards**
STAFFING AND BOARDS			
Public Safety Officials	Eastham Police Chief and the Eastham Fire Chief direct emergency management operations and coordinate with regional emergency response personnel.	**Police and Fire**	**All**
Town Planner	Eastham's Town Planner oversees and coordinates land use planning and zoning administration, including development of hazard mitigation and climate change adaption plans and funding opportunities. The Town Planner also oversees the town's GIS operations.	**Planning**	**All**
Conservation Agent	Eastham's Conservation Agent administers the local and state wetlands regulations and oversees management of the town's conservation land.	**Conservation**	**Flooding, sea level rise, coastal erosion**
Conservation Commission	The Conservation Commission reviews the local regulations and regulates development within and adjacent to wetland resource areas.	**Conservation**	**Flooding, sea level rise, coastal erosion**
Building Commissioner	The Building Commissioner enforces the State Building Code and local zoning regulations.	**Building**	**All**
Council on Aging Director	The COA director runs the Senior Center, which is a resource for Eastham residents and provides educational programs for the community, including hazard planning and emergency preparedness.	**COA**	**All**

Table 5.2 | Existing capabilities assessment (continued)

Existing Capability	Explanation of Capability	Responsible Department	Natural Hazard(s)
Director of Health and Environment	Director of Health and Environment enforces the State and local Health regulations and assists Police, Fire, and DPW Departments with emergency management operations.	**Health and Environment**	**All**
Superintendent	Department of Public Works Superintendent oversees infrastructure planning and maintenance and assists Police, Fire and Health Departments with emergency management operations	**Public Works**	**All**
FINANCIAL			
Capital Improvements Projects funding	Eastham's 5-year Capital Improvement Plan identifies municipal projects for future funding.	**Town Administration. Finance**	**All**
Chapter 90 funds	The state's Chapter 90 program provides funds for road infrastructure projects	**DPW**	**Flooding, sea level rise, coastal erosion,**
State and Federal transportation funds	Federal Highway and MassDOT funds are available for road infrastructure and associated projects.	**DPW**	**Flooding, sea level rise, coastal erosion,**
Grant Funding	Town Departments have proactively applied for grant funding for mitigation projects.	**Town Planner, Assessing Department**	**All Hazards**

Table 5.2 | Existing capabilities assessment (continued)

Plan Evaluation and Maintenance

CHAPTER SIX

Once the 2020 Eastham Hazard Plan Update is adopted by the Board of Selection, the plan enters into a five-year "maintenance" phase. **Chapter 6 describes how the Eastham Hazard Plan will be evaluated, updated and enhanced over the next five years.**

Plan Maintenance

A6d

Who is involved?

Each department identified in the Eastham Hazard Mitigation Plan is responsible for implementing specific mitigation actions as listed in the Mitigation Action section of the plan (Chapter 5). Every proposed action listed in the Mitigation Action section is assigned to a specific "lead" department as a way to assign responsibility and accountability and increase the likelihood of subsequent implementation.

The Eastham Town Administrator will be responsible for ensuring that the plan is monitored, evaluated and updated throughout the next five years.

How will the plan be maintained?

Below is a list of the activities describing how the plan will be maintained and updated over the next five years:

A6a

- Plan Monitoring:
  - Members of the Planning Team will meet annually to discuss the implementation status of each Mitigation Action identified in Chapter 5. During these meetings, the Planning Team will also describe and document any new hazard data that can be incorporated in the Hazard Profile section of the plan; specifically new hazard locations, extent and impacts.
  - After the annual meeting, members of the Planning Team will present to the Board of Selectman on the implementation status of the Mitigation Actions identified in Chapter 5. This presentation will occur once per year and will include an evaluation of the appropriateness of Mitigation Actions. If an amendment, change or update is needed, the Board of Selectman can vote to adopt the change and amend the Eastham Hazard Mitigation Plan Update.
- Plan Evaluation:

A6b

  - A subset of the Planning Team (Police or Fire, DPW, and Town Planner) will meet annually to evaluate the stated purpose and goals of the Eastham Hazard Plan. During this annual meeting, this smaller group will ensure that the plan continues to serve its purpose through the following activities:
    - Review the Mitigation Goals in the 2020 Eastham Hazard Mitigation Plan Update
    - Discuss any recent activities to reduce the loss of life and property in Eastham such as grants received/applied for and any completed Mitigation Actions
    - Distribute an online survey to gauge the public's awareness of the risks posed by natural hazards.

- Discuss ongoing or recent planning efforts that are consistent with the Mitigation Goals and Actions of the Eastham Plan Update.

A6c

- Plan Update:
  - The Eastham Hazard Mitigation Plan Update will be reviewed and updated every five years to ensure that there is no lapse in plan coverage. The Hazard Mitigation Plan update process must begin one to one and half years before the plan is set to expire.

When will the plan be maintained?

A time period was assigned to each Mitigation Action in Chapter 5 to assess whether actions are being implemented in a timely fashion. Also, the Planning Team will also reconvene annually to discuss progress on the Mitigation Actions.

Following a disaster declaration, the Eastham Hazard Plan will be revised as necessary to reflect lessons learned or to address specific issues and circumstances arising from the event. It will be the responsibility of the Planning Team to reconvene and to ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Plan Adoption

CHAPTER SEVEN

Once the draft of the 2020 Eastham Hazard Mitigation Plan Update is reviewed by the Planning Team, stakeholders and the general public, the plan is reviewed by the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA). If approved by MEMA and FEMA, the Eastham Board of Selectmen can officially adopt the plan. If and when the plan is approved, it enters into the five year "maintenance" phase. **Chapter 7 describes the timeline for plan adoption and includes documentation for plan adoption by the Eastham Board of Selectmen.**

Timeline for Plan Adoption

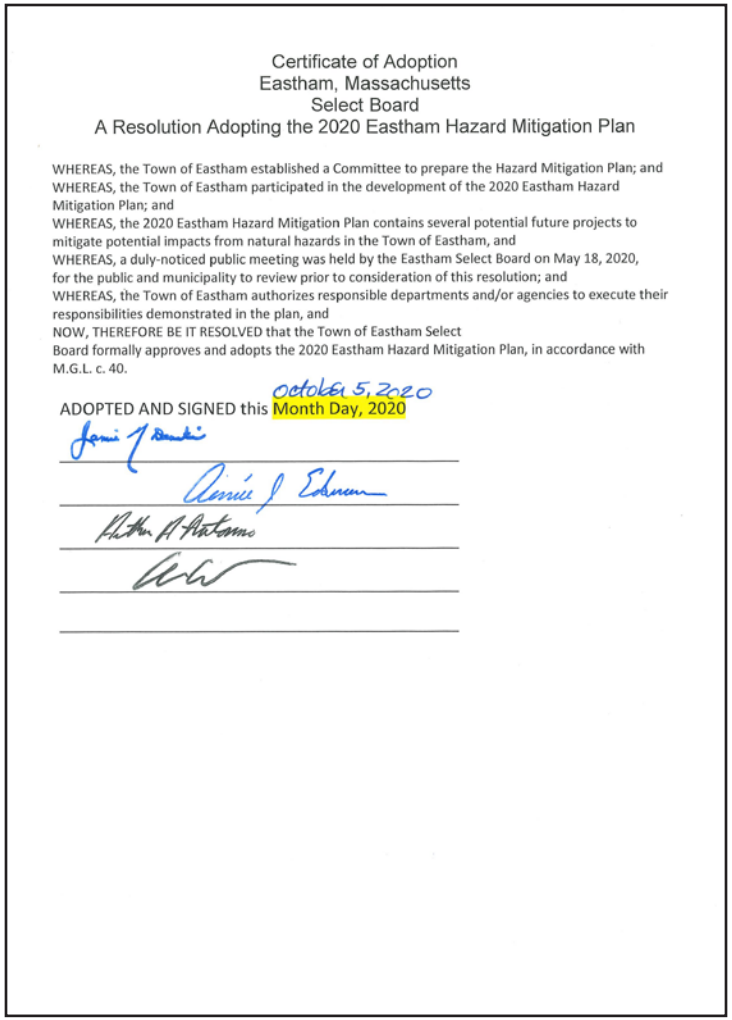
The timeline for Plan Adoption is as follows:

- **May 2020:** After approval by the Board of Selectmen, the Planning Team submitted the Eastham Hazard Mitigation Plan Update to the Massachusetts Emergency Management Agency (MEMA). MEMA reviewed the plan and returned it to the Town of Eastham with required edits. The updated Plan was then submitted to the Federal Emergency Management Agency (FEMA) for final review.
- **August 2020:** FEMA issued an Approved Pending Adoption status and the Eastham Board of Selectmen officially adopted the Eastham Hazard Mitigation Plan during its meeting on October 5, 2020.

E1a

Plan Adoption

The Certificate of Adoption signed by the Eastham Board of Selectmen is shown in ***Figure 7.1***.



Certificate of Adoption
Eastham, Massachusetts
Select Board
A Resolution Adopting the 2020 Eastham Hazard Mitigation Plan

WHEREAS, the Town of Eastham established a Committee to prepare the Hazard Mitigation Plan; and
WHEREAS, the Town of Eastham participated in the development of the 2020 Eastham Hazard Mitigation Plan; and
WHEREAS, the 2020 Eastham Hazard Mitigation Plan contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Eastham, and
WHEREAS, a duly-noticed public meeting was held by the Eastham Select Board on May 18, 2020, for the public and municipality to review prior to consideration of this resolution; and
WHEREAS, the Town of Eastham authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan, and
NOW, THEREFORE BE IT RESOLVED that the Town of Eastham Select Board formally approves and adopts the 2020 Eastham Hazard Mitigation Plan, in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this October 5, 2020

Figure 7.1 | Certificate of Adoption signed by the Eastham Board of Selectmen

Appendix

Introduction: Local Mitigation Plan Review Guide, FEMA

Local Mitigation Plan Review Guide

October 1, 2011

FEMA

4.1 ELEMENT A: PLANNING PROCESS

Requirement §201.6(b)	An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
§201.6(b)(1)	(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
§201.6(b)(2)	(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
§201.6(b)(3)	(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
§201.6(c)(1)	[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.
§201.6(c)(4)(i)	[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.
§201.6(c)(4)(iii)	[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Overall Intent. The planning process is as important as the plan itself. Any successful planning activity, such as developing a comprehensive plan or local land use plan, involves a cross-section of stakeholders and the public to reach consensus on desired outcomes or to resolve a community problem. The result is a common set of community values and widespread support for directing financial, technical, and human resources to an agreed upon course of action, usually identified in a plan. The same is true for mitigation planning. An effective and open planning process helps ensure that citizens understand risks and vulnerability, and they can work with the jurisdiction to support policies, actions, and tools that over the long-term will lead to a reduction in future losses.

Leadership, staffing, and in-house knowledge in local government may fluctuate over time. Therefore, the description of the planning process serves as a permanent record that explains how decisions were reached and who involved. FEMA will accept the planning process as defined by the community, as long as the mitigation plan includes a narrative description of the process used to develop the mitigation plan—a systematic account about how the mitigation plan evolved from the formation of a planning team, to how the public participated, to how each section of the plan was developed, to what plans or studies were incorporated into the plan, to how it will be implemented. Documentation of a current planning process is required for both new and updated plans.

ELEMENT	REQUIREMENTS
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? ***44 CFR 201.6(c)(1)*** ***Intent****: To inform the public and other readers about the overall approach to the plan's development and serve as a permanent record of how decisions were made and who was involved. This record also is useful for the next plan update.*	a. Documentation of how the plan was prepared **must** include the schedule or timeframe and activities that made up the plan's development as well as who was involved. Documentation typically is met with a narrative description, but may also include, for example, other documentation such as copies of meeting minutes, sign-in sheets, or newspaper articles. ***Document*** *means provide the factual evidence for how the jurisdictions developed the plan.* b. The plan **must** list the jurisdiction(s) participating in the plan that seek approval. c. The plan **must** identify who represented each jurisdiction. The Plan **must** provide, at a minimum, the jurisdiction represented and the person's position or title and agency within the jurisdiction. d. For each jurisdiction seeking plan approval, the plan **must** document how they were involved in the planning process. For example, the plan may document meetings attended, data provided, or stakeholder and public involvement activities offered. Jurisdictions that adopt the plan without documenting how they participated in the planning process will not be approved. ***Involved in the process*** *means engaged as participants and given the chance to provide input to affect the plan's content*. This is more than simply being invited (*See* "***opportunity to be involved in the planning process***" in A2 below) or only adopting the plan. e. Plan updates **must** include documentation of the current planning process undertaken to update the plan.
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? ***44 CFR 201.6(b)(2)***	a. The plan **must** identify all stakeholders involved or given an opportunity to be involved in the planning process. At a minimum, stakeholders **must** include: 1) Local and regional agencies involved in hazard mitigation activities; 2) Agencies that have the authority to regulate development; and 3) Neighboring communities. *An* ***opportunity to be involved in the planning process*** *means that the stakeholders are engaged or invited as participants and given the chance to provide input to affect the plan's content.*

Introduction: Local Mitigation Plan Review Guide, FEMA

ELEMENT	REQUIREMENTS
***Intent**: To demonstrate a deliberative planning process that involves stakeholders with the data and expertise needed to develop the plan, with responsibility or authority to implement hazard mitigation activities, and who will be most affected by the plan's outcomes.*	b. The Plan **must** provide the agency or organization represented and the person's position or title within the agency. c. The plan **must** identify how the stakeholders were invited to participate in the process. Examples of stakeholders include, but are not limited to: • Local and regional agencies involved in hazard mitigation include public works, zoning, emergency management, local floodplain administrators, special districts, and GIS departments. • Agencies that have the authority to regulate development include planning and community development departments, building officials, planning commissions, or other elected officials. • Neighboring communities include adjacent counties and municipalities, such as those that are affected by similar hazard events or may be partners in hazard mitigation and response activities. • Other interests may be defined by each jurisdiction and will vary with each one. These include, but are not limited to, business, academia, and other private and non-profit interests depending on the unique characteristics of the community.
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? ***44 CFR 201.6(b)(1) and 201.6(c)(1)*** ***Intent**: To ensure citizens understand what the community is doing on their behalf, and to provide a chance for input on community vulnerabilities and mitigation activities that will inform the plan's content. Public involvement is also an opportunity to educate the public about hazards and risks in the community, types of activities to mitigate those risks, and how these impact them.*	a. The plan **must** document how the public was given the opportunity to be involved in the planning process and how their feedback was incorporated into the plan. Examples include, but are not limited to, sign-in sheets from open meetings, interactive websites with drafts for public review and comment, questionnaires or surveys, or booths at popular community events. b. The opportunity for participation **must** occur during the plan development, which is prior to the comment period on the final plan and prior to the plan approval / adoption.

The Mitigation Planning regulation includes several "optional" requirements for the vulnerability assessment. These are easily recognizable with the use of the term "should" in the requirement (*See* §201.6(c)(2)(ii)(A-C)). Although not required, these are strongly recommended to be included in the plan. However, their absence will not cause FEMA to disapprove the plan. These "optional" requirements were originally intended to meet the overall vulnerability assessment, and this analysis can assist with identifying mitigation actions.

ELEMENT	REQUIREMENTS
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction? ***44 CFR 201.6(c)(2)(i) and 44 CFR 201.6(c)(2)(iii)*** ***Intent**: To understand the potential and chronic hazards affecting the planning area in order to identify which hazard risks are most significant and which jurisdictions or locations are most adversely affected.*	a. The plan **must** include a description of the natural hazards that can affect the jurisdiction(s) in the planning area. *A **natural hazard** is a source of harm or difficulty created by a meteorological, environmental, or geological event*[3]. The plan **must** address natural hazards. Manmade or human-caused hazards may be included in the document, but these are not required and will not be reviewed to meet the requirements for natural hazards. In addition, FEMA will not require the removal of this extra information prior to plan approval. b. The plan **must** provide the rationale for the omission of any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area. c. The description, or profile, **must** include information on location, extent, previous occurrences, and future probability for each hazard. Previous occurrences and future probability are addressed in sub-element B2. The information does not necessarily need to be described or presented separately for location, extent, previous occurrences, and future probability. For example, for some hazards, one map with explanatory text could provide information on location, extent, and future probability. ***Location** means the geographic areas in the planning area that are affected by the hazard.* For many hazards, maps are the best way to illustrate location. However, location may be described in other formats. For example, if a geographically-specific location cannot be identified for a hazard, such as tornados, the plan may state that the entire planning area is equally at risk to that hazard. ***Extent** means the strength or magnitude of the hazard*. For example, extent could be described in terms of the specific measurement of an occurrence on a scientific scale (*for example*, Enhanced Fujita Scale, Saffir-Simpson Hurricane Scale, Richter Scale, flood depth grids) and/or other hazard factors, such as duration and speed of onset. Extent is not the same as impacts, which are described in sub-element B3.

[3] DHS Risk Lexicon, 2010 Edition. http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

ELEMENT	REQUIREMENTS
	d. For participating jurisdictions in a multi-jurisdictional plan, the plan **must** describe any hazards that are unique and/or varied from those affecting the overall planning area.
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? ***44 CFR 201.6(c)(2)(i)*** ***Intent****: To understand potential impacts to the community based on information on the hazard events that have occurred in the past and the likelihood they will occur in the future.*	a. The plan **must** include the history of previous hazard events for each of the identified hazards. b. The plan **must** include the probability of future events for each identified hazard. ***Probability*** *means the likelihood of the hazard occurring and may be defined in terms of general descriptors (for example, unlikely, likely, highly likely), historical frequencies, statistical probabilities (for example: 1% chance of occurrence in any given year), and/or hazard probability maps.* If general descriptors are used, then they **must** be defined in the plan. For example, "highly likely" could be defined as equals near 100% chance of occurrence next year or happens every year. c. Plan updates **must** include hazard events that have occurred since the last plan was developed.
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? ***44 CFR 201.6(c)(2)(ii)*** ***Intent****: For each jurisdiction to consider their community as a whole and analyze the potential impacts of future hazard events and the vulnerabilities that could be reduced through hazard mitigation actions.*	a. For each participating jurisdiction, the plan **must** describe the potential impacts of each of the identified hazards on the community. ***Impact*** *means the consequence or effect of the hazard on the community and its assets. Assets are determined by the community and include, for example, people, structures, facilities, systems, capabilities, and/or activities that have value to the community.* For example, impacts could be described by referencing historical disaster impacts and/or an estimate of potential future losses (such as percent damage of total exposure). b. The plan **must** provide an overall summary of each jurisdiction's vulnerability to the identified hazards. The overall summary of vulnerability identifies structures, systems, populations or other community assets as defined by the community that are susceptible to damage and loss from hazard events. A plan will meet this sub-element by addressing the requirements described in §201.6(c)(2)(ii)(A-C). Vulnerable assets and potential losses is more than a list of the total exposure of population, structures, and critical facilities in the planning area. An example of an overall summary is a list of key issues or problem statements that clearly describes the community's greatest vulnerabilities and that will be addressed in the mitigation strategy.

ELEMENT	REQUIREMENTS
B4. Does the Plan address NFIP insured structures within each jurisdiction that have been repetitively damaged by floods? ***44 CFR 201.6(c)(2)(ii)*** ***Intent****: To inform hazard mitigation actions for properties that have suffered repetitive damage due to flooding, particularly problem areas that may not be apparent on floodplain maps. Information on repetitive loss properties helps inform FEMA hazard mitigation assistance programs under the National Flood Insurance Act.*	a. The plan **must** describe the types (residential, commercial, institutional, etc.) and estimate the numbers of repetitive loss properties located in identified flood hazard areas. ***Repetitive loss properties*** *are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978.* ***Severe repetitive loss properties*** *are residential properties that have at least four NFIP payments over $5,000 each and the cumulative amount of such claims exceeds $20,000, or at least two separate claims payments with the cumulative amount exceeding the market value of the building.* Use of flood insurance claim and disaster assistance information is subject to The Privacy Act of 1974, as amended, which prohibits public release of the names of policy holders or recipients of financial assistance and the amount of the claim payment or assistance. However, maps showing general areas where claims have been paid can be made public. If a plan includes the names of policy holders or recipients of financial assistance and the amount of the claim payment or assistance, the plan cannot be approved until this Privacy Act covered information is removed from the plan.

Introduction: Local Mitigation Plan Review Guide, FEMA

4.3 ELEMENT C. MITIGATION STRATEGY

Requirement §201.6(c)(3)	[The plan shall include the following:] A *mitigation strategy* that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.
§201.6(c)(3)(i)	[The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
§201.6(c)(3)(ii)	[The hazard mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.
§201.6(c)(3)(iii)	[The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
§201.6(c)(3)(iv)	For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.
§201.6(c)(4)(ii)	[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements, when appropriate.

Overall Intent. The mitigation strategy serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The Stafford Act directs Local Mitigation Plans to describe hazard mitigation actions and establish a strategy to implement those actions.[4] Therefore, all other requirements for a Local Mitigation Plan lead to and support the mitigation strategy.

[4] Section 322(b), Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, 42 U.S.C. 5165.

The mitigation strategy includes the development of goals and prioritized hazard mitigation actions. Goals are long-term policy statements and global visions that support the mitigation strategy. A critical step in the development of specific hazard mitigation actions and projects is assessing the community's existing authorities, policies, programs, and resources and its capability to use or modify local tools to reduce losses and vulnerability from profiled hazards.

In the plan update, goals and actions are either reaffirmed or updated based on current conditions, including the completion of hazard mitigation initiatives, an updated or new risk assessment, or changes in State or local priorities.

ELEMENT	REQUIREMENTS
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources, and its ability to expand on and improve these existing policies and programs? *44 CFR 201.6(c)(3)* ***Intent**: To ensure that each jurisdiction evaluates its capabilities to accomplish hazard mitigation actions, through existing mechanisms. This is especially useful for multi-jurisdictional plans where local capability varies widely.*	a. The plan **must** describe each jurisdiction's existing authorities, policies, programs and resources available to accomplish hazard mitigation. Examples include, but are not limited to: staff involved in local planning activities, public works, and emergency management; funding through taxing authority, and annual budgets; or regulatory authorities for comprehensive planning, building codes, and ordinances.
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? *44 CFR 201.6(c)(3)(ii)* ***Intent:** To demonstrate flood hazard mitigation efforts by the community through NFIP activities. Where FEMA is the official administering Federal agency of the NFIP, participation in the program is a basic community capability and resource for flood hazard mitigation activities.*	a. The plan **must** describe each jurisdiction's participation in the NFIP and describe their floodplain management program for continued compliance. Simply stating "The community will continue to comply with NFIP," will not meet this requirement. The description could include, but is not limited to: • Adoption and enforcement of floodplain management requirements, including regulating new construction in Special Flood Hazard Areas (SFHAs); • Floodplain identification and mapping, including any local requests for map updates; or • Description of community assistance and monitoring activities. Jurisdictions that are currently not participating in the NFIP and where an FHBM or FIRM has been issued may meet this requirement by describing the reasons why the community does not participate.

ELEMENT	REQUIREMENTS
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? *44 CFR 201.6(c)(3)(i)* ***Intent**: To guide the development and implementation of hazard mitigation actions for the community(ies). Goals are statements of the community's visions for the future.*	a. The plan **must** include general hazard mitigation goals that represent what the jurisdiction(s) seeks to accomplish through mitigation plan implementation. ***Goals** are broad policy statements that explain what is to be achieved.* b. The goals **must** be consistent with the hazards identified in the plan.
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? *44 CFR 201.6(c)(3)(ii) and 44 CFR 201.6(c)(3)(iv)* ***Intent**: To ensure the hazard mitigation actions are based on the identified hazard vulnerabilities, are within the capability of each jurisdiction, and reduce or avoid future losses. This is the heart of the mitigation plan, and is essential to leading communities to reduce their risk. Communities, not FEMA, "own" the hazard mitigation actions in the strategy.*	a. The plan **must** include a mitigation strategy that 1) analyzes actions and/or projects that the jurisdiction considered to reduce the impacts of hazards identified in the risk assessment, and 2) identifies the actions and/or projects that the jurisdiction intends to implement. ***Mitigation actions and projects** means a hazard mitigation action, activity or process (for example, adopting a building code) or it can be a physical project (for example, elevating structures or retrofitting critical infrastructure) designed to reduce or eliminate the long term risks from hazards.* This sub-element can be met with either actions or projects, or a combination of actions and projects. The mitigation plan may include non-mitigation actions, such as actions that are emergency response or operational preparedness in nature. These will not be accepted as hazard mitigation actions, but neither will FEMA require these to be removed from the plan prior to approval. *A **comprehensive range** consists of different hazard mitigation alternatives that address the vulnerabilities to the hazards that the jurisdiction(s) determine are most important.* b. Each jurisdiction participating in the plan **must** have mitigation actions specific to that jurisdiction that are based on the community's risk and vulnerabilities, as well as community priorities. c. The action plan **must** reduce risk to existing buildings and infrastructure as well as limit any risk to new development and redevelopment. ***With emphasis on new and existing building and infrastructure** means that the action plan includes a consideration of actions that address the built environment.*

ELEMENT	REQUIREMENTS
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? *44 CFR 201.6(c)(3)(iii) and 44 CFR (c)(3)(iv)* ***Intent**: To identify how the plan will directly lead to implementation of the hazard mitigation actions. As opportunities arise for actions or projects to be implemented, the responsible entity will be able to take action towards completion of the activities.*	a. The plan **must** describe the criteria used for prioritizing implementation of the actions. b. The plan **must** demonstrate when prioritizing hazard mitigation actions that the local jurisdictions considered the benefits that would result from the hazard mitigation actions versus the cost of those actions. The requirement is met as long as the economic considerations are summarized in the plan as part of the community's analysis. A complete benefic-cost analysis is not required. Qualitative benefits (*for example*, quality of life, natural and beneficial values, or other "benefits") can also be included in how actions will be prioritized. c. The plan **must** identify the position, office, department, or agency responsible for implementing and administering the action (for each jurisdiction), and identify potential funding sources and expected timeframes for completion.
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? *44 CFR 201.6(c)(4)(ii)* ***Intent**: To assist communities in capitalizing on all available mechanisms that they have at their disposal to accomplish hazard mitigation and reduce risk.*	a. The plan **must** describe the community's process to integrate the data, information, and hazard mitigation goals and actions into other planning mechanisms. b. The plan **must** identify the local planning mechanisms where hazard mitigation information and/or actions may be incorporated. ***Planning mechanisms** means governance structures that are used to manage local land use development and community decision-making, such as comprehensive plans, capital improvement plans, or other long-range plans.* c. A multi-jurisdictional plan **must** describe each participating jurisdiction's individual process for integrating hazard mitigation actions applicable to their community into other planning mechanisms. d. The updated plan **must** explain how the jurisdiction(s) incorporated the mitigation plan, when appropriate, into other planning mechanisms as a demonstration of progress in local hazard mitigation efforts. e. The updated plan **must** continue to describe how the mitigation strategy, including the goals and hazard mitigation actions will be incorporated into other planning mechanisms.

Introduction: Local Mitigation Plan Review Guide, FEMA

Requirement §201.6(d)(3)	A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit if for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

Overall Intent. In order to continue to be an effective representation of the jurisdiction's overall strategy for reducing its risks from natural hazards, the mitigation plan must reflect current conditions. This will require an assessment of the current development patterns and development pressures as well as an evaluation of any new hazard or risk information. The plan update is an opportunity for the jurisdiction to assess its previous goals and action plan, evaluate progress in implementing hazard mitigation actions, and adjust its actions to address the current realities.

Where conditions of growth and revisions in priorities may have changed very little in a community, much of the text in the updated plan may be unchanged. This is acceptable as long as it still fits the priorities of their community, and it reflects current conditions. The key for plan readers to recognize a good plan update is documentation of the community's progress or changes in their hazard mitigation program, along with the community's continued engagement in the mitigation planning process.

ELEMENT	REQUIREMENTS
D1. Was the plan revised to reflect changes in development? *44 CFR 201.6(d)(3)* ***Intent**: To ensure that the mitigation strategy continues to address the risk and vulnerabilities to existing and potential development, and takes into consideration possible future conditions that can impact the vulnerability of the community.*	a. The plan **must** describe changes in development that have occurred in hazard prone areas and increased or decreased the vulnerability of each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. ***Changes in development*** means recent development (*for example*, construction completed since the last plan was approved), potential development (*for example*, development planned or under consideration by the jurisdiction), or conditions that may affect the risks and vulnerabilities of the jurisdictions (*for example*, climate variability, declining populations or projected increases in population, or foreclosures). Not all development will affect a jurisdiction's vulnerability.

ELEMENT	REQUIREMENTS
D2. Was the plan revised to reflect progress in local mitigation efforts? *44 CFR 201.6(d)(3)* ***Intent**: To evaluate and demonstrate progress made in the past five years in achieving goals and implementing actions outlined in their mitigation strategy.*	a. The plan **must** describe the status of hazard mitigation actions in the previous plan by identifying those that have been completed or not completed. For actions that have not been completed, the plan **must** either describe whether the action is no longer relevant or be included as part of the updated action plan.
D3. Was the plan revised to reflect changes in priorities? *44 CFR 201.6(d)(3)* ***Intent**: To ensure the plan reflects current conditions, including financial, legal, and political realities as well as post-disaster conditions.*	a. The plan **must** describe if and how any priorities changed since the plan was previously approved. If no changes in priorities are necessary, plan updates may validate the information in the previously approved plan.

4.5 ELEMENT E. PLAN ADOPTION

Requirement §201.6(c)(5)	[The plan shall include…] Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

Overall Intent. Adoption by the local governing body demonstrates the jurisdiction's commitment to fulfilling the hazard mitigation goals and actions outlined in the plan. Adoption legitimizes the plan and authorizes responsible agencies to execute their responsibilities. Updated plans also are adopted anew to demonstrate community recognition of the current planning process, changes that have occurred within the previous five years, and validate community priorities for hazard mitigation actions.

ELEMENT	REQUIREMENTS
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? ***44 CFR 201.6(c)(5)*** ***Intent****: To demonstrate the jurisdiction's commitment to fulfilling the hazard mitigation goals outlined in the plan, and to authorize responsible agencies to execute their responsibilities.*	a. The plan **must** include documentation of plan adoption, usually a resolution by the governing body or other authority. If the local jurisdiction has not passed a formal resolution, or used some other documentation of adoption, the clerk or city attorney **must** provide written confirmation that the action meets their community's legal requirements for official adoption and/or the highest elected official or their designee **must** submit written proof of the adoption. The signature of one of these officials is required with the explanation or other proof of adoption. Minutes of a council or other meeting during which the plan is adopted will be sufficient if local law allows meeting records to be submitted as documentation of adoption. The clerk of the governing body, or city attorney, **must** provide a copy of the law and a brief, written explanation such as, "in accordance with section ___ of the city code/ordinance, this constitutes formal adoption of the measure," with an official signature. If adopted after FEMA review, adoption **must** take place within one calendar year of receipt of FEMA's "Approval Pending Adoption." See Section 5, *Plan Review Procedure* for more information on "Approvable Pending Adoption."

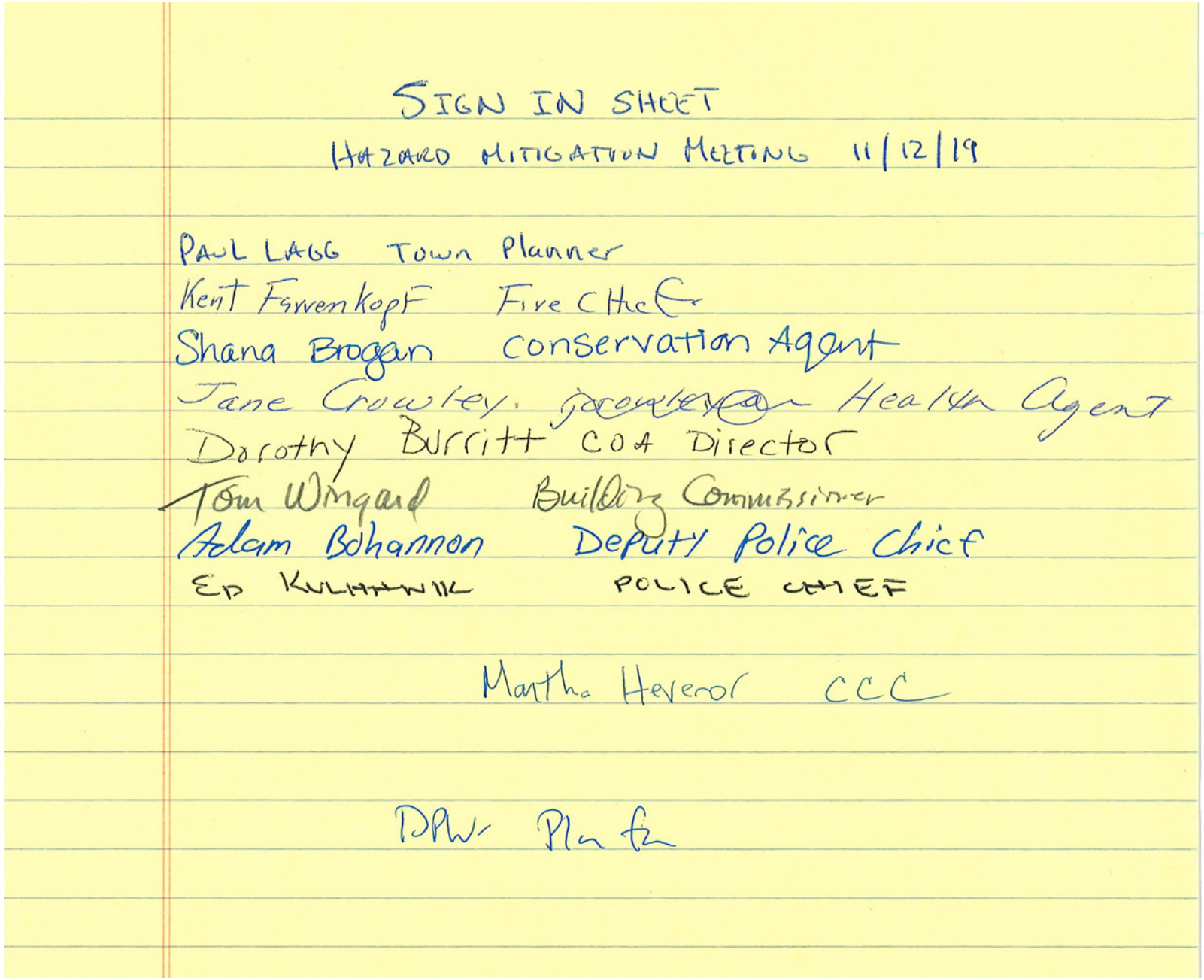
ELEMENT	REQUIREMENTS
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? ***44 CFR 201.6(c)(5)*** ***Intent****: To demonstrate the jurisdiction's commitment to fulfilling the hazard mitigation goals outlined in the plan, and to authorize responsible agencies to execute their responsibilities.*	a. Each jurisdiction that is included in the plan **must** have its governing body adopt the plan prior to FEMA approval, even when a regional agency has the authority to prepare such plans. As with single jurisdictional plans, in order for FEMA to give approval to a multi-jurisdictional plan, at least one participating jurisdiction **must** formally adopt the plan within one calendar year of FEMA's designation of the plan as "Approvable Pending Adoption." See Section 5, *Plan Review Procedure* for more information on "Approvable Pending Adoption."

Chapter 1: Planning Team Meeting Attendance

Eastham Multi-Hazard Mitigation Plan
Planning Team Kick-off Meeting
Eastham Town Hall
October 22, 2019

Sign-In Sheet

Name	Title	Email
Dorothy Burritt	Director	coadirector@eastham-ma.g
Kent Farrenkopf	Fire Chief	KFarrenkopF@Eastham-MA.G
Shana Brogan	Conservation Agent	Conservation@eastham-ma.gov
Silvio Genao	DPW Superintendent	DPWDir@EASTHAM-MA.GOV
Ed Kulhawik	POLICE CHIEF	EKULHAWIK@EASTHAM-MA.GOV
Paul Lagg	TOWN PLANNER	plagg@eastham-ma.gov



SIGN IN SHEET

HAZARD MITIGATION MEETING 11/12/19

PAUL LAGG Town Planner
Kent Farwenkopf Fire Chief
Shana Brogan conservation Agent
Jane Crowley. Health Agent
Dorothy Burritt COA Director
Tom Wingard Building Commissioner
Adam Bohannon Deputy Police Chief
Ed Kulhawik POLICE CHIEF

Martha Hevenor CCC

DPW Plan fr

Chapter 1: Planning Team Meeting Attendance

Eastham Multi-Hazard Mitigation Plan

Meeting #3

Eastham Library

December 3, 2019

Planning Team Attendance Sheet

Name	Title	Affiliation
Silvio Genao	Superintendent	Department of Public Works
Tom Wingard	Building Commissioner	Building Department
Jane Crowley	Director of Health & Environment	Health Department
Shana Brogan	Natural Resource Manager/Conservation Agent	Conservation Department
Ed Kulhawik	Chief	Police Department
Kent Farrenkopf	Chief	Fire Department
Dorothy Burritt	Director	Council on Aging
~~Dan Keane~~	~~Assistant Chief~~	~~Fire Department~~
Paul Lagg	Town Planner	Planning Department
Adam Bohannon	Deputy Chief	Police Department

+ Martha Hevenor, Cape Cod Commission

Eastham Multi-Hazard Mitigation Plan

Meeting #4

Eastham Town Hall

January 7, 2020

Planning Team Attendance Sheet

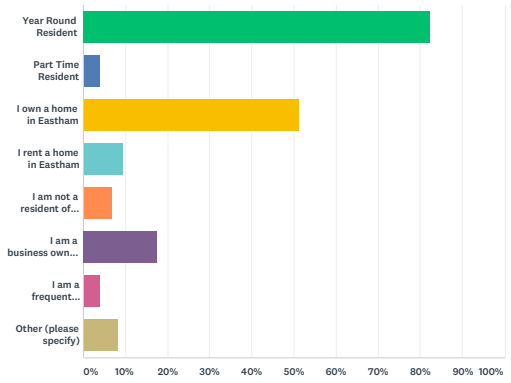
Name	Title	Affiliation
Silvio Genao	**Superintendent**	**Department of Public Works**
Tom Wingard	**Building Commissioner**	**Building Department**
Jane Crowley	**Director of Health & Environment**	**Health Department**
Shana Brogan	**Natural Resource Manager/Conservation Agent**	**Conservation Department**
Ed Kulhawik	**Chief**	**Police Department**
Kent Farrenkopf	**Chief**	**Fire Department**
Dorothy Burritt	**Director**	**Council on Aging**
Dan Keane	**Assistant Chief**	**Fire Department**
Paul Lagg	**Town Planner**	**Planning Department**
Adam Bohannon	**Deputy Chief**	**Police Department**
Martha Hevenor	**Planner**	**Cape Cod Commission**

Chapter 1: Public Survey

Eastham Natural Hazard Mitigation Public Survey

Q1 Please tell us about yourself (check all that apply)

Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Year Round Resident	82.43%	61
Part Time Resident	4.05%	3
I own a home in Eastham	51.35%	38
I rent a home in Eastham	9.46%	7
I am not a resident of Eastham, but I am employed in Eastham	6.76%	5
I am a business owner in Eastham	17.57%	13
I am a frequent visitor to Eastham	4.05%	3
Other (please specify)	8.11%	6
Total Respondents: 74		

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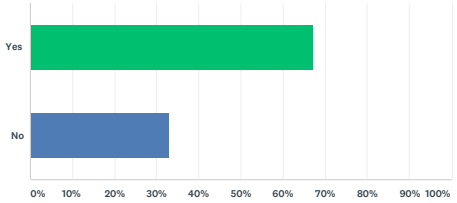
Eastham Natural Hazard Mitigation Public Survey

Q2 Have you experienced a weather related disaster while living, working or visiting Eastham?

Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	67.12%	49
No	32.88%	24
TOTAL		73

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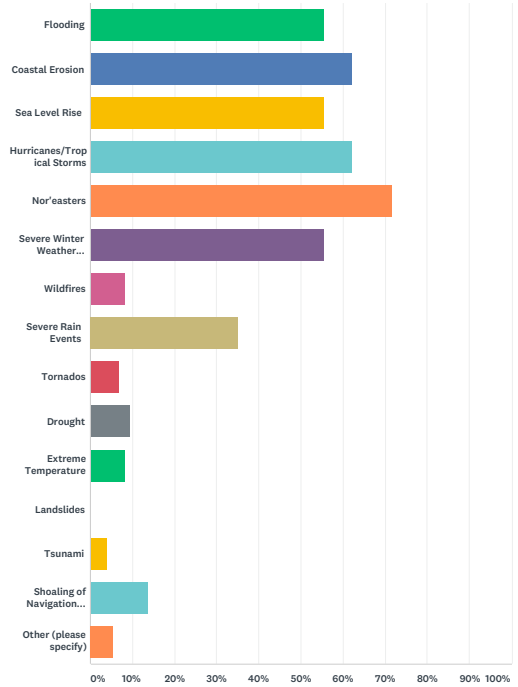
Eastham Natural Hazard Mitigation Public Survey

Q3 Which of the following natural hazards most concern you?

Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Flooding	55.41%	41
Coastal Erosion	62.16%	46
Sea Level Rise	55.41%	41

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Eastham Natural Hazard Mitigation Public Survey

Hurricanes/Tropical Storms	62.16%	46
Nor'easters	71.62%	53
Severe Winter Weather (Snow/Ice)	55.41%	41
Wildfires	8.11%	6
Severe Rain Events	35.14%	26
Tornados	6.76%	5
Drought	9.46%	7
Extreme Temperature	8.11%	6
Landslides	0.00%	0
Tsunami	4.05%	3
Shoaling of Navigation Channels	13.51%	10
Other (please specify)	5.41%	4
Total Respondents: 74		

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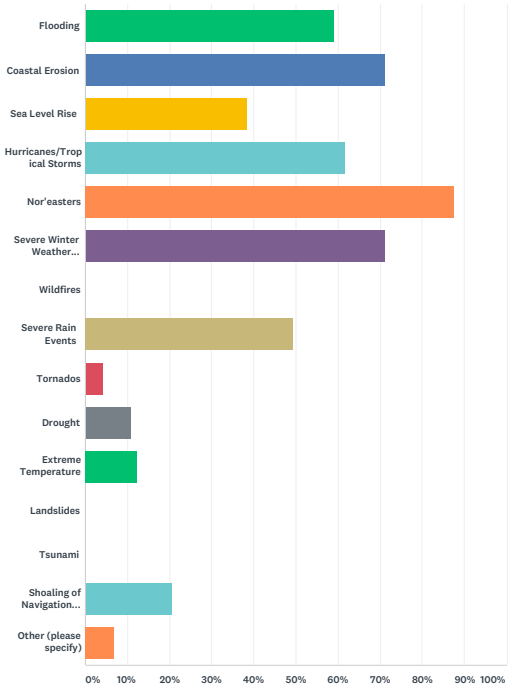
Chapter 1: Public Survey

Eastham Natural Hazard Mitigation Public Survey

Q4 Which of the following natural hazards have you experienced while in Eastham?

Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Flooding	58.90%	43
Coastal Erosion	71.23%	52

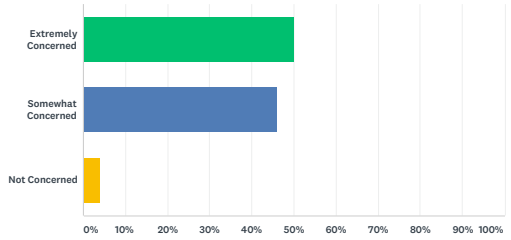
Eastham Natural Hazard Mitigation Public Survey

Sea Level Rise	38.36%	28
Hurricanes/Tropical Storms	61.64%	45
Nor'easters	87.67%	64
Severe Winter Weather (Snow/Ice)	71.23%	52
Wildfires	0.00%	0
Severe Rain Events	49.32%	36
Tornados	4.11%	3
Drought	10.96%	8
Extreme Temperature	12.33%	9
Landslides	0.00%	0
Tsunami	0.00%	0
Shoaling of Navigation Channels	20.55%	15
Other (please specify)	6.85%	5
Total Respondents: 73		

Eastham Natural Hazard Mitigation Public Survey

Q5 How concerned are you about the possibility of natural hazards impacting Eastham?

Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Extremely Concerned	50.00%	37
Somewhat Concerned	45.95%	34
Not Concerned	4.05%	3
TOTAL		74

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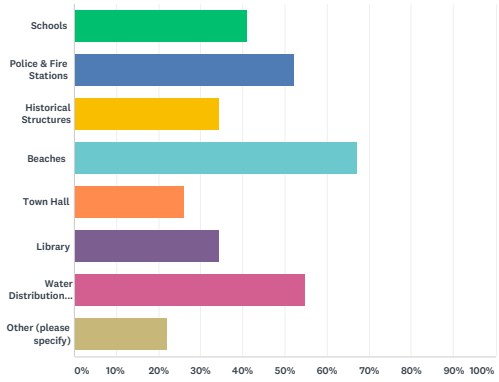
Eastham Natural Hazard Mitigation Public Survey

Q6 What specific public assets are you most concerned with protecting from the effects of natural hazards and climate change?

Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Schools	41.10%	30
Police & Fire Stations	52.05%	38
Historical Structures	34.25%	25
Beaches	67.12%	49
Town Hall	26.03%	19
Library	34.25%	25
Water Distribution System	54.79%	40
Other (please specify)	21.92%	16
Total Respondents: 73		

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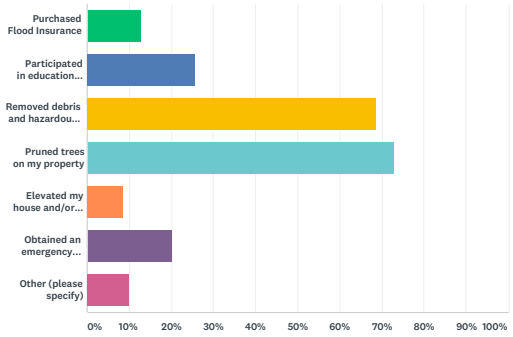
Chapter 1: Public Survey

Eastham Natural Hazard Mitigation Public Survey

Q7 Which of the following actions have you taken to protect you and/or your property from natural hazards?

Answered: 70 Skipped: 4



ANSWER CHOICES	RESPONSES	
Purchased Flood Insurance	12.86%	9
Participated in educational activities/training on emergency preparedness	25.71%	18
Removed debris and hazardous materials from my property	68.57%	48
Pruned trees on my property	72.86%	51
Elevated my house and/or mechanical equipment above the base flood elevation	8.57%	6
Obtained an emergency response kit	20.00%	14
Other (please specify)	10.00%	7
Total Respondents: 70		

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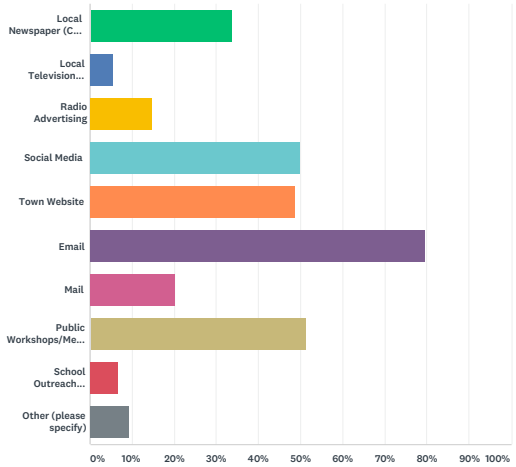
Eastham Natural Hazard Mitigation Public Survey

Q8 What is the most effective way to engage you in hazard planning and emergency preparedness activities?

Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Local Newspaper (Cape Codder)	33.78%	25
Local Television (Channel 18/Lower Cape TV)	5.41%	4
Radio Advertising	14.86%	11
Social Media	50.00%	37
Town Website	48.65%	36
Email	79.73%	59
Mail	20.27%	15
Public Workshops/Meetings	51.35%	38
School Outreach (meetings/flyers etc.)	6.76%	5
Other (please specify)	9.46%	7

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Eastham Natural Hazard Mitigation Public Survey

Total Respondents: 74

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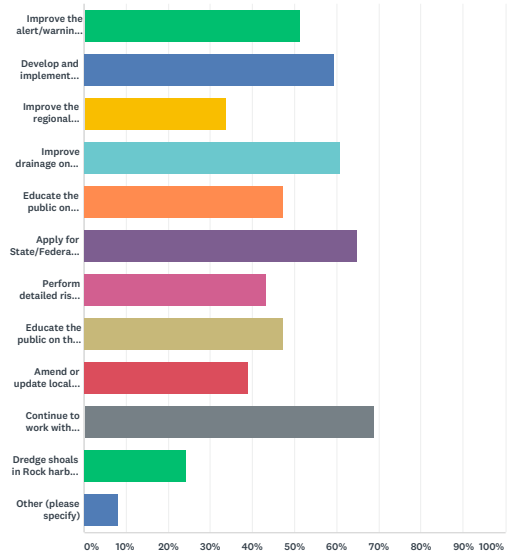
Eastham Natural Hazard Mitigation Public Survey

Q9 What steps can your local government take to reduce its risk from natural hazards and better protect the people of Eastham?

Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Improve the alert/warning/notification systems	51.35%	38
Develop and implement climate change adaption plans	59.46%	44
Improve the regional emergency shelter (Nauset High School)	33.78%	25
Improve drainage on area roads	60.81%	45
Educate the public on evacuation methods/procedures	47.30%	35
Apply for State/Federal funding to reduce Eastham's risk to natural hazards	64.86%	48
Perform detailed risk assessments	43.24%	32

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Chapter 1: Public Survey Notice: Eastham Town Website

Eastham Natural Hazard Mitigation Public Survey

Educate the public on the science of natural hazards, climate chnage and emergency preparedness	47.30%	35
Amend or update local regulations as they relate to flooding	39.19%	29
Continue to work with regional partners to prepare for and recover from natural hazard events	68.92%	51
Dredge shoals in Rock harbor and Town Cove to reduce the risk of boating hazards	24.32%	18
Other (please specify)	8.11%	6
Total Respondents: 74		

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Eastham Natural Hazard Mitigation Public Survey

Q10 If you would like to become involved in the hazard planning process, please provide your name, email and phone number below.

Answered: 20 Skipped: 54

ANSWER CHOICES	RESPONSES	
Name	100.00%	20
Email	95.00%	19
Phone Number	75.00%	15

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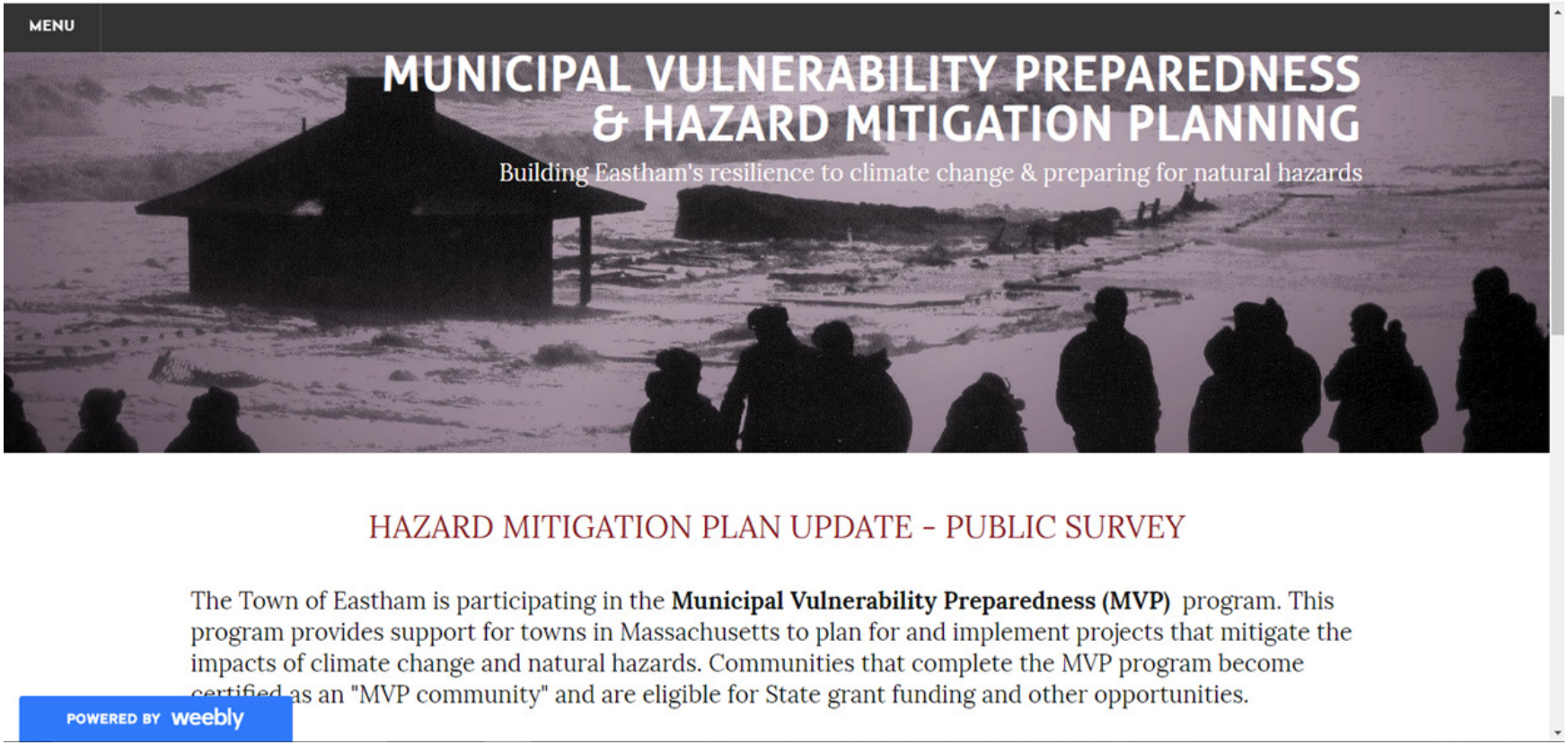
Chapter 1: Public Survey Notice: Eastham Town Website



The Town of Eastham website for the MVP and Hazard Mitigation Plan included a link to the public survey opportunity.

Chapter 1: Articles on MVP Process

WICKED LOCAL® EASTHAM

Town works to overcome vulnerabilities

Ryan Fitzgerald

Wednesday

Jun 12, 2019 at 3:37 PM

EASTHAM – Like other towns across the Cape, Eastham is planning ahead for worst-case scenarios by participating in the state's Municipal Vulnerability Preparedness (MVP) program, which provides support for communities to mitigate the impacts of climate change and natural hazards.

The town received a $30,000 grant from the state for a community resiliency planning process and has partnered with the Cape Cod Commission, Cape Cod Cooperative Extension and Woods Hole Sea Grant to work on planning, town planner Paul Lagg explained at a information session for residents May 29.

In conjunction with the MVP initiative, the town is also updating its Hazard Mitigation Plan. Its goal is to safeguard the community from the impacts of storm events and natural hazards by increasing economic, social and environmental resiliency, according to information provided by the town.

The MVP program tries to focus on climate resiliency and is tied to state grants while the hazard mitigation plan takes a broader look at all natural hazard possibilities and is tied to Federal Emergency Management Agency (FEMA) grants, according to Lagg.

He said the town is trying to prepare for any possible storm situation. For instance, Eastham lacks a major supermarket and has limited evacuation routes. Residents would be hard pressed if flooding were to cut off access to Orleans.

"We're trying to get awareness out there and get different stakeholders to offer different perspectives," he said.

Lagg said that the hazard mitigation plan will try to hone in on what exactly the town needs in specific areas to safeguard the community.

Two workshops were held in January, when members of town staff, committee and board members and the public identified potential hazards and discussed how the town could best improve its safety measures through the two plans.

Flooding, erosion, high winds, hurricanes and sea level rise are the most immediate hazards Eastham currently faces. Residents at the workshops said they were most concerned with low-lying infrastructure for transportation, such as the rotary or Bridge Road. These areas flooded during storms in the winter of 2018-19. A flash flood last August caused the road to be shut down for some time.

Lagg said town officials plan to work on local bylaws and regulations so that redevelopment or new development of properties account for sea level rise and other environmental factors.

Other concerns included the limited evacuation routes, narrow roads or difficult access points, lack of a major supermarket, and distance from Cape Cod Hospital, especially for seniors or other at-risk populations.

The fire department obtained a high water rescue vehicle last year that can travel in heavily flooded areas in emergency situations.

Eastham has a new water system but does not have a dedicated water department; Whitewater Inc., based in Sandwich, manages the system. If anything were to happen to the water system and running water was affected, the town must rely on the contractor to come to town and assist.

Workshop attendees did note some strengths the town has, such as the availability of Nauset Regional High School as a shelter, the library as a warming station and a Code RED system in full effect. These were utilized during some major storms last year.

Communities that complete the MVP program become certified as an MVP community and are eligible for state grant funding and other opportunities.

Lagg said he expects to go to the board of selectmen soon with a final plan in place before sending it to the state for certification.

For more information, visit easthammvp.weebly.com.

[FROM THE PROVINCETOWN INDEPENDENT NOVEMBER 29, 2019]
CLIMATE CRISIS MANAGEMENT

Hazard Mitigation Is Focus for Eastham Planners

Survey seeks input on increasing resiliency against natural disasters

By Ryan Fitzgerald Nov 21, 2019


Bridge Road in Eastham is a flood risk during major storms. (Photo Ryan Fitzgerald)

EASTHAM — If a severe storm or flood hit the Outer Cape forcing residents to evacuate, it would cause a major traffic backup.

Route 6 is the main evacuation route to Orleans and beyond. But what if the Orleans Rotary were under water?

Drivers could try the back roads through Eastham, but that would require travelling down Bridge Road, which is often the first road in town to flood when a storm hits. If the rotary is impassable, chances are Bridge Road will be, too.

At forums over the past year, Eastham residents have expressed concerns about infrastructure at low elevation, the lack of a major supermarket on the Outer Cape except for Provincetown, and the distance to Cape Cod Hospital.

Chapter 1: Articles on MVP Process

Eastham is updating its local hazard mitigation plan and looking to publish a final draft in 2020. Provincetown published its hazard mitigation plan in 2016, while Truro and Wellfleet published plans in 2017.


A downed tree from a storm in early spring 2018 at Fort Hill. (Photo Ryan Fitzgerald)

The purpose of the plan is to safeguard the community from the effects of storms and natural hazards by increasing its economic, social, and environmental resiliency, according to the town website.

Eastham residents can complete an online survey to let planners know which issues they think should take priority during hazard mitigation planning. The survey will be available through December and can be found at eastham-ma.gov/home/news/hazard-mitigation-plan-update-public-survey.

A public hearing on the draft plan is scheduled for January 2020. After that hearing the select board must endorse the plan and submit it to the Mass. Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for approval. If all goes according to plan, the town will adopt the plan in March 2020.

Like other towns across the Cape, Eastham is a part of the state's Municipal Vulnerability Preparedness (MVP) program, which provides support for communities to mitigate the effects of climate change and natural hazards. The town received a $30,000 grant from the state for a community resiliency planning process and has partnered with the Cape Cod Commission, Cape Cod Cooperative Extension, and Woods Hole Sea Grant to work on planning, according to the town website.

The town's MVP plan was approved by the state and published in June, and Eastham has been designated as an MVP Community, meaning it is eligible for more state funding.

Chapter 1: Articles on MVP Process

The process of developing comprehensive plans will educate local residents about the dangers posed by natural hazards and encourage citizens to develop a strategy to reduce or eliminate potential risks, allowing the community to recover quickly after storms, according to Town Planner Paul Lagg.

The MVP program focuses more on climate resiliency and is tied to state grants, while the hazard mitigation plan takes a broader look at all the possible natural hazards and is tied to federal grants, according to Lagg.

“We’re trying to get awareness out there and get different stakeholders to offer different perspectives,” he said.

Separately, Outer Cape towns are also working in collaboration on an Outer Cape Regional Shoreline Management Project.

Flooding, erosion, high winds, hurricanes, and sea level rise are the most immediate hazards Eastham now faces. Residents at workshops over the last year said they were most concerned with low-lying infrastructure for transportation, such as the rotary and Bridge Road. These areas saw increased flooding during storms in the winter of 2018-19, and a flash flood in August 2018 caused Bridge Road to be shut down for a few days.

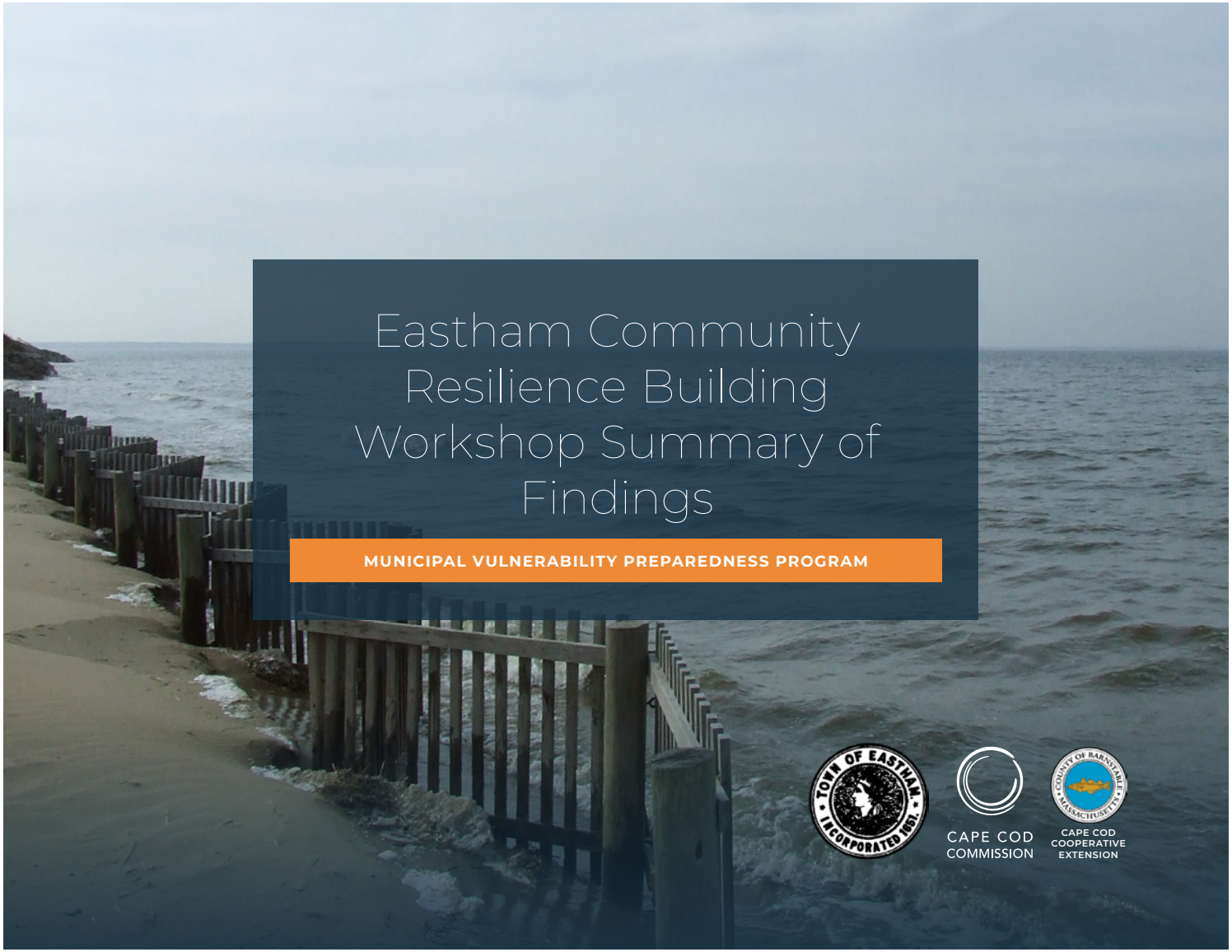
Lagg said town officials plan to work on local bylaws and regulations so that redevelopment or new development of properties take account of sea level rise and other environmental factors.

The median age of Eastham residents is now 65 years. The town has numerous narrow private roads, creating risky conditions for accessibility and mobility.

The town does use Nauset Regional High School as a shelter and the library as a warming station. A Code RED system provides emergency notifications for residents who are signed up, and the fire department has a high-water vehicle that can access flooded areas and narrow roads to help residents get out of their homes in emergencies.

For more information, visit easthammvp.weebly.com.

MVP Summary of Findings



EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

ACKNOWLEDGEMENTS

Special thanks to the Town of Eastham for their willingness to embrace this process and provide the facilities and refreshments for the workshop, and to the participants for their invaluable input about the community.

This project was made possible through funding by the Municipal Vulnerability Preparedness Program from the Massachusetts Executive Office of Energy and Environmental Affairs.

Table of Contents

Introduction and Overview

The need for municipalities, regional planning organizations, states, and federal agencies to increase resilience and adapt to extreme weather events and climate change is evident, particularly in coastal communities. Cape Cod has already begun to experience effects of climate change and associated natural hazards, including sea level rise and extreme weather events. The strong nor'easters of 2018 unleashed a new sense of urgency to act. Massachusetts Governor Baker's Executive Order 569 aims to provide communities with technical support, climate change data, and planning tools to identify natural hazards and develop strategies to improve resilience. This resulted in the Massachusetts Municipal Vulnerability Preparedness (MVP) program, which provides communities with funding to identify vulnerabilities and develop plans to specifically increase resilience to climate change.

The Town of Eastham recognized the need to update its hazard mitigation plan and to align that effort with a plan to increase the community's resilience to climate change. As a coastal community bordered to the east by the Atlantic Ocean, and to the west by Cape Cod Bay, Eastham has a long history of dealing with the impacts of a dynamic coastal environment. These impacts will continue to be exacerbated by the effects of climate change. With 37.4 miles of tidal shoreline and natural resource areas, Eastham is highly susceptible to climate change and natural hazards such as coastal flooding, storm surge and erosion. As a tourist destination, the economy is highly seasonal. The year-round resident population is 4,956 and the seasonal population is conservatively estimated at 22,000. This huge fluctuation in population creates challenges for the community's emergency response staff. It also poses challenges to the Town's long-range planning efforts as the Town must maximize its relatively small staff and financial resources to compensate for the influx of its large seasonal population. The seasonal challenges

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

combined with Eastham's coastal geography reinforce the importance of planning for climate change adaption.

The Town is committed to taking a comprehensive approach to its planning efforts. A core component of the assigned duties of both the Town Planner and Conservation Agent is to oversee hazard mitigation planning and related efforts. With a $25,000 grant from the Massachusetts Executive Office of Energy and Environmental Affairs MVP Program, the Town of Eastham contracted with staff from the Cape Cod Commission and Woods Hole Sea Grant & Cape Cod Cooperative Extension, certified MVP providers, to conduct the Community Resilience Building workshop.

With the Town Planner as the lead, the Town established a Core Team to help prepare for and conduct the workshop. In addition to the Town Planner, the Core Team included representatives from the Eastham Department of Public Works, Police and Fire Departments, Council on Aging, Building Inspector, School Department and Health Department. For a complete list of Eastham Core Team members, see Project Team Members on pg. 17. The project team held a kickoff meeting with the Core Team in November to review the project scope and discuss ways to engage stakeholders to participate in the workshop. This early meeting with the Core Team helped to identify a broad range of interests to invite to the workshop.

After the kickoff meeting with the Core Team, the Eastham Town Planner met with the project team in December 2018 to discuss resource mapping, format, and timeframe for the workshop. At this meeting, the project team reviewed a draft storymap with the Town Planner that could be distributed to stakeholders prior to the workshop to help educate stakeholders about the purpose of the MVP planning effort, provide resource maps and data on climate change, and to help identify critical facilities in the community.

Several weeks before the workshop the Town sought community members/stakeholder participation through invitations to local board and committee members. The Town Planner also created a web page on the Town website with information about the workshop, including a public invitation to participate. To help prepare and inform community members about the workshop, the website provided a story map (produced by the Cape Cod Commission) with a data viewer that allowed users to review maps and data related to climate change and natural hazards. The Town Planner sent a brief survey to workshop participants before the workshop to understand their interest in/ knowledge of climate change effects.

The goal of the workshop was to engage community stakeholders to facilitate the education, planning and ultimately, implementation of priority adaptation actions.

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

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.

The workshop was conducted in accordance with CRB guidance and held on January 7 and January 8, 2019 in two four-hour sessions. In addition to the Core Team and project team members, approximately 25 stakeholder/community members participated in the workshops, including Town elected officials and board members, Town department staff including public works, planning, and board of health, public safety officials, school department, local organizations such as the council on aging, community development, local business owners and residents of the Town. Workshop participants were assigned to small diversified teams for the duration of the workshop.

This report provides a summary of the concerns, ideas, and priorities shared by these participants during Eastham's two-day CRB workshop. The summary of findings described in this report, including those that concern the evolving nature of risk assessment and associated action, are compiled from comments, corrections, and updates from workshop participants and Core Team members.

MVP Summary of Findings

Hazards, Concerns, and Strengths

TOP HAZARDS AND VULNERABLE AREAS

On the first day of the workshop, participants learned about and discussed eight locally relevant climate hazards:

- Coastal erosion
- Flooding
- High winds
- Hurricanes
- Nor'easters
- Sea level rise
- Severe winter weather
- Thunderstorms

Greg Berman, Coastal Processes Specialist with the Woods Hole Sea Grant & Cape Cod Cooperative Extension, gave a PowerPoint presentation on top vulnerabilities/ hazards identified by the State, regional vulnerabilities/hazards, and climate change projections in Massachusetts with data from the Climate Change Clearing House for the Commonwealth (www.resilientma.org). (See Appendix).

The first day of the workshop focused on identifying top hazards, vulnerabilities, and strengths. The second day of the workshop focused on prioritizing actions. Workshop participants were directed to sit at any one of four tables (A, B, C, or D) and were joined by a project team member, acting as facilitator, and a Core Team member acting as scribe. Basemaps with critical town information such as infrastructure (e.g., stormwater pipes, hydrants, firefighting cistern locations, etc.), floodplains, public water supply areas, and conservation land were placed at each table (see Appendix). Each table worked on its own risk matrix through facilitated "small team" exercises and later worked together as a large team with all stakeholders to consolidate information (See Appendix for completed risk matrices). The combination of the Risk Matrix and the basemap provided decision-support and risk visualization to enable stakeholders to identify the community's strengths and

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

vulnerabilities and prioritize actions to reinforce strengths or mitigate vulnerabilities. The process resulted in informed input, shared experiences, and dialogue among stakeholders.

Using the basemaps and storymap resources as a guide, each small team engaged in a facilitated discussion to identify what it considered to be the top four hazards that pose the greatest current and future threats to Eastham. To help each group determine the priority hazards, facilitators asked participants to consider where, how often, and in what ways hazards have impacted the community; what hazards are impacting the community currently; what effects will these hazards have in the future; what is exposed to hazards and climate threats; what have been the impacts to municipal operations and budgets, planning and mitigation efforts; and other concerns/considerations related to impacts. Each team identified infrastructural, societal, and environmental community vulnerabilities and strengths.

Small teams discussed whether top hazards should be identified as those with the most impact, such as a hurricane, one that occurs more frequently such as flooding or high winds, hazards that the town was least prepared for or would impact the town's budget and/or impact the most people. Stakeholders also felt that there was significant overlap among the top hazards, such as high winds and hurricanes, or nor'easters and winter weather. Stakeholder discussion was focused primarily on current hazards; while sea level rise was identified as a top priority hazard by two of the four small teams, there was less consensus about this being a top hazard for the community.

TOP HAZARDS

Based on the results of the small team exercise, workshop participants identified the following as the top/priority hazards:

- Flooding
- Coastal erosion
- High winds
- Hurricanes
- Sea level rise

Flooding was identified as the hazard having the greatest direct impact on the Town of Eastham both currently and in the recent past, particularly the impact of flooding on regional and local roadways. As a community that depends greatly upon transportation access on U.S. Route 6, access to/from the community is severely impacted by flooding of this roadway as well as other routes such as Bridge Road which serve as a bypass in times of heavy seasonal traffic.

Coastal erosion was another top priority hazard as it impacts bayside beaches, parking lots that serve these beaches, and numerous private properties. Maintaining access to local beaches presents both natural resources and economic concerns for the community.

High winds and severe storms such as nor'easters and hurricanes were also identified as a major concern for the community as these events result in power

MVP Summary of Findings

outages, downed tree limbs and place a strain on public safety resources and personnel.

AREAS OF CONCERN

Areas of concern identified during the workshop were grouped into the following categories:

TRANSPORTATION

Bridge Road by Boat Meadow and Herring River and Eastham/Orleans rotary; other low-lying roads such as Ellis Road – Town Cove area, South Sunken Meadow Road; Herring Brook Road herring run and Salt Pond culvert; Dyer Prince Road, and private roads.

OTHER INFRASTRUCTURE

New public water system that lacks sufficient human infrastructure in the event of an emergency; above-ground electrical and other utilities are vulnerable to damage/ outage from storms/high winds; concern about singular service provider and lack of cell service in the event of a severe storm; tree trimming on private roads

PUBLIC AMENITIES/FACILITIES

Town beach parking lots - concerns about loss of parking facilities due to erosion; Bayside beaches – Thumpertown, First Encounter beach; maintenance of eroded beaches, parking lots is cost to town; Nauset Regional High School, Council on Aging – facility serves multiple functions/ needs for the community; Town library – currently used as a warming shelter; need to ensure maintenance to facility; lack of local supermarket and reliance on small businesses to supply food during an emergency

ECOSYSTEMS

Wetlands in multiple locations, Mary Chase area, Nauset Marsh, Floodplains in multiple locations, Herring run off Herring Brook Road. Lack of regulations preventing development in flood zones, and areas for marsh migration needed; coastal dunes and banks with bayside erosion; Boat Meadow/ Herring River marsh; development in floodplains; Nauset spit; concerns over how to undevelop or limit development to allow for natural migration of dunes; maintenance dredging is a cost to town

NEIGHBORHOODS

Bayside coastal development is vulnerable to erosion; senior population town-wide lack of access to communication, seasonal property owners lack of contact information for emergency notification

CURRENT CONCERNS AND CHALLENGES PRESENTED BY HAZARDS AND CLIMATE CHANGE

The town of Eastham has experienced challenges during recent coastal storms. Hurricane Sandy (2012) and a series of winter storms in 2013 caused significant erosion of along the Atlantic Ocean shoreline. Large portions of the coast lost more than 5 vertical

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

feet of beach elevation; however, much of this beach elevation was soon redeposited, and most if it regained a few months later due to the uninterrupted flow of sediment in this area. Coastal bank erosion permanently removed sections of upland property; however, this provided the material for the dune and beach recovery. Flooding of the Cape Cod Bay shoreline also occurred during these events, as well as during the winter storms of 2018. The winter storm of January 4/5th, 2018 is the new record-breaking water level (Boston Tide Gauge), having exceeded the previous record (Winter storm of 1978) by 2 inches. The tide gauge record shows about 4.5 inches of sea level rise during the time between these two storms, meaning that the only reason 2018 was a record-breaking event was due to climate change. Another anomaly was the series of winter storms in early March 2018. The storm surge was 1-2' for over a week, which weakened many coastal resource areas and resulted in significant erosion. There are concerns that both long-duration and high water-level storms will be the "new normal".

The primary climate and natural hazards identified by the participants included winter storms and flooding. Nor'easters have impacted Eastham for many years, but storm frequency and intensity in recent years have increased. In addition to Nor'easters, several participants noted concern about hurricanes, which can have different impacts than a Nor'easter. Participants identified areas where flooding impacts local roadways, and expressed concern about anticipated flooding along Route 6, the major north/south highway. Participants also expressed concern about impacts from downed utility lines, communication lines and downed trees and limbs across roadways, hampering access/egress and communication during storm events. Erosion was also a concern, though there were fewer specific examples of erosion impacts than there were of flooding and winter storm damage. Looking forward, participants also recognized the threat of sea level rise as something their community will need to contend with.

SPECIFIC CATEGORIES OF CONCERNS AND CHALLENGES

LOW-LYING INFRASTRUCTURE (TRANSPORTATION)

Flooding along Bridge Road and Eastham/Orleans rotary limits access to emergency medical facilities and results in lack of egress options during flooding with limited evacuation transportation routes. These areas are critical points of access to medical facilities for Eastham and the rest of the Outer Cape (including Wellfleet, Truro, and Provincetown) in addition to Eastham. If the rotary is impassable, evacuation and emergency access is cut off. Additionally, there are several local roads that experience flooding, including but not limited to Bridge Road, which serves as the secondary egress route out of Eastham, Dyer Prince Road, and Samoset Road.

MVP Summary of Findings

ISOLATION AND EMERGENCY ACCESS (NEIGHBORHOODS AND PUBLIC AMENITIES/FACILITIES)

Route 6 is the main thoroughfare through and within Eastham. It provides access to most neighborhoods, with limited other access points or routes. Many of the local roads in Eastham are private roads, which can be difficult to access due to narrower road widths and a lack of signage. Strong storms could cause fallen trees or flooding that could restrict or completely block access to these areas, isolating residents from emergency services.

Eastham does not have a local supermarket of sufficient size to provide adequate food supplies in the event of an emergency or prolonged power outage. Larger supermarkets are located in Provincetown and Orleans, which are accessible only via Route 6.

As with all Cape Cod communities, Eastham has a significant senior population. Many of these seniors may have difficulty moving around during intense weather and may be confined to a home with limited food, water, medical supplies, and heating and cooling during significant weather events. Eastham does have a system of checking in on certain seniors who have opted into their program, but it is unlikely that all seniors are on this list. With limited mobility, there may be several isolated individuals who need assistance and access to medications or other medical supplies that need assistance from the town during an emergency.

STAFFING RESOURCES

The Town of Eastham has a new public water system but does not have a water department. The town works with a contractor that responds to main breaks or other system needs. Participants identified this as a weakness as in times of emergency or severe weather, as it may be difficult or there could be delays in response times. Furthermore, if access points are flooded, the contractor may not be able to reach the town at all.

TELECOMMUNICATIONS/ UTILITIES

Eastham is primarily reliant on above ground utilities, which can become incapacitated with storms. Without power, residents may lose access to heat, food may spoil, and without telecommunications, it can be difficult to know if a household is okay or in need of help.

CURRENT STRENGTHS AND ASSETS

Workshop participants were aware of the community's strengths and how they relate to its vulnerabilities. It was a clear priority that these strengths be reinforced and expanded to increase preparedness and resiliency in the community.

EMERGENCY SERVICES

The Town of Eastham maintains a regional shelter at the Nauset Regional High School that functions as a shelter during emergencies, as well as warming stations at the Town library and other Town buildings.

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

The shelter is equipped to accommodate displaced residents in the event of extended power outages, though it is in need of some updates.

The Town operates a CodeRED system that is an alert system that enables town officials to send out notifications of emergencies to all users who have signed up for the service. This is an effective means of communication but is limited by the fact that only those who have signed up will get the notifications.

COMMUNITY

Eastham has an active citizenry committed to their community. There is an active Council on Aging, neighborhood watch programs, and other programs coordinated by the police and fire departments. The residents are educated, engaged and contribute their skills and knowledge to the community. There are also many strong local commercial establishments that support the community.

NATURAL ASSETS

The natural environment and assets are a key draw to residents and visitors in Eastham. Participants noted that the town's marshes are community strengths, as they help absorb floodwaters and potentially sea level rise. Fishing and shellfishing, as well as water-based recreation and tourism, are also community assets, though it was noted that these are potentially vulnerable to impacts from climate change and severe storms.

Recommendations and Next Steps

TOP RECOMMENDATIONS TO IMPROVE RESILIENCE

In small groups, workshop participants developed recommended actions based on identified vulnerabilities. On the second day of the workshop, participants returned to the small teams they had been assigned to on day one to complete the following:

1. Generate potential actions to reduce vulnerabilities and reinforce the strengths identified during day 1 of the workshop;

2. Consider whether the actions address more than one top hazard, are intermediate steps, or strengthen existing initiatives;

3. Prioritize actions and differentiate them as short-term, long-term, and ongoing; and

4. Identify their top three recommendations to improve resilience to the top hazards in Eastham.

Recommended actions were then discussed as a large group to obtain consensus on the most important recommendations to benefit the community. Considerable overlap existed among the small groups. The top recommendations that follow represent a consensus among participants, organized by priority.

1. Improve the resilience of Route 6/Bridge Road to flooding

Workshop participants agreed that Bridge Road and Route 6/rotary flooding presents a significant transportation impediment. While raising the road appears to be a solution, the group felt that the town needs to conduct a feasibility study to understand potential impacts, costs, and other considerations of elevating the road as well as identifying other alternatives for mitigating the flooding.

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

2. Create a task force responsible for public education on local emergency preparedness

Workshop participants discussed concerns about being unprepared for hazard events, particularly emergency planning. With seasonal residents (a significant portion of Eastham's population) residing elsewhere during part of the year, many are unaware of the increases in storms and their impacts and are disconnected from community discourse. In addition, many residents – year-round as well as seasonal – do not know about the regional shelter at the high school and how to respond in case of an evacuation order. Many residents will not leave their homes due to concerns about their pets. A task force comprised of public safety officials and neighborhood representatives could develop educational materials about emergency planning and also explore additional/alternative shelter options to accommodate people and their pets. This effort would include a survey of existing warming/shelter capacity and emergency generator locations for small businesses and critical facilities.

3. Evaluate the needs/upgrades/improvements to shelters and warming stations

Workshop participants agreed that Memoranda of Understanding with local businesses should be pursued with local grocery and pharmacies to ensure that these local businesses remain open in the event of power outages during storm events. In addition, the Town should evaluate the need for more back-up shelters centrally located (such as at the elementary school).

4. Develop conservation commission regulations that address Lands Subject to Coastal Storm Flowage (LSCSF)

Both the Massachusetts Wetlands Protection Act and the Eastham Conservation Commission regulations lack performance standards for Lands Subject to Coastal Storm Flowage, a coastal resource area within the flood zone. Standards are needed to preserve the characteristics of the landforms of the floodplain (e.g. slope, vegetative cover, permeability etc.) to protect the interests of storm damage prevention and flood control. With rising sea level, stronger storms, and continuing development pressure in these areas, the town needs to adopt standards as soon as possible.

5. Develop a Memorandum of Understanding with the water system operator for maintenance/repair (during storm events)

While the town has acquired a public water system, it does not operate it internally – it is operated by a contractor located outside of Eastham. During emergencies, the contractor would need to come to Eastham to address any problems. Having an MOU with the contractor to pre-position someone to address any break, emergency shutoff, or other issues during an event would help the town avert further problems during a disaster.

MVP Summary of Findings

6. Develop a tree trimming program town-wide and/or undergrounding utilities program

A regular tree trimming program will help reduce power outages during storm events by eliminating the risk of falling tree branches taking out power lines, as well as ensuring that access along roadways is maintained in the event of storms and emergencies. The town could improve coordination with Eversource, which already conducts regular tree trimming.

Additional recommendations included the following:

- Evaluate alternatives for inland beach parking
- Conduct tree inventory for local/private roads
- Evaluate septic systems in flood areas
- Offer free cellphones for elderly residents
- Development of medical facility for Outer Cape
- Research tidal flooding at herring run and potential solutions
- Develop seasonal property owner contact information
- Maintain/upgrade DPW gas pumps/generator
- Limit low-lying development/ redevelopment
- Acquire hurricane moorings for fishing/shellfishing fleet
- Underground utility lines
- Upgrade stormwater infrastructure
- Pursue culvert/stormwater upgrades at Salt Pond

CONCLUSION AND NEXT STEPS

The Town of Eastham will continue the MVP certification process by presenting and distributing this report to the public at a formal public information and listening session scheduled for May 29, 2019. This session will provide an opportunity for any member of the interested public to learn about the MVP process and provide feedback about the MVP workshop and recommended highest priority actions resulting from the workshop.

Priorities identified during the January 2019 workshop will be integrated into existing local planning efforts. The Town will consider pursuing grant funding to implement the priority actions as appropriate to continue to improve the Town's resilience to climate change.

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

CRB WORKSHOP PARTICIPANTS

- Dorothy Burritt
- Ellen Lariviere
- Peter Wade
- MaryLou Roberts
- Ed Schneiderhan
- Melissa Lowe Cestaro
- Deb Cohen
- Silvio Genao
- Bryan Horsley
- Thomas Thompsen
- Willow Shire
- Andrea Aldana
- Mary Shaw
- Jane Crowley
- John "Jeff" Bumby
- Kathy Bunnell
- Stephanie Ellis
- Maurice J Boisvert
- Jennifer Taylor
- Edward Kulhawik
- Randal Bol
- Susan Bol

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CRB WORKSHOP PROJECT TEAM

PROJECT COORDINATOR

- Paul Lagg, Eastham Town Planner

CORE TEAM MEMBERS

- Paul Lagg, Town Planner
- Shana Brogan, Conservation Agent
- Ed Kulhawik, Police Chief
- Adam Bohannon, Deputy Police Chief
- Kent Farrenkopf, Fire Chief
- Dan Keane, Deputy Fire Chief
- Tom Wingard, Building Commissioner
- Jane Crowley, Health Agent
- Dorothy Burritt, Director, Eastham Council on Aging
- Silvio Genao, DPW Superintendent

MVP PROVIDER – CAPE COD COMMISSION

- Sharon Rooney, Chief Planner
- Heather McElroy, Natural Resources Manager
- Erin Perry, Deputy Director
- Chloe Schaefer, Community Design Planner
- Martha Hevenor, Planner II
- Anne Reynolds, GIS Director

MVP PROVIDER – WOODS HOLE SEA GRANT/CAPE COD COOPERATIVE EXTENSION

- Greg Berman, Coastal Processes Specialist
- Shannon Jarbeau, Floodplain Specialist & CRS Coordinator

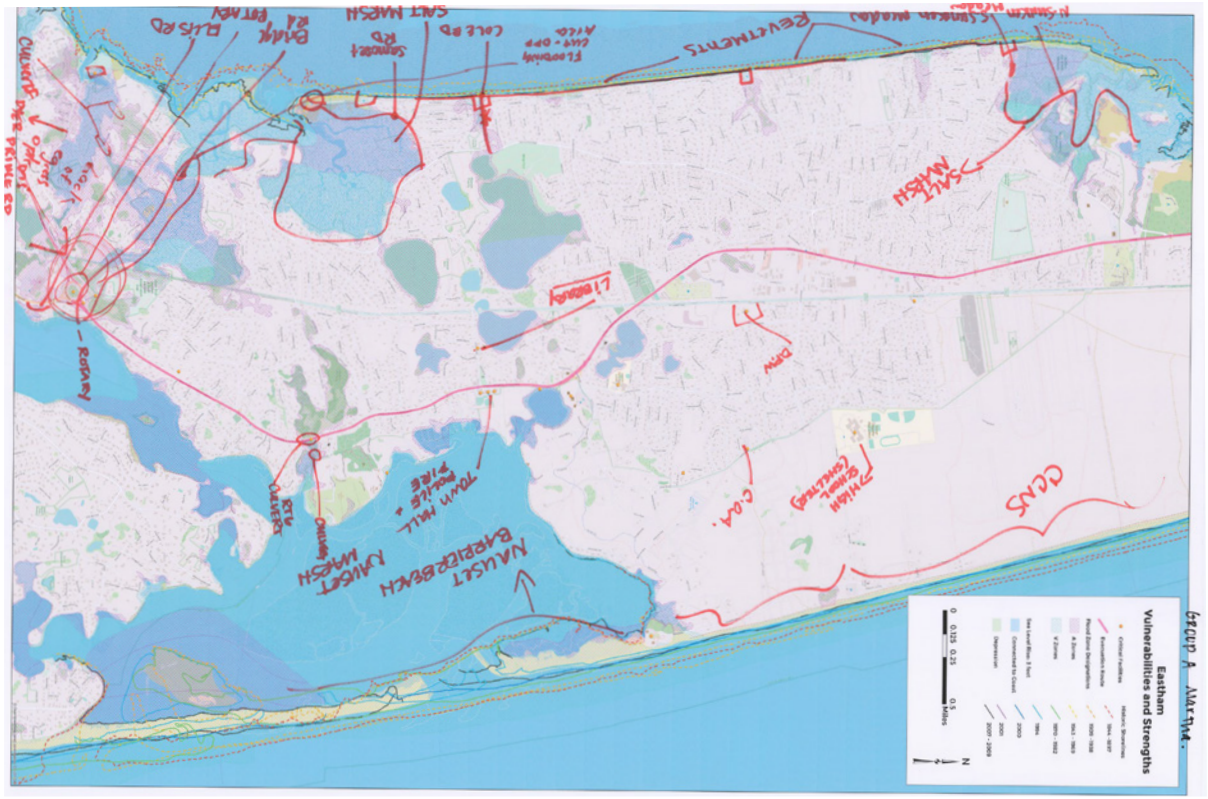
PROJECT SPONSOR

- Eastham Board of Selectmen
- Jacqueline Beebe, Town Administrator

Appendix

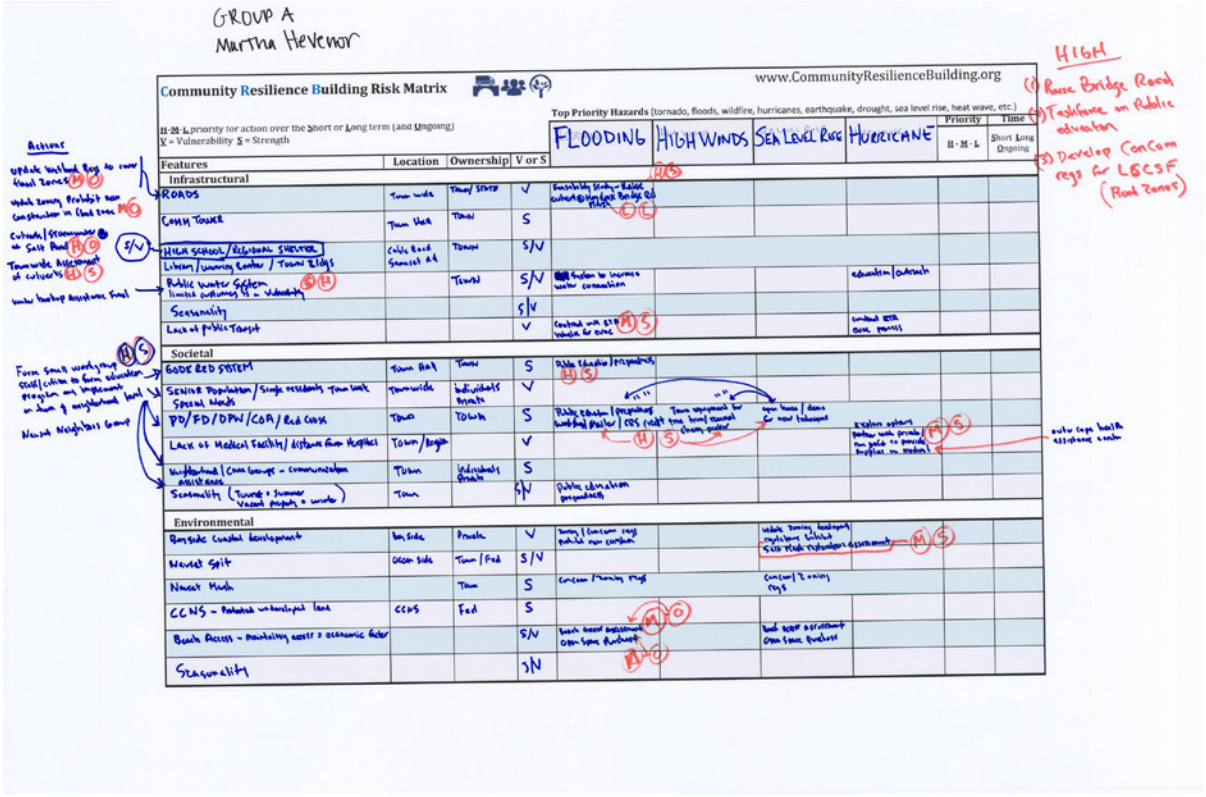
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP A BASEMAP

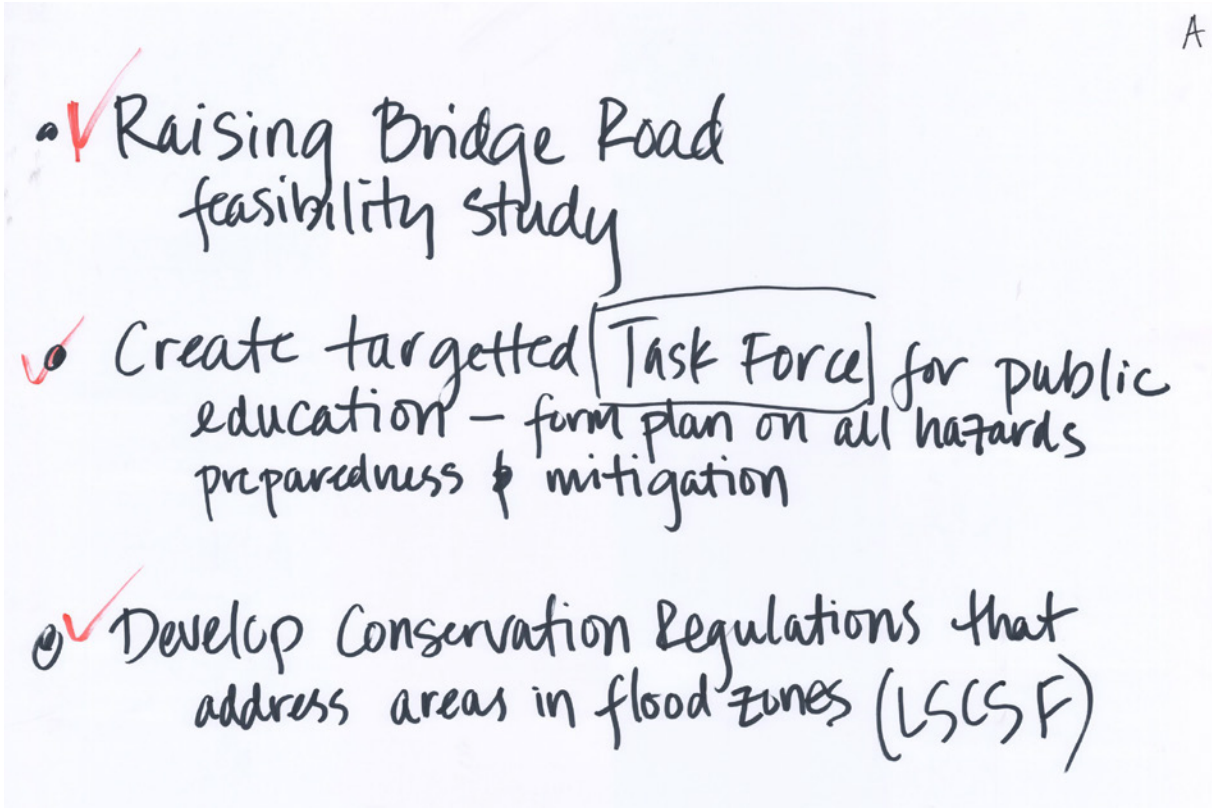
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP A RISK MATRIX

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP A PRIORITIES

SUMMARY OF FINDINGS: APPENDIX | 21

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

GROUP B BASEMAP

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

B

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

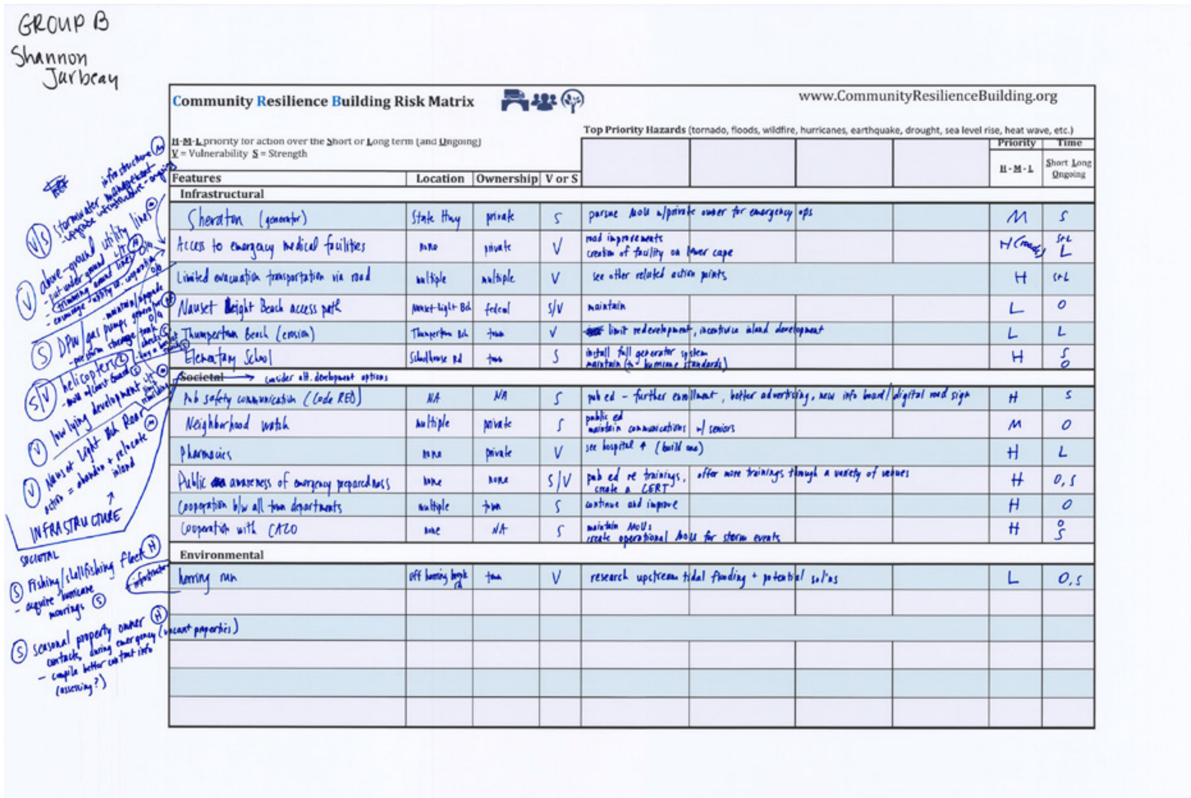
Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Coastal erosion	Flooding	~~High winds~~ Hurricanes	~~Nor'easters~~ (keep)	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Low lying roads	see map	state, local, private	V	state hwy - elevate/barriers; other - evacuation plan	at many; and public education →s	possible flyover; LT long term retreat/abandon		H	S+L
Nauset Regional HS (shelter location)	Cable Road	regional	V/S	replace generator system	. upgrade entire facility			H	S
Library (warming location)	Samoset Rd	town	S	maintenance; public outreach				H	O
Council on Aging (emergency dispensing site)	Nauset Rd	town	S	eventual replacement built to hurricane standards				M	L?
Town Hall / Fire / PD campus	State Hwy	town	S	new roof at Town Hall and basement windows; regular maintenance				L	O
Municipal water system	multiple/Nauset Rd	town	S	keep operators on site during emergencies - put in contract				H	S
Societal									
Ace Hardware	State Hwy	private	S	Mou re storm protocol	stocking of store			H	S, O/G
Cumberland Farms (w/generator)	"	"	S	"	" , gas			H	S, O
Superette	"	"	V	" add generator	"			H	S, O
Non-evacuees	multiple	NA	V	public education; legal agreements re non rescuability				H	O S
Public safety coordination PD/FD	State Hwy	town	S	maintain. Spread out tactical response teams		pre-storm		H	O
Pub safety equipment	"	"	S	maintain/replace high water [illegible] vehicles. More; maintain boats for shallow water ops		loaders @ DPW + bucket truck and appropriate staff		H	O, S
Environmental									
Wetlands - storm buffering, WQ	multiple	NA	S/V	provide areas for marsh migration. limit development	tidal research on	restoration in many Chase area floodwater constriction points		M	O
Nauset Marsh	CCNS side	NA	V/S	pursue opportunities for migration. limit development				M-L	O
Coastal dunes (erosion) + banks	"	private/federal	V	undevelop (incentivize?), limit future development				L	LT
limited development in CACO (protect against high winds)	"	federal	S	continue				L	O
barrier beaches, shoaling	" + harbors nwy	town	V	promote natural functions; well-planned waterway maintenance + channel maintenance				L	O
flood plains	multiple	multiple	V	public ed, undevelopment, zoning regs, WQ maintenance				L	O, L

GROUP B MATRIX 1

SUMMARY OF FINDINGS: APPENDIX | 23

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP


GROUP B
Shannon Jurbeay

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
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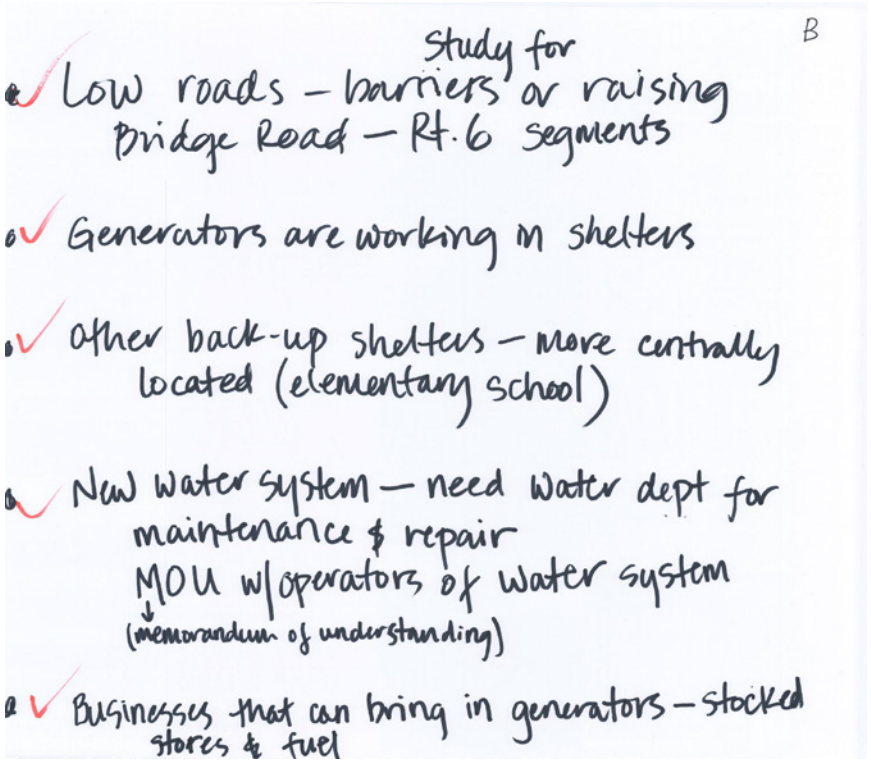
Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Sheraton (generator)	State Hwy	private	S	pursue MOU w/private owner for emergency ops				M	S
Access to emergency medical facilities	none	private	V	road improvements; creation of facility on lower cape				H	S+L
Limited evacuation transportation via road	multiple	multiple	V	see other related action points				H	S+L
Nauset Light Beach access path	Nauset Light Bch Rd	federal	S/V	maintain				L	O
Thumpertown Beach (erosion)	Thumpertown Rd	town	V	limit redevelopment, incentivize inland development				L	L
Elementary School	Schoolhouse Rd	town	S	install full generator system; maintain (to hurricane standards)				H	S, O
Societal → consider alt. development options									
Pub safety communication (Code RED)	NA	NA	S	pub ed – further enrollment, better advertising, new info board/digital road sign				H	S
Neighborhood watch	multiple	private	S	public ed; maintain communications w/ seniors				M	O
Pharmacies	none	private	V	see hospital + (build one)				H	L
Public awareness of emergency preparedness	none	none	S/V	pub ed re trainings, create a CERT; offer more trainings through a variety of venues				H	O, S
Cooperation b/w all town departments	multiple	town	S	continue and improve				H	O
Cooperation with CAZO	none	NA	S	maintain MOUs; create operational MOU for storm events				H	O, S
Environmental									
herring run	off herring brook rd	town	V	research upstream tidal flooding + potential sol'ns				L	O, S

GROUP B MATRIX 2

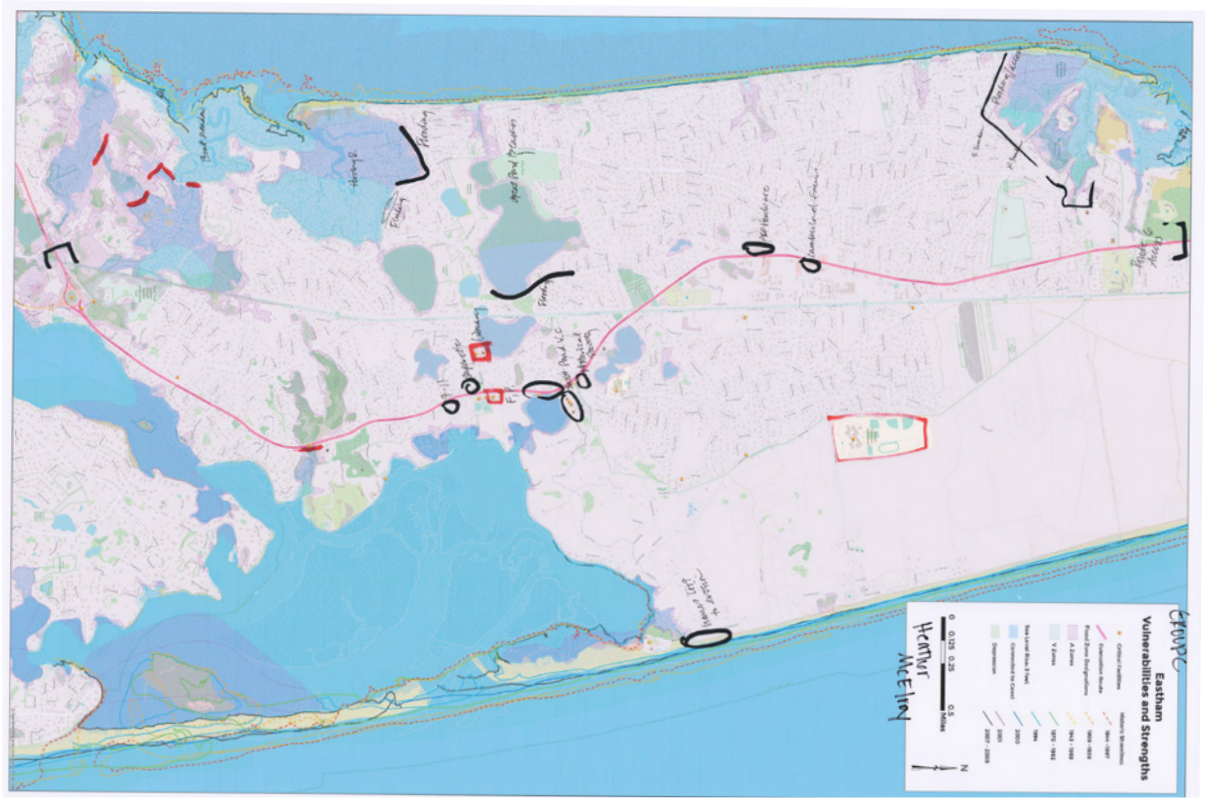
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP B PRIORITIES

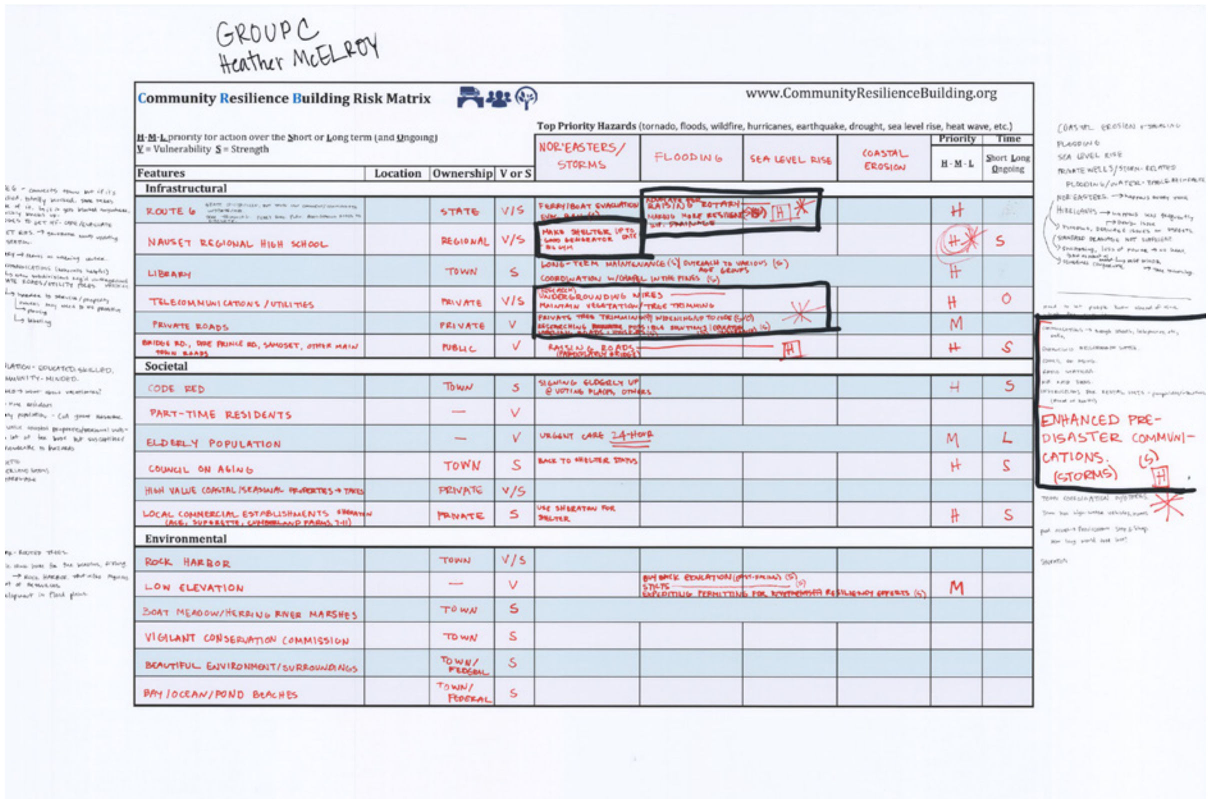
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP C BASEMAP

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP C
Heather McELROY

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	NOR'EASTERS/ STORMS	FLOODING	SEA LEVEL RISE	COASTAL EROSION	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
ROUTE 6 [illegible]		STATE	V/S	FERRY/BOAT EVACUATION [illegible]	ADVOCATE FOR RAISING ROTARY; MAKING MORE RESILIENT (S); [illegible] DRAINAGE [H]			H	
NAUSET REGIONAL HIGH SCHOOL		REGIONAL	V/S	MAKE SHELTER UP TO DATE; GOOD GENERATOR [illegible]				H	S
LIBRARY		TOWN	S	LONG-TERM MAINTENANCE (S) OUTREACH TO VARIOUS AGE GROUPS (S); COORDINATION W/CHAPEL IN THE PINES (S)				H	
TELECOMMUNICATIONS / UTILITIES		PRIVATE	V/S	(RESEARCH) UNDERGROUNDING WIRES; MAINTAIN VEGETATION/TREE TRIMMING				H	O
PRIVATE ROADS		PRIVATE	V	PRIVATE TREE TRIMMING (V) WIDENING [illegible] TO CODE (S/O); [illegible]				M	
BRIDGE RD., DUNE PRINCE RD, SAMOSET, OTHER MAIN TOWN ROADS		PUBLIC	V	RAISING ROADS [illegible]		[H]		H	S
Societal									
CODE RED		TOWN	S	SIGNING ELDERLY UP @ VOTING PLACES, OTHERS				H	S
PART-TIME RESIDENTS		—	V						
ELDERLY POPULATION		—	V	URGENT CARE 24-HOUR				M	L
COUNCIL ON AGING		TOWN	S	BACK TO SHELTER STATUS				H	S
HIGH VALUE COASTAL/SEASONAL PROPERTIES + TAXES		PRIVATE	V/S						
LOCAL COMMERCIAL ESTABLISHMENTS SHERATON (ACE, SUPERETTE, CUMBERLAND FARMS, 7-11)		PRIVATE	S	USE SHERATON FOR SHELTER				H	S
Environmental									
ROCK HARBOR		TOWN	V/S						
LOW ELEVATION		—	V		BUY BACK EDUCATION [illegible] (S); STILTS (S); EXPEDITING PERMITTING FOR [illegible] RESILIENCY EFFORTS (S)			M	
BOAT MEADOW/HERRING RIVER MARSHES		TOWN	S						
VIGILANT CONSERVATION COMMISSION		TOWN	S						
BEAUTIFUL ENVIRONMENT/SURROUNDINGS		TOWN/ FEDERAL	S						
BAY/OCEAN/POND BEACHES		TOWN/ FEDERAL	S						

ENHANCED PRE-DISASTER COMMUNICATIONS. (S) (STORMS) [H]

GROUP C MATRIX 1

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

GROUP C
Heather McElroy

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	STORMS	FLOODING	SEA LEVEL RISE	COASTAL EROSION	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
WASTEWATER MANAGEMENT				SEWERING / I/A				H	L
Societal									
HISTORICAL SOCIETY		TOWN	S						
LOWER CAPE TV				OUTREACH ON PREPAREDNESS				M	O
EASTHAM PD FACEBOOK PAGE				"				M	O
Environmental									
FISHING / SHELLFISHING		—	V/S	ROLE OF OYSTER REEFS				L	L
WATER RECREATION / TOURISM			V/S		DREDGING IN COORD W/ ORLEANS			M	S/O
SALT POND VISITOR'S CENTER		FEDERAL	S						

GROUP C MATRIX 2

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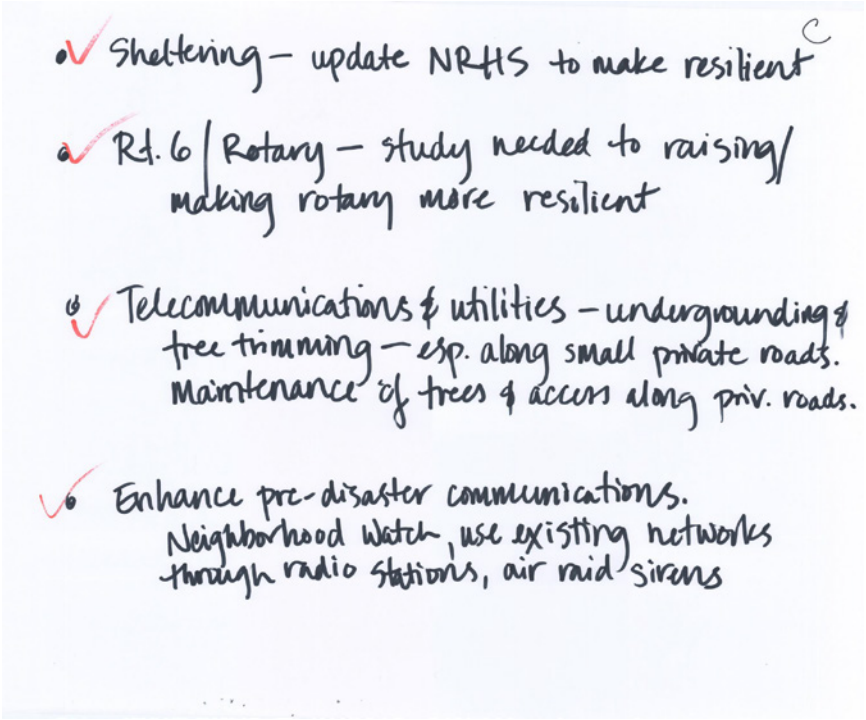
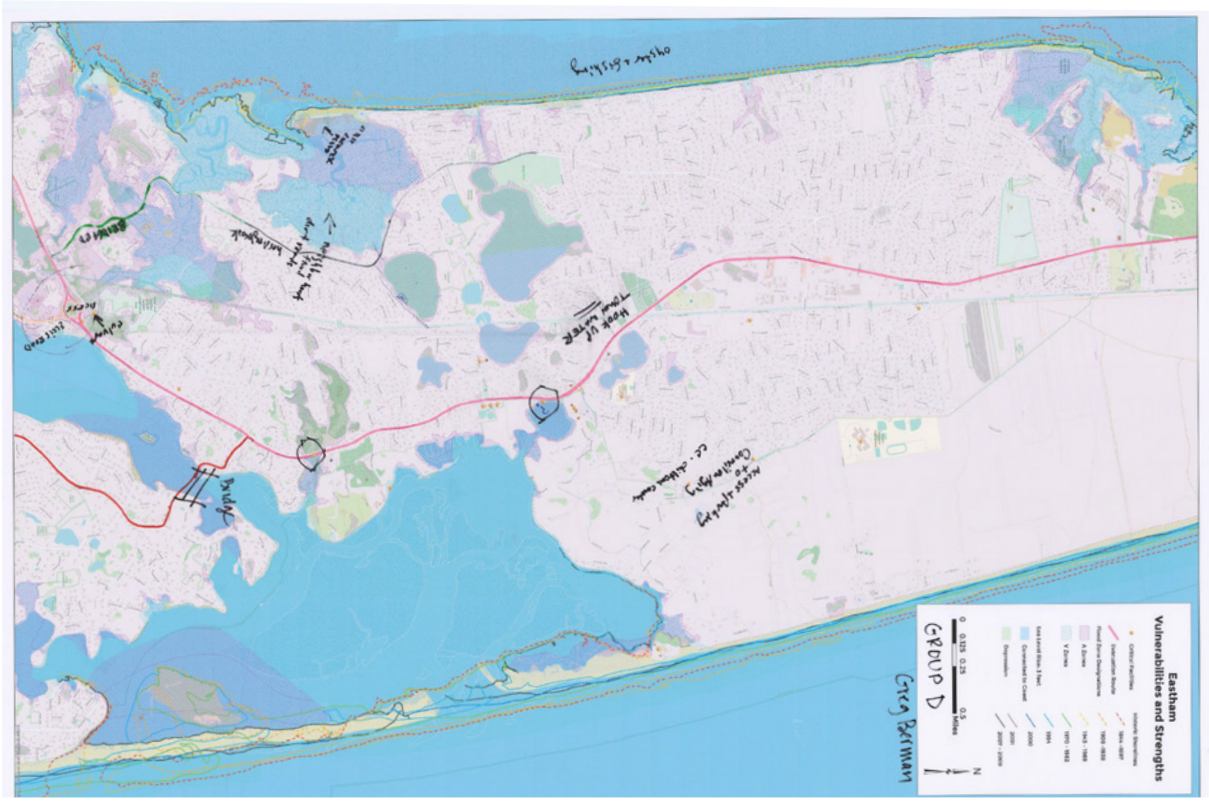
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP C PRIORITIES

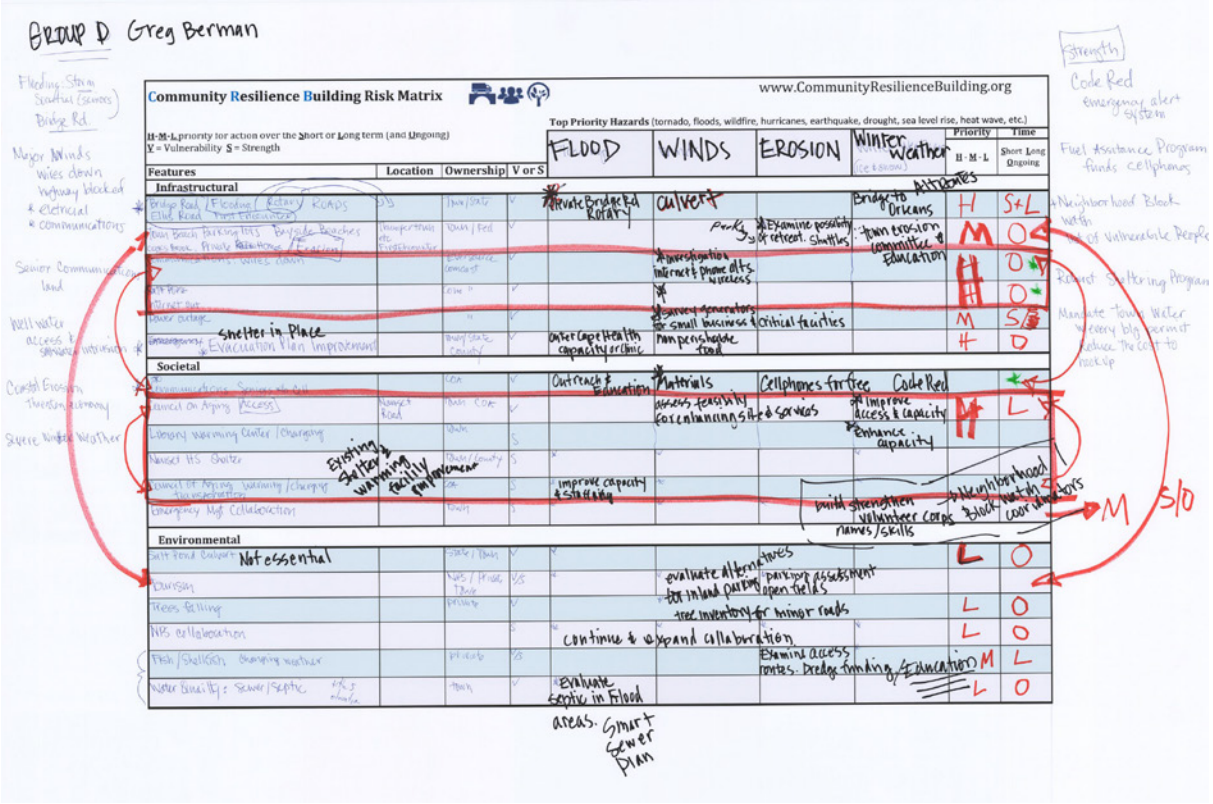
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP D BASEMAP

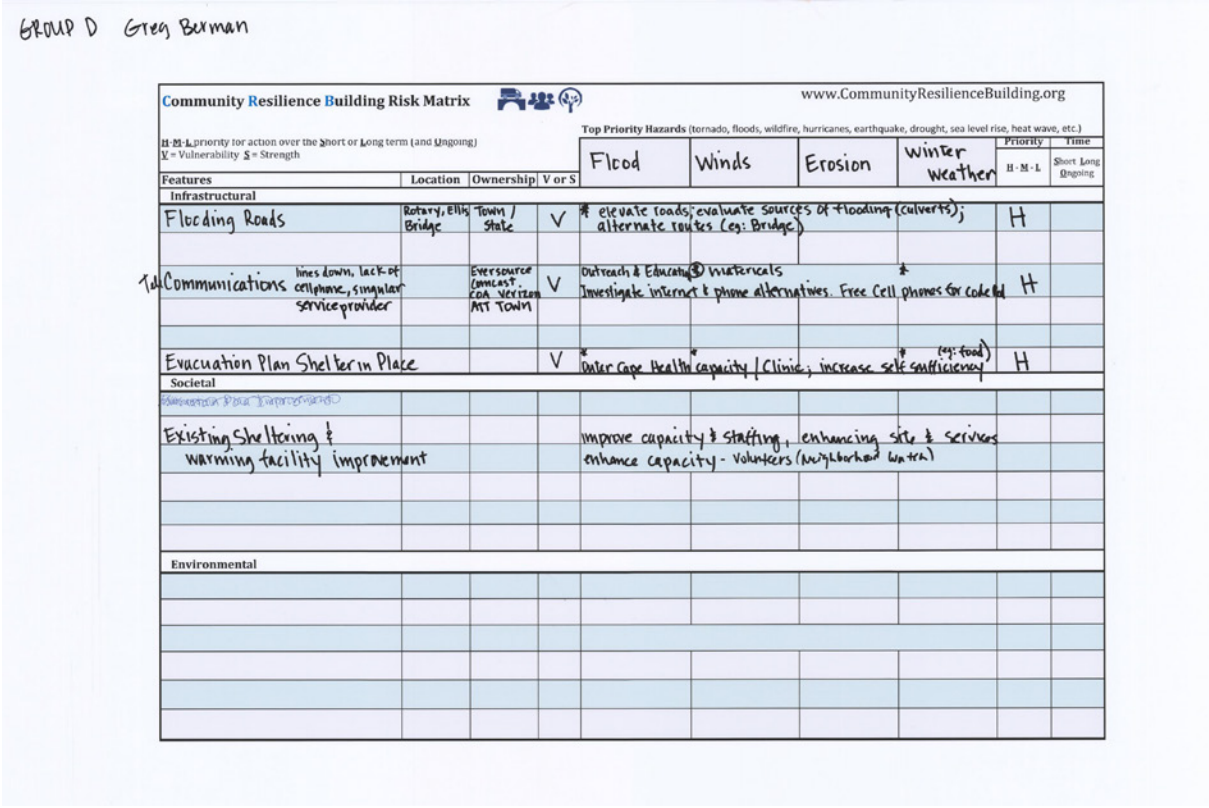
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP D MATRIX 1

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP D Greg Berman

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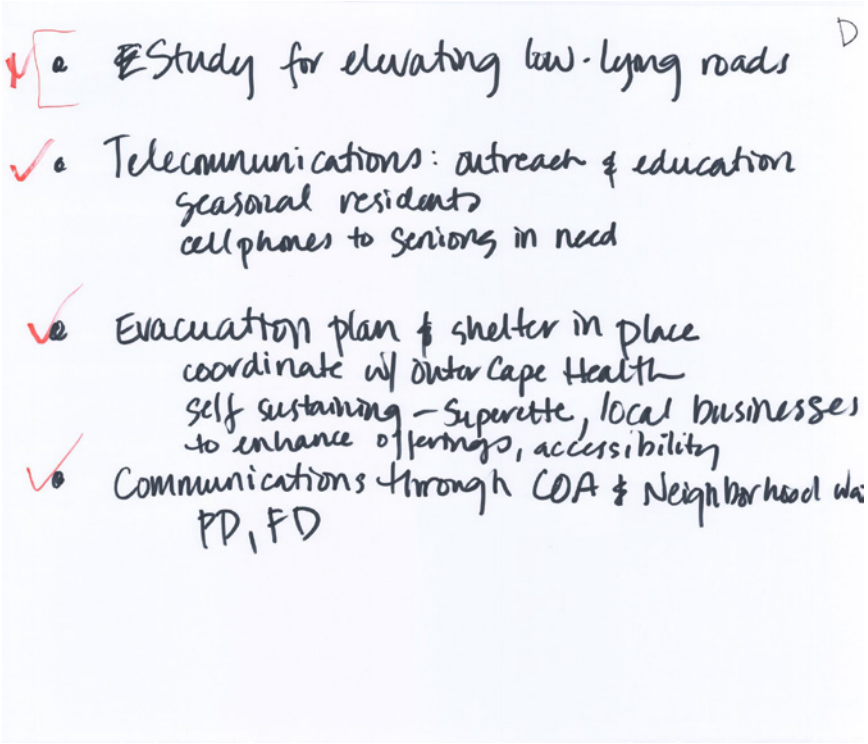
Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flood	Winds	Erosion	Winter Weather	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Flooding Roads	Rotary, Ellis Bridge	Town / State	V	* elevate roads; evaluate sources of flooding (culverts); alternate routes (eg: Bridge)				H	
Communications (1st) lines down, lack of cellphone, singular service provider		Eversource Comcast COA Verizon MT Town	V	Outreach & Education (3) materials * Investigate internet & phone alternatives. Free Cell phones for coded			*	H	
Evacuation Plan Shelter in Place			V	* Water Cage Health capacity / Clinic; increase self sufficiency (eg: food)				H	
Societal									
Existing Sheltering & warming facility improvement				improve capacity & staffing, enhancing site & services enhance capacity - Volunteers (neighborhood watch)					
Environmental									

GROUP D MATRIX 2

MVP Summary of Findings

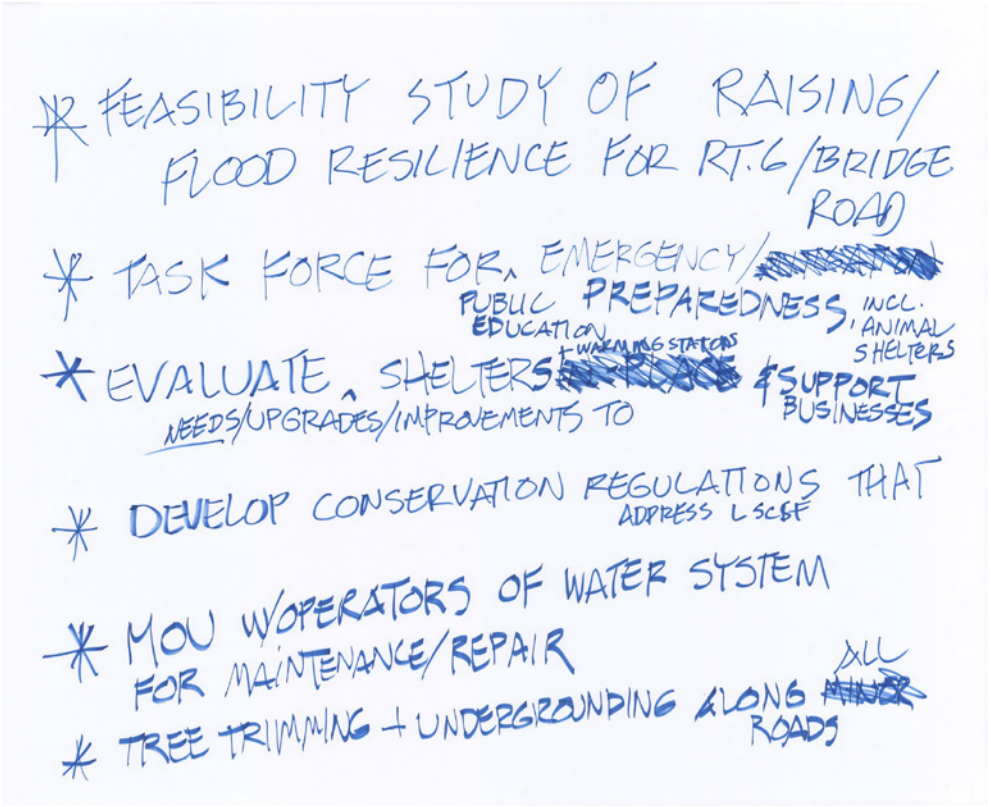
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



GROUP D PRIORITIES

SUMMARY OF FINDINGS: APPENDIX | 33

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



ENTIRE GROUP PRIORITIES

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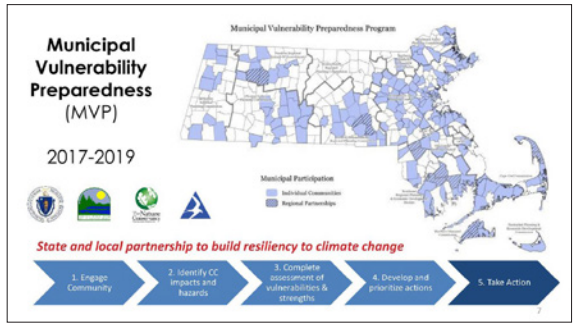
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

WORKSHOP PRESENTATION

SUMMARY OF FINDINGS: APPENDIX | 35

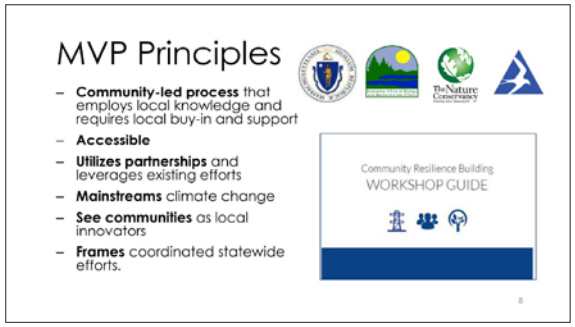
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

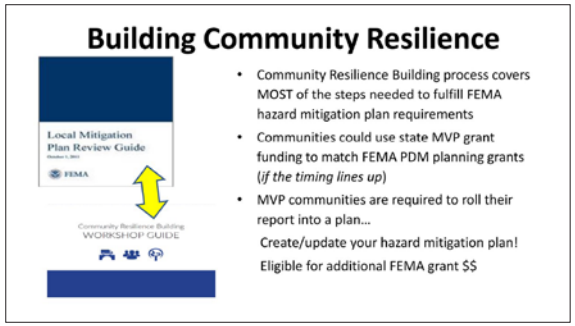


WORKSHOP PRESENTATION

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

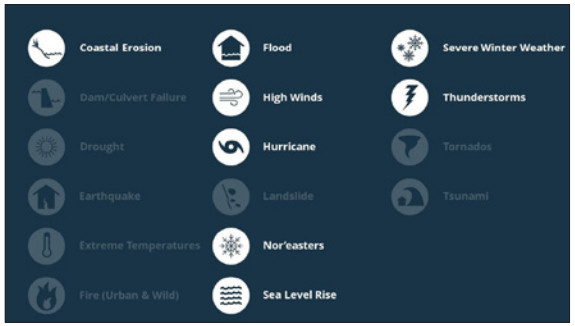




WORKSHOP PRESENTATION

SUMMARY OF FINDINGS: APPENDIX | 37

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

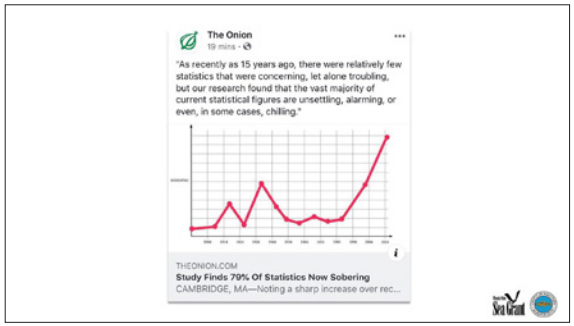


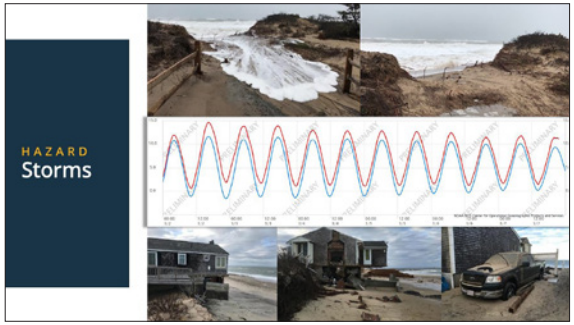
WORKSHOP PRESENTATION

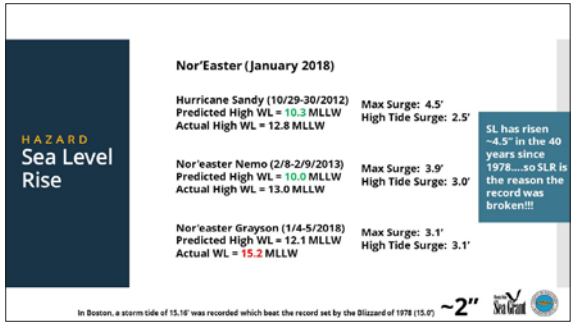
38 | SUMMARY OF FINDINGS: APPENDIX

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

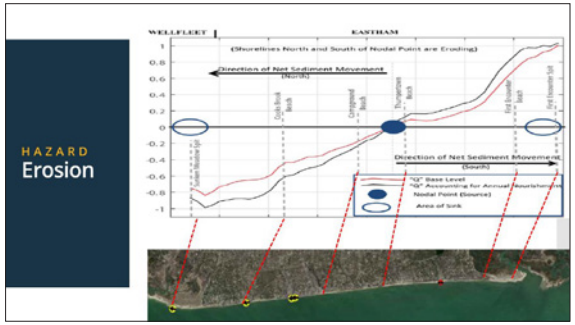


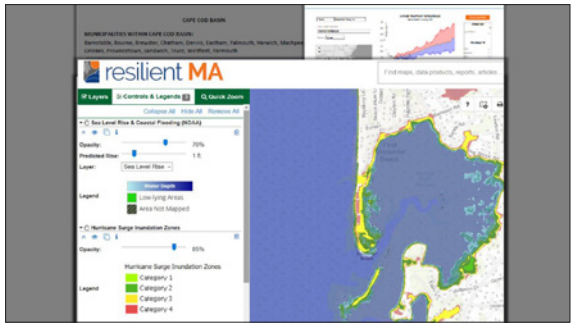


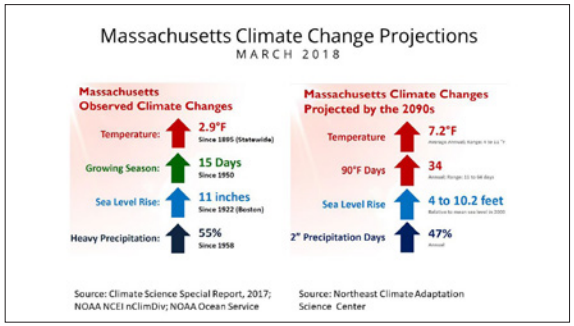


WORKSHOP PRESENTATION

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



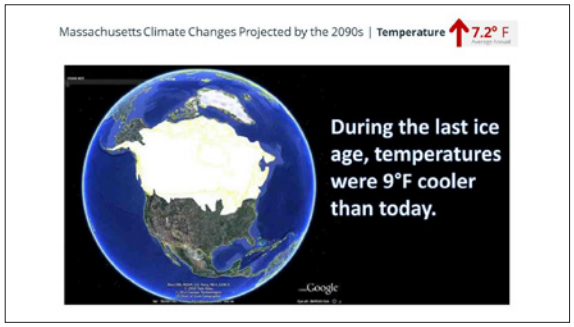


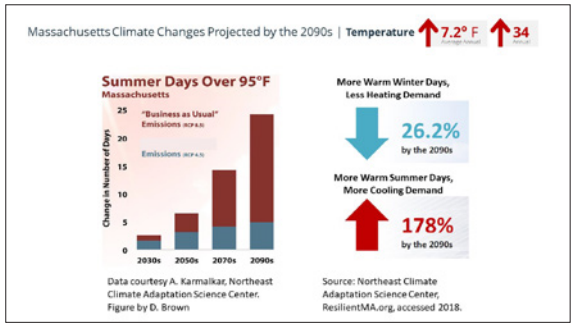


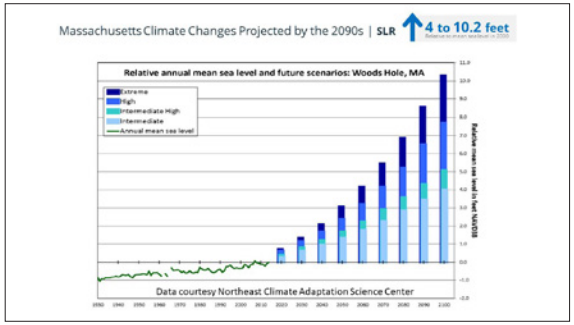
WORKSHOP PRESENTATION

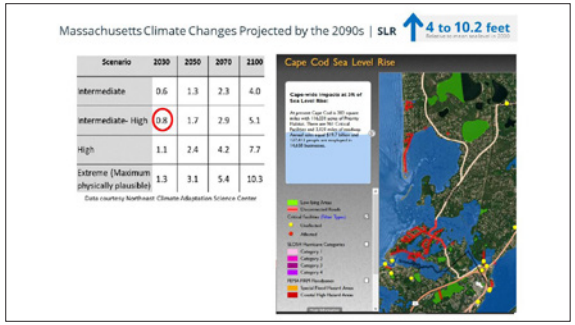
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



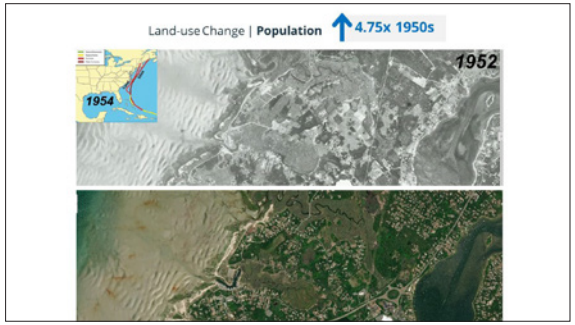


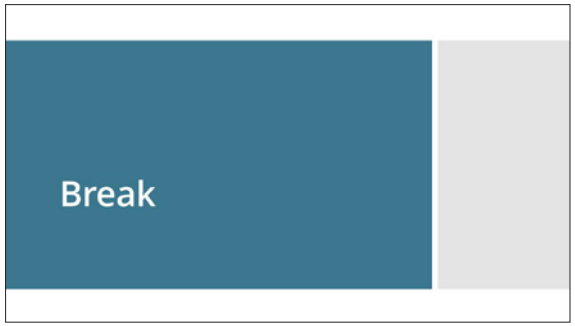


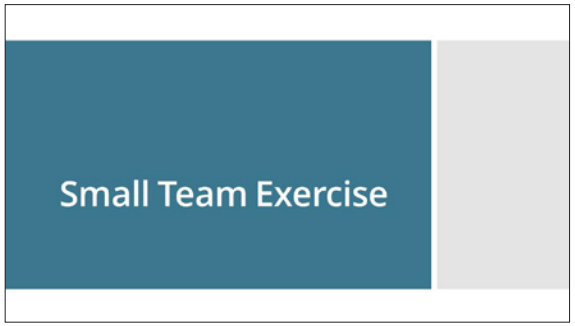


WORKSHOP PRESENTATION

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP





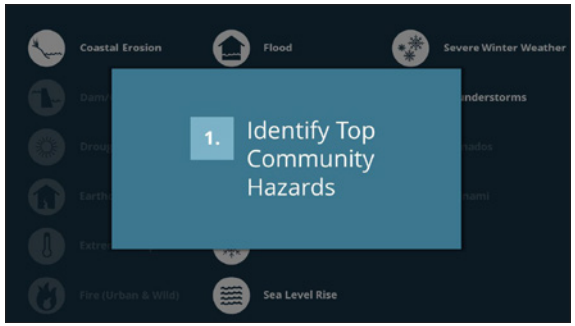


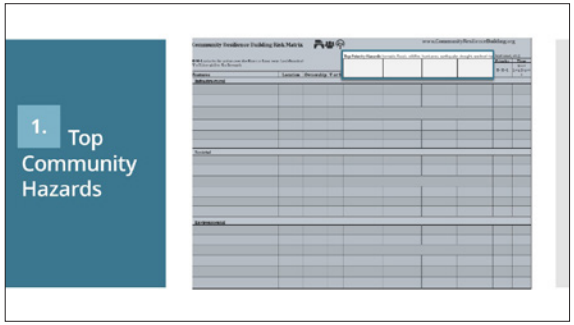
WORKSHOP PRESENTATION

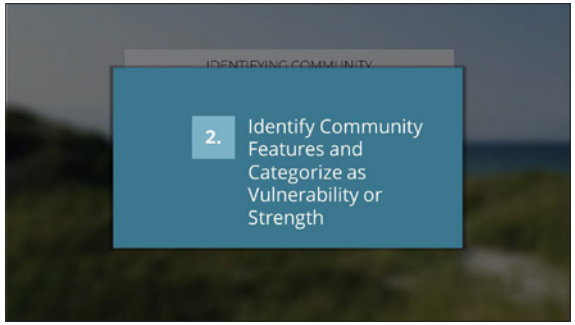
42 | SUMMARY OF FINDINGS: APPENDIX

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



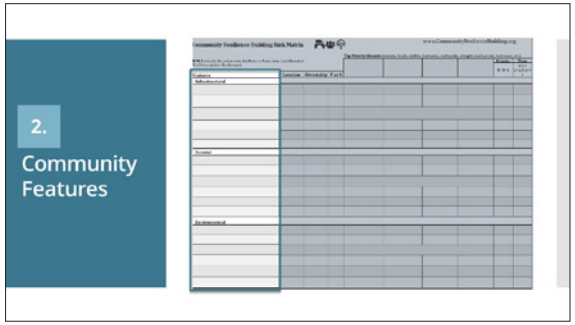


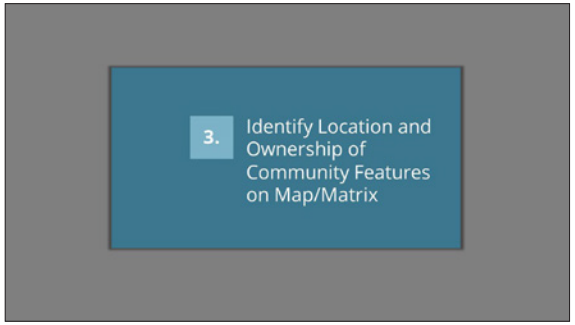


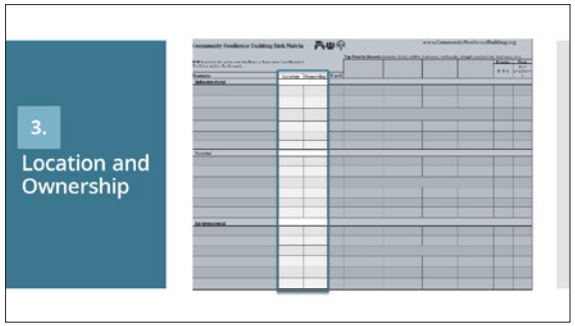
WORKSHOP PRESENTATION

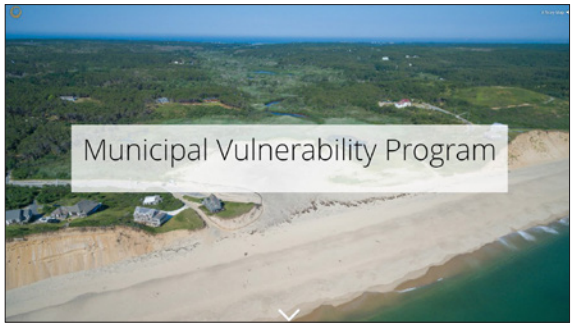
SUMMARY OF FINDINGS: APPENDIX | 43

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP





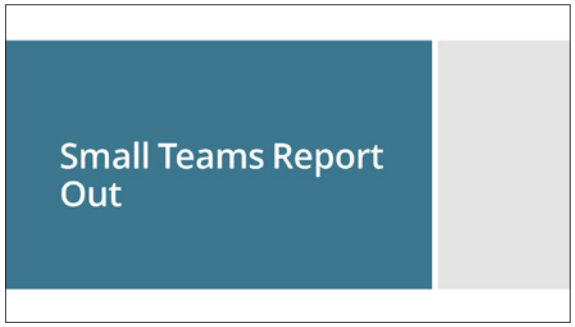


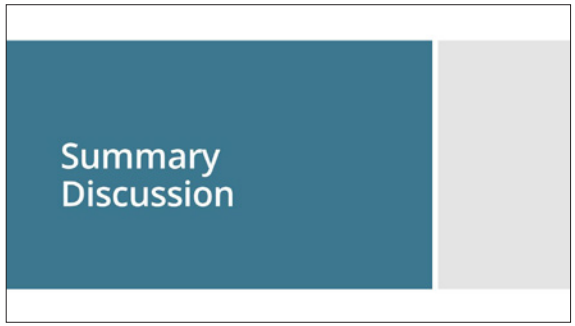


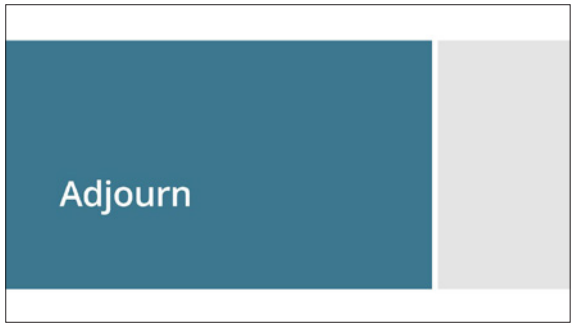
WORKSHOP PRESENTATION

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



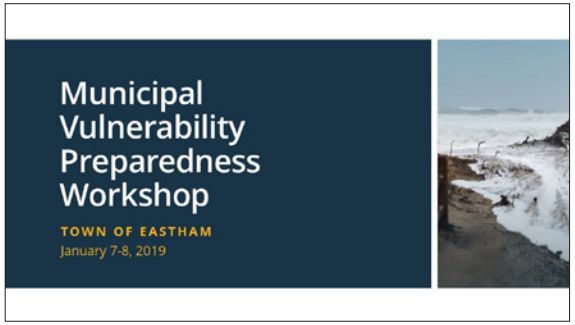




WORKSHOP PRESENTATION

SUMMARY OF FINDINGS: APPENDIX | 45

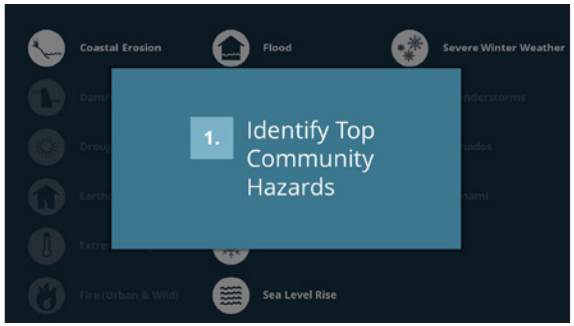
EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

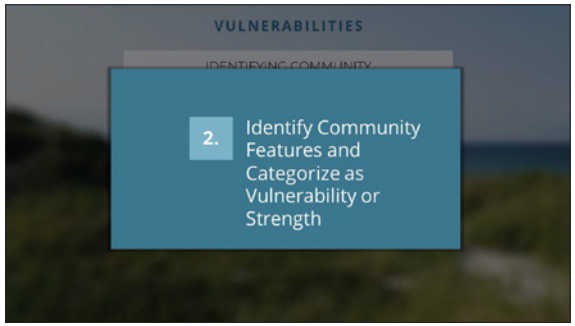


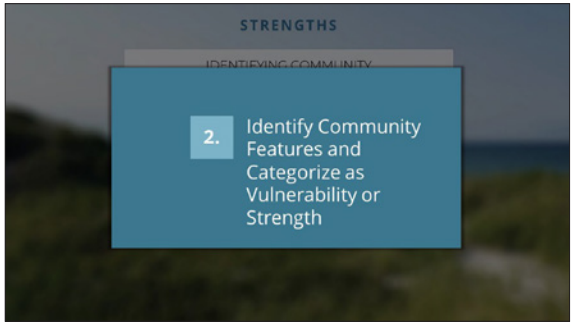
WORKSHOP PRESENTATION

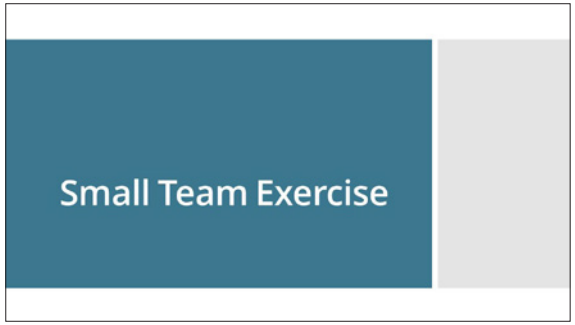
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP





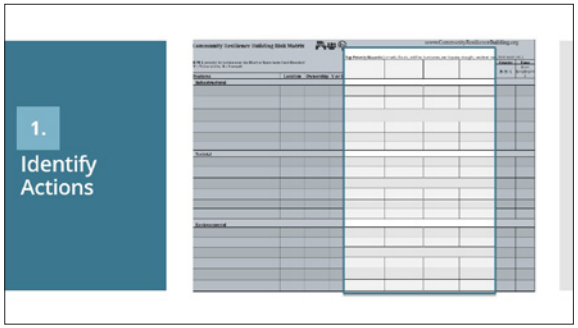


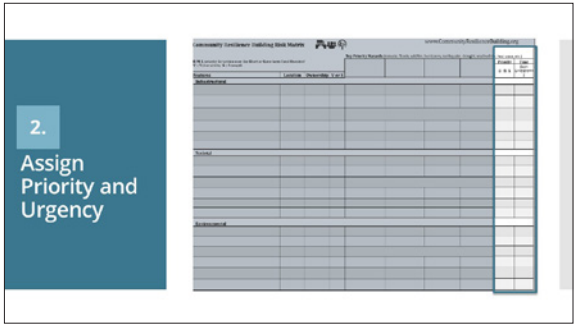


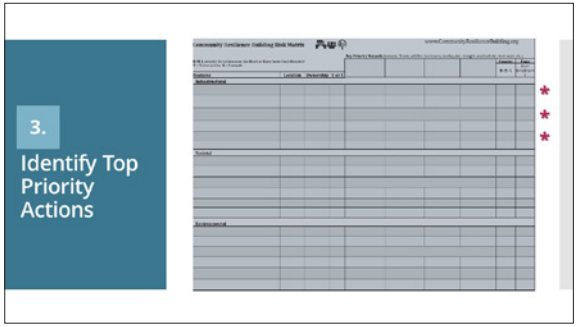
WORKSHOP PRESENTATION

SUMMARY OF FINDINGS: APPENDIX | 47

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP





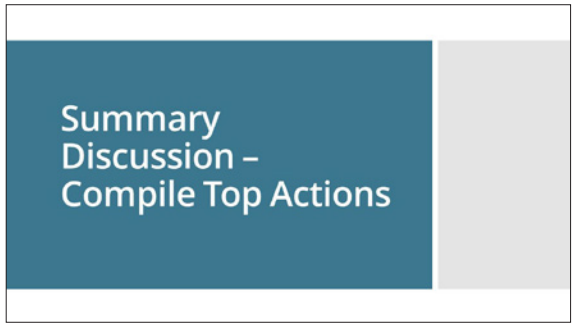


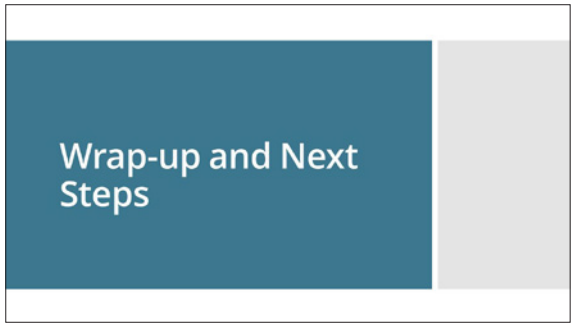
WORKSHOP PRESENTATION

48 | SUMMARY OF FINDINGS: APPENDIX

MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

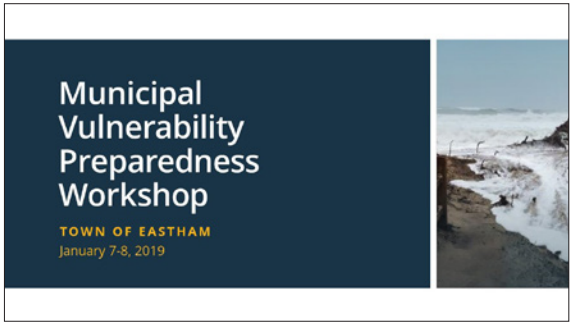




WORKSHOP PRESENTATION

SUMMARY OF FINDINGS: APPENDIX | 49

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP

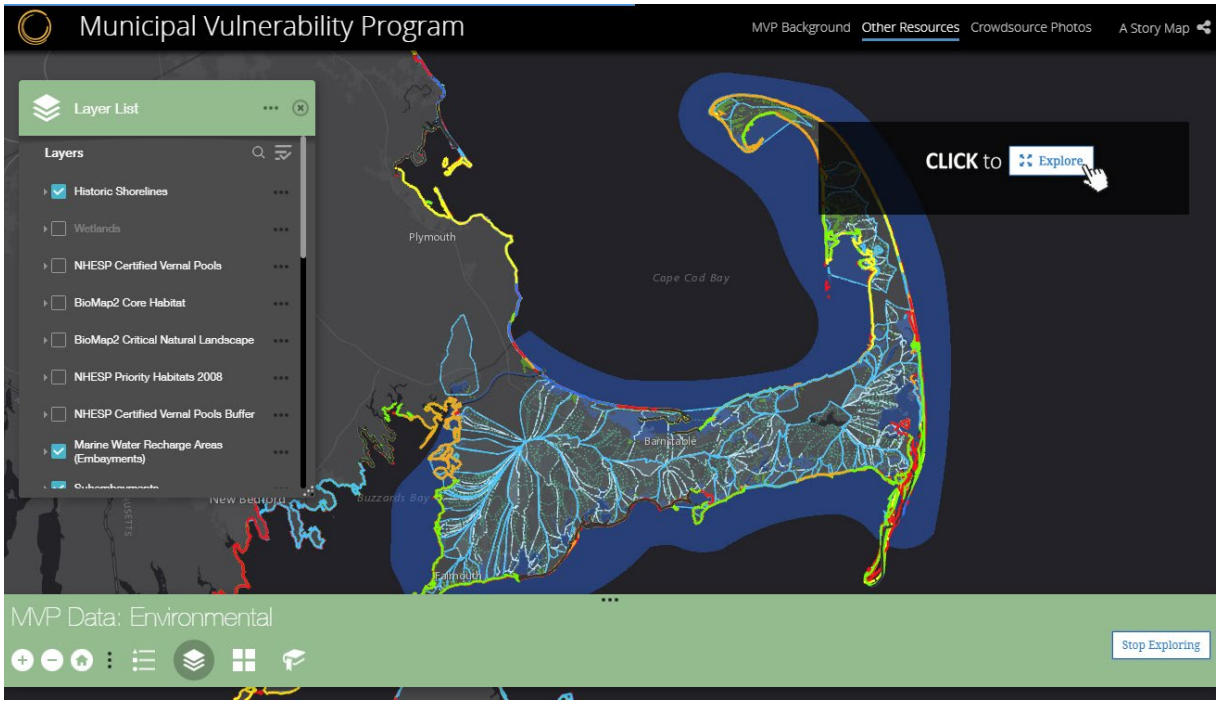


WORKSHOP PRESENTATION

50 | SUMMARY OF FINDINGS: APPENDIX

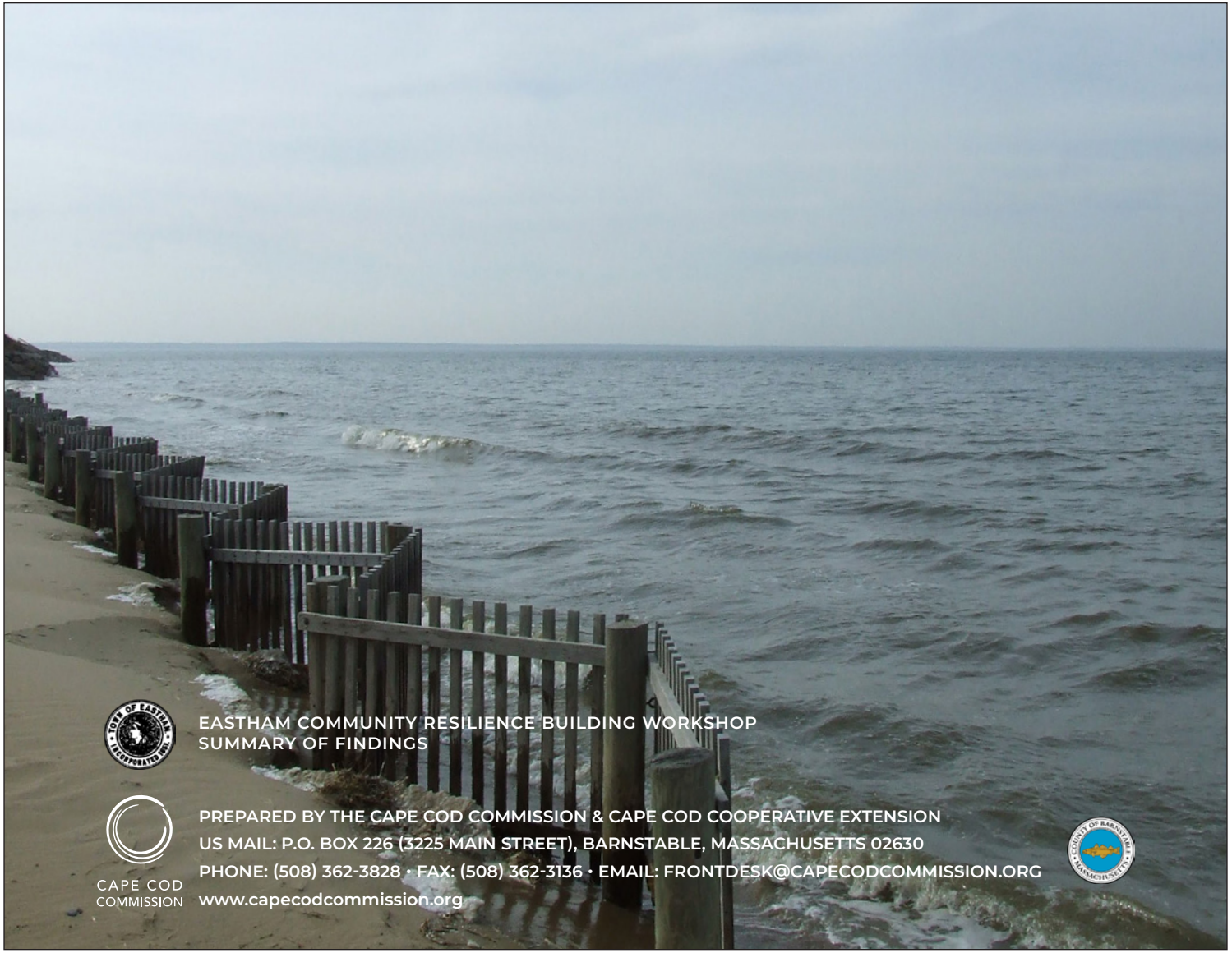
MVP Summary of Findings

EASTHAM COMMUNITY RESILIENCE BUILDING WORKSHOP



MVP STORYMAP (available at https://arcg.is/1CX4K9)

MVP Summary of Findings



Notices to Neighboring Towns

From: Paul Lagg
To: "gmeservey@town.orleans.ma.us"
Subject: Eastham Draft Hazard Mitigation Plan

Hi George:
Eastham has completed its Draft Hazard Mitigation Plan. Compliance with FEMA's process requires participation from neighboring communities. I am sending you (as representative for the Town of Orleans) the project link where the draft plan is posted for public review and comment.

I would appreciate any feedback you may have on the draft plan.

https://easthammvp.weebly.com/

Thank you,
Paul

Paul Lagg
Town Planner
TOWN OF EASTHAM
2500 State Highway Eastham, MA 02642
508.240.5900 Ext. 3228
plagg@eastham-ma.gov

From: Paul Lagg
To: mike.trovato@wellfleet-ma.gov
Subject: Eastham Hazard Mitigation Plan

Hi Mike
Eastham has completed its Draft Hazard Mitigation Plan. Compliance with FEMA's process requires participation from neighboring communities. I am sending you (as representative for the Town of Wellfleet) the project link where the draft plan is posted for public review and comment.

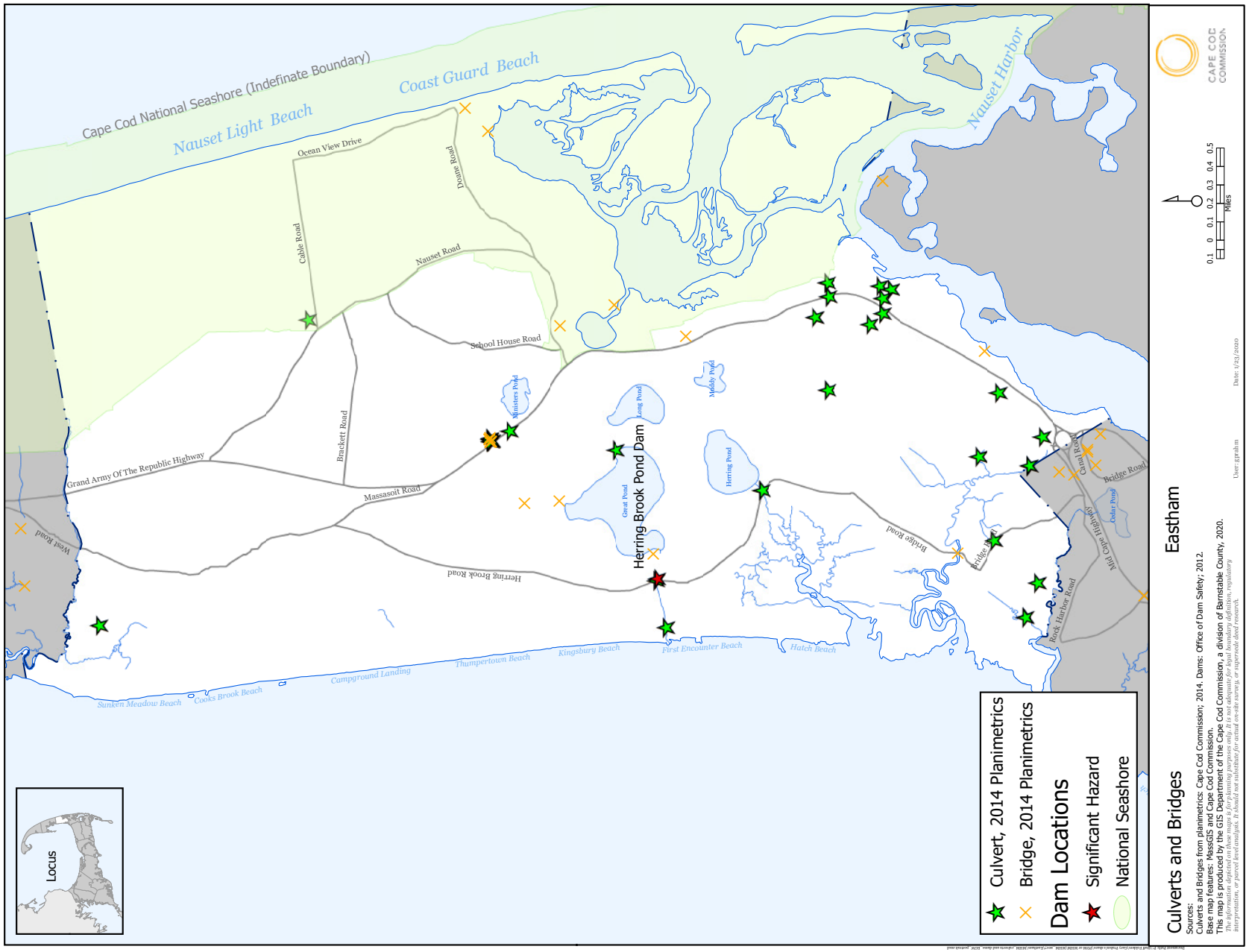
I would appreciate any feedback you may have on the draft plan.

https://easthammvp.weebly.com/

Thank you,
Paul

Paul Lagg
Town Planner
TOWN OF EASTHAM
2500 State Highway Eastham, MA 02642
508.240.5900 Ext. 3228
plagg@eastham-ma.gov

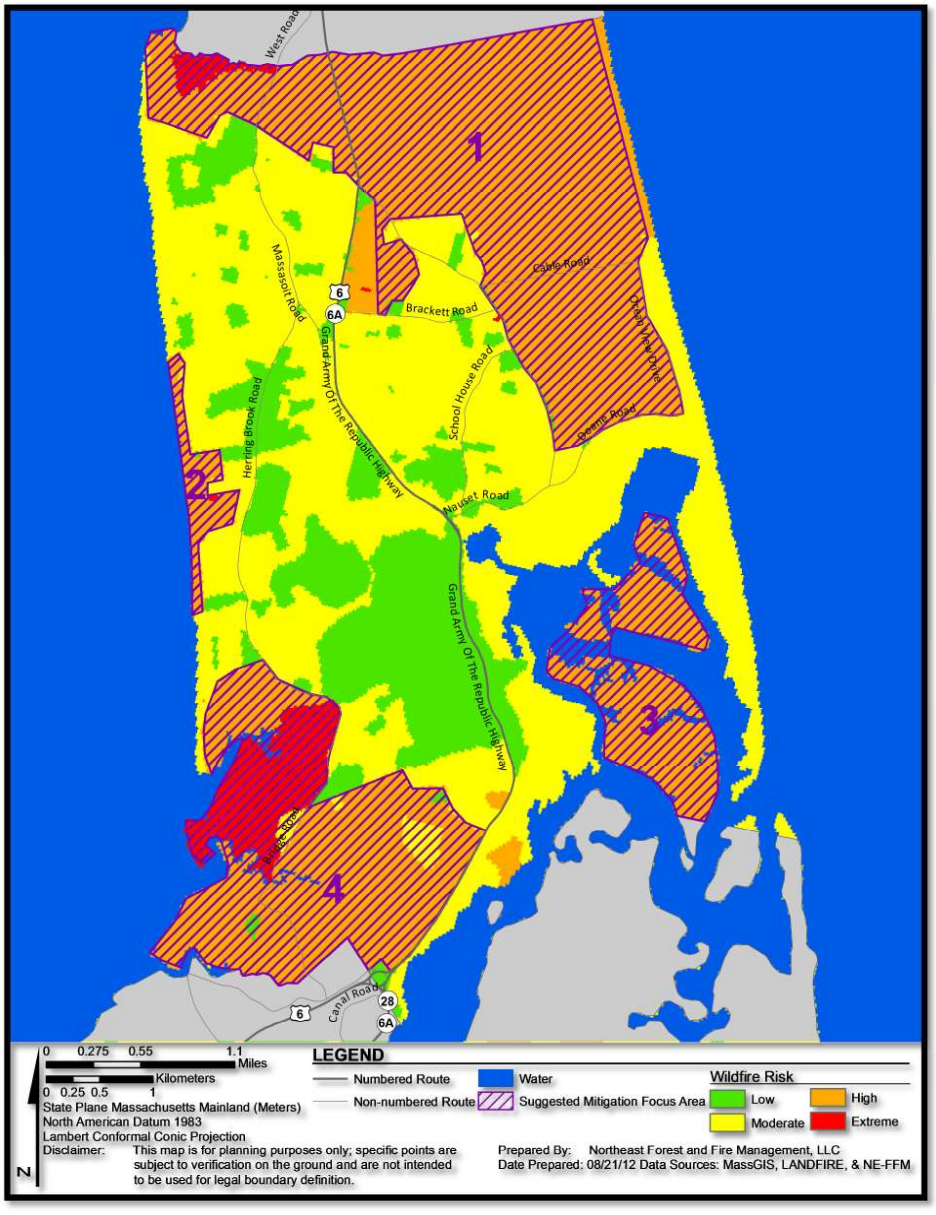
Select Maps


Cape Cod National Seashore (Indefinate Boundary)
Nauset Light Beach
Coast Guard Beach
Nauset Harbor
Ocean View Drive
Doane Road
Cable Road
Nauset Road
School House Road
Brackett Road
Grand Army Of The Republic Highway
Massasoit Road
Herring Brook Road
West Road
Herring Brook Pond Dam
Ministers Pond
Long Pond
Middy Pond
Great Pond
Herring Pond
Canal Road
Bridge Road
Bridge Road
Rock Harbor Road
Main Gate Highway
Cedar Pond
Sunken Meadow Beach
Cooks Brook Beach
Campground Landing
Thumpertown Beach
Kingsbury Beach
First Encounter Beach
Hatch Beach
Locus
Culvert, 2014 Planimetrics
Bridge, 2014 Planimetrics
Dam Locations
Significant Hazard
National Seashore
Culverts and Bridges
Eastham
CAPE COD COMMISSION
0.1 0 0.1 0.2 0.3 0.4 0.5
Miles
Date: 1/23/2020
User: gjrahim
Sources:
Culverts and Bridges from planimetrics: Cape Cod Commission; 2014. Dams: Office of Dam Safety; 2012.
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2020.
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretations or project level analysis. It should not substitute for actual on-the-ground surveys.

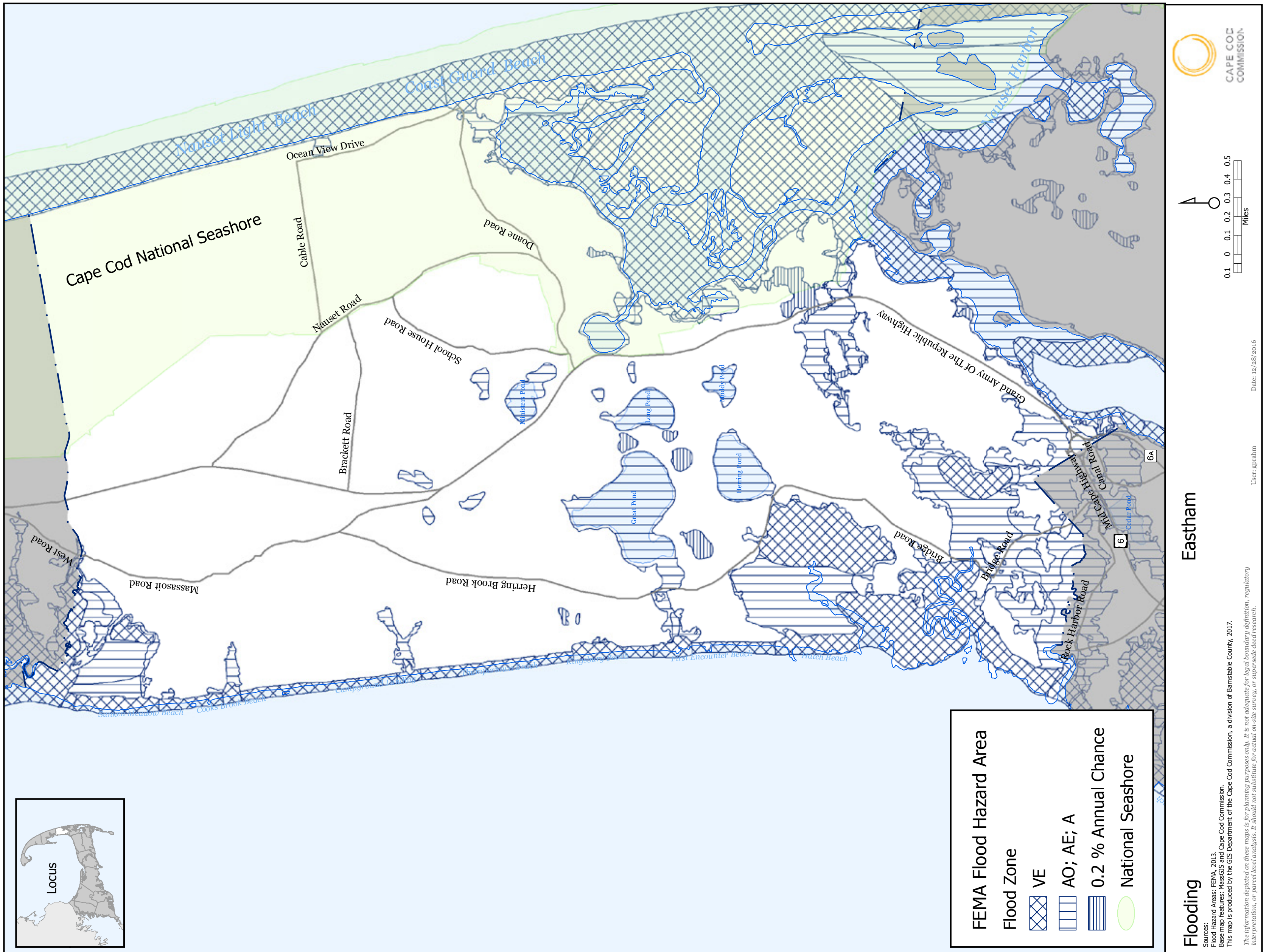
BARNSTABLE COUNTY WILDFIRE PREPAREDNESS PLAN
Community Wildfire Protection Plan

Town of Eastham

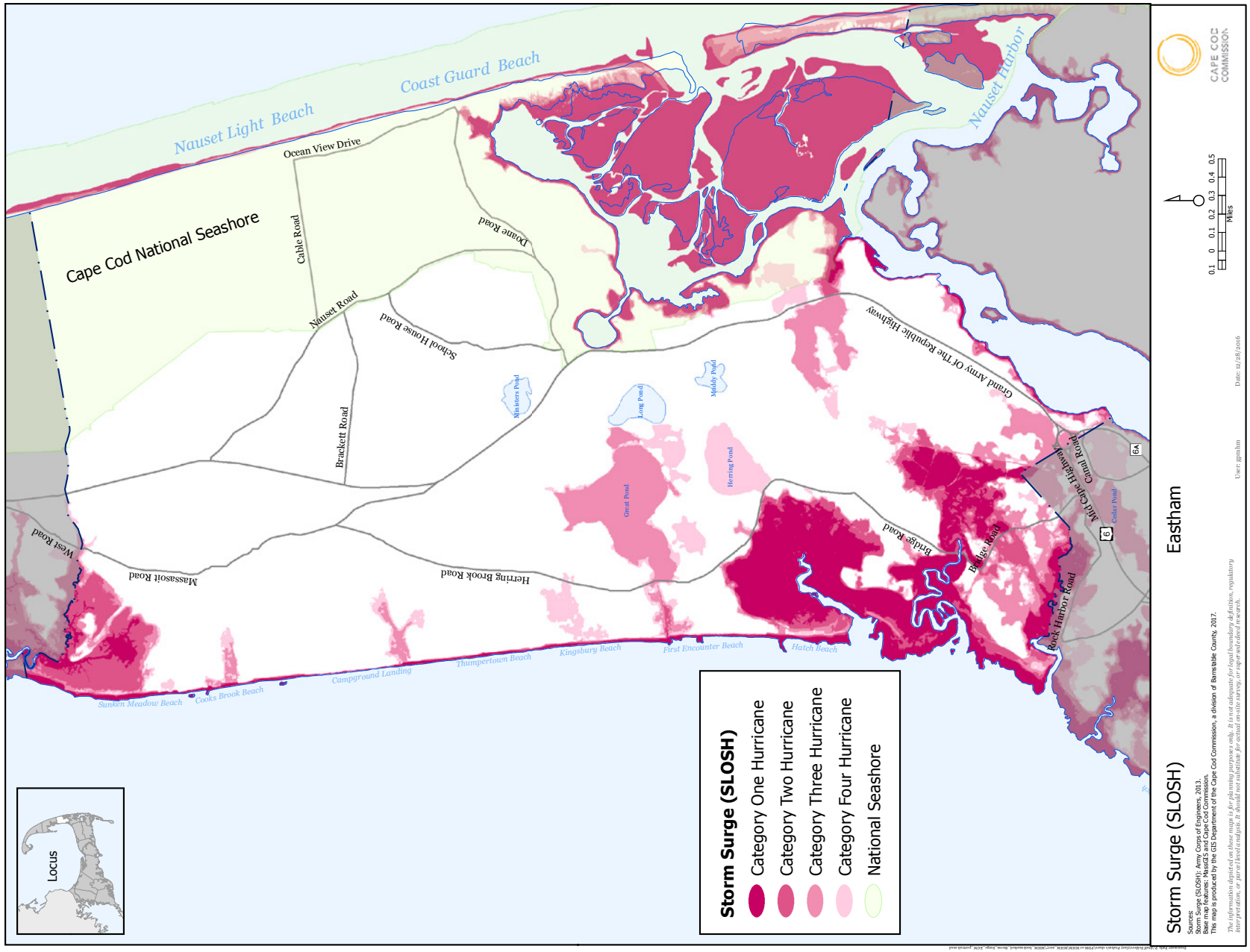
TOWN OF EASTHAM WILDFIRE RISK MAP



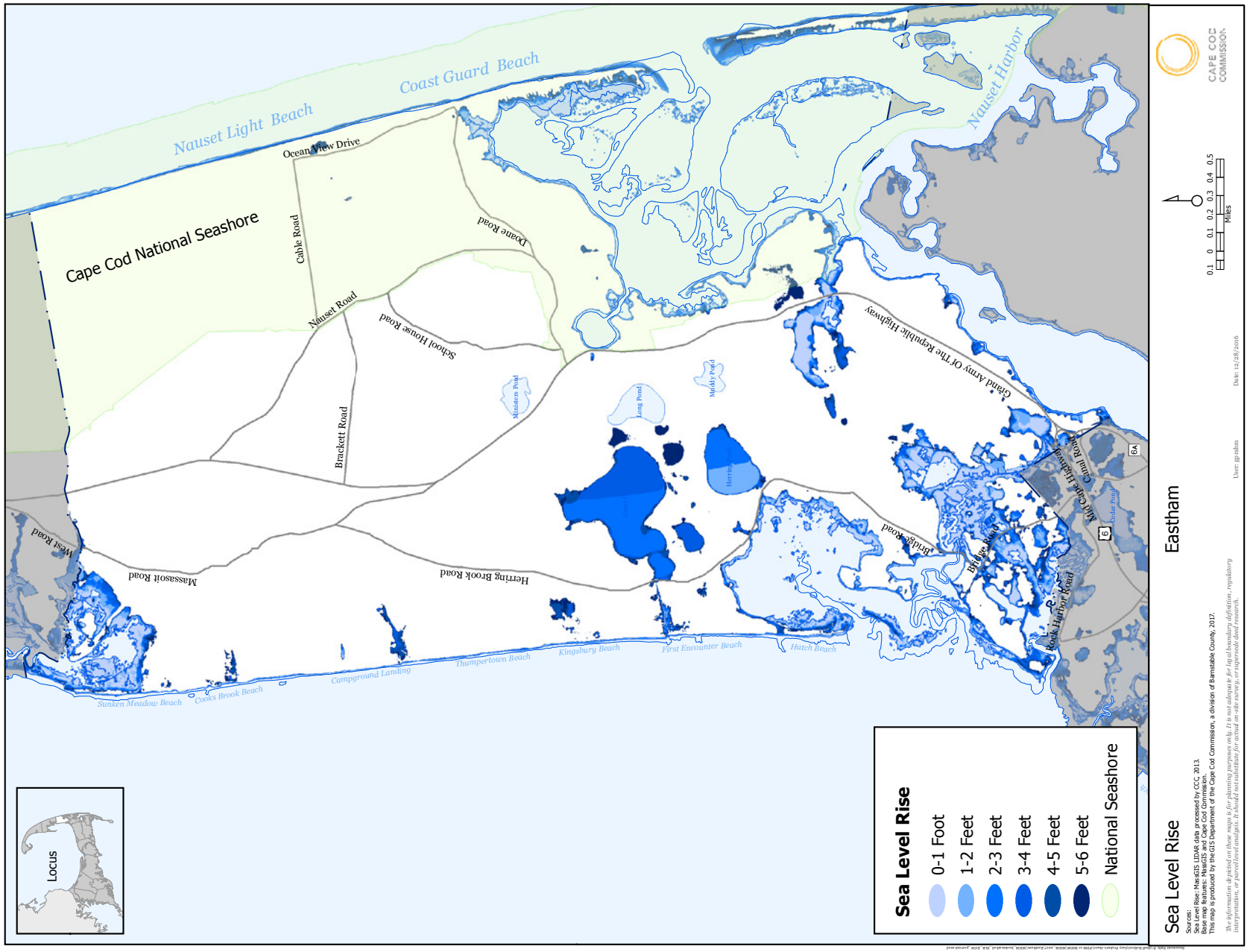
Select Maps


Flooding
Eastham
FEMA Flood Hazard Area
Flood Zone
VE
AO; AE; A
0.2 % Annual Chance
National Seashore
Locus
Miles
CAPE COD COMMISSION
Cape Cod National Seashore
Nauset Light Beach
Coast Guard Beach
Nauset Harbor
Ocean View Drive
Cable Road
Doane Road
Nauset Road
School House Road
Brackett Road
Grand Army Of The Republic Highway
West Road
Massasoit Road
Herring Brook Road
Bridge Road
Rock Harbor Road
Canal Road
Mid Cape Highway
Sources:
Flood Hazard Areas: FEMA, 2013.
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2017.

Select Maps


Nauset Light Beach
Coast Guard Beach
Nauset Harbor
Ocean View Drive
Cape Cod National Seashore
Cable Road
Doane Road
Nauset Road
School House Road
Brackett Road
Grand Army Of The Republic Highway
Mid Cape Highway
Canal Road
Bridge Road
Rock Harbor Road
Meeting House Road
Massasoit Road
West Road
Sunken Meadow Beach
Cooks Brook Beach
Campground Landing
Thumpertown Beach
Kingsbury Beach
First Encounter Beach
Hatch Beach
Ministers Pond
Long Pond
Middy Pond
Herring Pond
Great Pond
Cedar Pond
Locus
Storm Surge (SLOSH)
Category One Hurricane
Category Two Hurricane
Category Three Hurricane
Category Four Hurricane
National Seashore
Eastham
Storm Surge (SLOSH)
Miles
CAPE COD COMMISSION

Select Maps


Nauset Light Beach
Coast Guard Beach
Nauset Harbor
Ocean View Drive
Cape Cod National Seashore
Cable Road
Doane Road
Nauset Road
School House Road
Brackett Road
Minister Pond
Long Pond
Muddy Pond
Herring Pond
Grand Army Of The Republic Highway
Mid Cape Highway
Cedar Pond
Canal Road
Bridge Road
Rock Harbor Road
West Road
Massasoit Road
Herring Brook Road
Sunken Meadow Beach
Cooks Brook Beach
Campground Landing
Thumpertown Beach
Kingsbury Beach
First Encounter Beach
Hatch Beach
Locus
Sea Level Rise
0-1 Foot
1-2 Feet
2-3 Feet
3-4 Feet
4-5 Feet
5-6 Feet
National Seashore
CAPE COD COMMISSION
0.1 0 0.1 0.2 0.3 0.4 0.5
Miles
Eastham
Sea Level Rise
Sources:
Sea Level Rise: MassGIS LIDAR data processed by CCC, 2013.
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2017.
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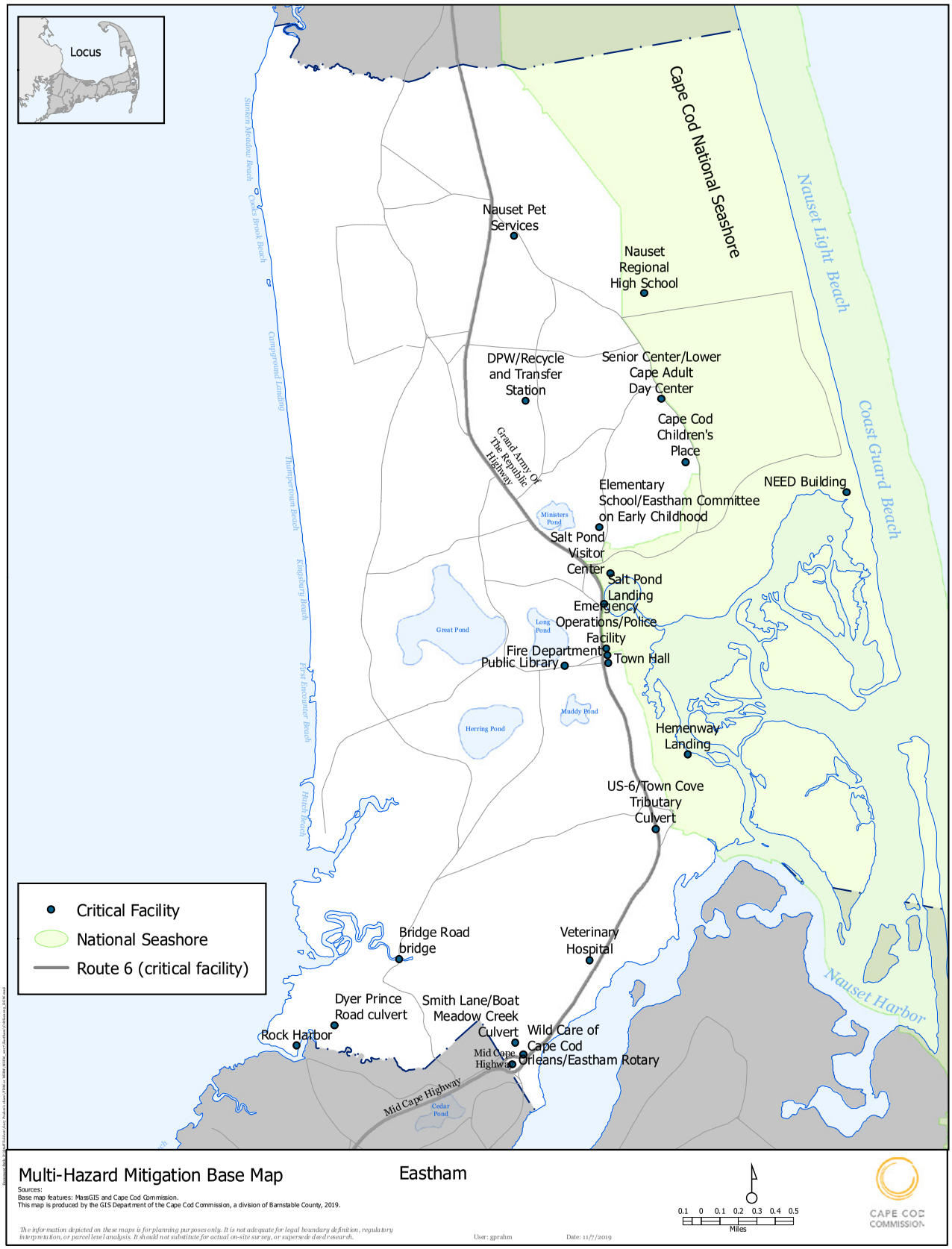
Date: 12/28/2016
User: gmahn


Locus
Cape Cod National Seashore
Nauset Light Beach
Coast Guard Beach
Nauset Harbor
Nauset Pet Services
Nauset Regional High School
DPW/Recycle and Transfer Station
Senior Center/Lower Cape Adult Day Center
Cape Cod Children's Place
NEED Building
Elementary School/Eastham Committee on Early Childhood
Grand Army Of The Republic Highway
Ministers Pond
Salt Pond Visitor Center
Salt Pond Landing
Emergency Operations/Police Facility
Fire Department
Public Library
Town Hall
Great Pond
Long Pond
Muddy Pond
Herring Pond
Hemenway Landing
US-6/Town Cove Tributary Culvert
Bridge Road bridge
Veterinary Hospital
Dyer Prince Road culvert
Smith Lane/Boat Meadow Creek Culvert
Rock Harbor
Wild Care of Cape Cod
Orleans/Eastham Rotary
Mid Cape Highway
Cedar Pond
Stockton Breakwater Beach
Cooks Brook Beach
Campground Landing
Thumpertown Beach
Kingsbury Beach
First Encounter Beach
Hatch Beach
Critical Facility
National Seashore
Route 6 (critical facility)
Multi-Hazard Mitigation Base Map
Eastham
Sources:
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2019.
The information depicted on these maps is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analysis. It should not substitute for actual on-site survey, or supersede deed research.
User: gprahm
Date: 11/7/2019
0.1 0 0.1 0.2 0.3 0.4 0.5
Miles
CAPE COD COMMISSION

Eastham Hazard Mitigation Plan, 2020

Prepared by the Cape Cod Commission
US Mail: P.O. Box 226 (3225 Main Street), Barnstable, Massachusetts 02630
Phone: (508) 362-3828 • Fax: (508) 362-3136 • Email: frontdesk@capecodcommission.org
Web Site: www.capecodcommission.org