

YARMOUTH

2017 Hazard Mitigation Plan





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Introduction

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 to reducing loss in a community is to have a plan for the future. To accomplish this task, most communities develop a local Hazard Mitigation Plan, also known as a single jurisdiction Hazard Mitigation plan. It is drafted and reviewed by town officials and residents and then approved by the Massachusetts Emergency Management Agency (MEMA) and by the Federal Emergency Management Agency (FEMA).

The purpose of the Yarmouth Hazard Mitigation Plan is to minimize damages resulting from natural hazards by implementing sustained actions to reduce or eliminate long-term risk to human life and property from hazards. The Yarmouth Hazard Mitigation Plan is also about building 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 to create a resilient town that can recover after a storm event. Over the last several months, town staff and the residents of Yarmouth have worked diligently to meet the FEMA requirements for developing a new single jurisdiction hazard plan while maintaining the character and individuality of Yarmouth.

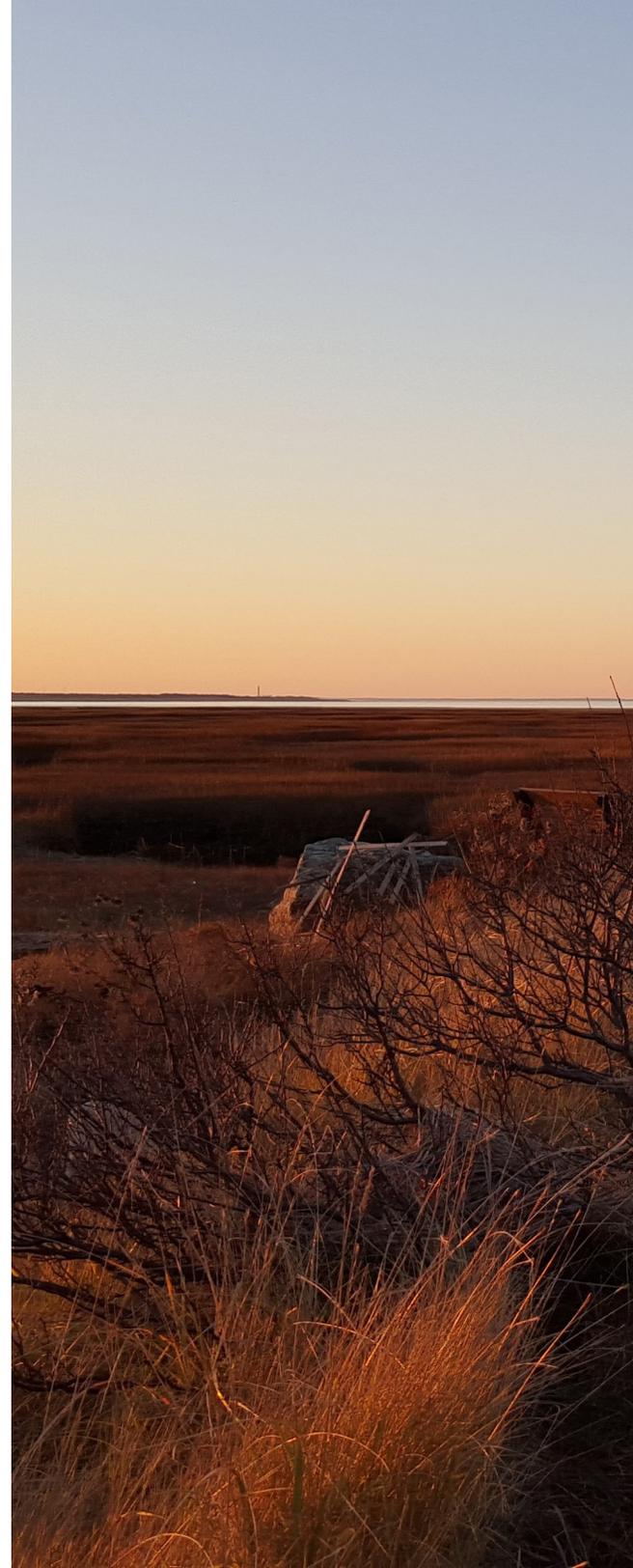
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It is important to note that if and when the 2017 Yarmouth Hazard Mitigation Plan is approved by FEMA and adopted by the Board of Selectman, the town becomes eligible to receive funding from FEMA's Hazard Mitigation Assistance (HMA) program, which 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 Yarmouth Hazard Mitigation Plan. When text in the Yarmouth Hazard Mitigation Plan 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 is a narrative on the hazard planning team and the outreach process used to develop the 2017 Yarmouth Hazard Mitigation Plan.**

Planning Team

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Planning Team

A1d

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 to implement the action items in the plan. Several staff members from the Cape Cod Commission provided technical support to the Planning Team. **Table 1.1** lists the names, titles and affiliations of the Yarmouth Hazard Mitigation Planning Team.

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Name	Title	Affiliation
Jeff Colby	Director	Department of Public Works
Frank Frederickson	Chief	Police Department
Kelly Grant	Conservation Administrator	Community Development
Rick Kelley	Highway Superintendent	Department of Public Works
Bruce Murphy	Director	Health Department
Philip Simonian	Chief	Fire Department
Karl von Hone	Director	Natural Resources
Kathy Williams	Planner	Community Development
Cally Harper (through 1/2017)	Planner	Cape Cod Commission
Chloe Schaefer (starting 2/2017)	Planner	Cape Cod Commission
Gary Prahm	GIS Analyst	Cape Cod Commission

Table 1.1 | Yarmouth Hazard Mitigation Planning Team

This core group was responsible for developing and reviewing drafts of the plan, creating the mitigation strategy, and submitting the plan for adoption by the Federal Emergency Management Agency (FEMA) and the Yarmouth Board of Selectman. **Table 1.2** outlines the responsibilities of each member of the Planning Team.

Meeting Schedule and Involvement

The Planning Team worked collaboratively in large and small group meetings over an extended period of time starting in 2013. The full team met five times in 2013 and 2014 to develop the backbone of much of the plan. However, for various reasons, the effort was placed on hold until 2016. Beginning in August 2016, the Planning Team met every few months to develop, refine, and update draft sections of the hazard plan.

Conservation Administrator	Identification of existing educational materials, assisted in identification of vulnerabilities and input on mitigation actions
Planner	Assisted with public outreach strategy, identification of critical facilities and vulnerabilities, and input on mitigation actions
Police Chief	Provided data on hazard impacts and vulnerabilities, information on existing capabilities, identification of critical facilities, and input on mitigation actions
Fire Chief	Provided data on hazard impacts and vulnerabilities, information on existing capabilities and previous hazard events, identification of critical facilities, and input on mitigation actions
Public Works	Identification of critical facilities (including transportation and municipal infrastructure), information on existing capabilities, information on previous hazard events, input on mitigation actions
Health Director	Input on mitigation actions
Natural Resources	Identification of existing educational materials, provided data on hazard impacts and vulnerabilities, information on existing capabilities, identification of critical facilities, and input on mitigation actions
Planners, Cape Cod Commission	Facilitated group meetings with the Planning Team; coordinated the development of the hazard plan
GIS Analyst, Cape Cod Commission	Prepared maps for the town hazard plan; used GIS software to conduct a risk assessment for the town

Table 1.2 | Planning Team Responsibilities

Outreach Strategy

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

- **August 1, 2016:** identification of critical facilities, definition of a hazard profile, discussion of draft hazard maps and discussion of the relevance and future probability of natural hazards in town, review public survey and outreach strategy
- **September 12, 2016:** hazard profiles to identify vulnerable areas in Yarmouth, develop new Mitigation Goals and Actions for the 2017 Yarmouth Hazard Mitigation Plan; developed capabilities assessment, review draft of public survey questions
- **January 12, 2017:** review of public survey results and draft mitigation goals and actions for the 2017 Yarmouth Hazard Mitigation Plan

For a list of meeting attendees, see “Team Meeting Attendance Sheet” in **Appendix 1**.

There were several instances where the expertise of only a few team members was required for a specific task in the Yarmouth Hazard Mitigation Plan. Therefore, small group meetings were also held from July to September 2016 with the Planner, Department of Natural Resources, Fire Chief, Police Chief, and/or Department of Public Works.

Outreach Strategy

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With the Public

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The public was engaged at two different times during the planning process: during plan development and just prior to submission of the draft plan for MEMA/FEMA review.

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During Plan Development

The Planning Team developed an online survey to gather data on the significance/relevance to Yarmouth of the natural hazards identified in the Massachusetts State Hazard Plan, the impact of those significant natural hazards, and preparedness efforts in Yarmouth. The survey also gathered data on how residents would like to be engaged in the future. The survey was launched on September 30, 2016 and the public was given at least three weeks to fill out the survey. A link to the survey was available to residents and to the people who work in Yarmouth via the main page of the town website. Individual notifications of the survey’s availability was also given to various Boards and Committees, as well as a number of local civic groups and the Chamber of Commerce. A notice was also posted on the popular Yarmouth Police Facebook page and Channel 18 local access station. The Planning Team received 174 responses to the public survey. For a copy of the survey,

see “Public Survey on Hazard Mitigation” in **Appendix 1**. Documentation for the launch of the survey can be found in the “Survey Documentation” section of **Appendix 1**.

The comments and responses to the online survey were reviewed by strategic Planning Team members during an in-person meeting held on 2017 and with the Planning Team on January 12, 2017. The Planning Team incorporated this public input into the plan in the following ways:

- The public was asked to identify specific hazards they experienced or are most concerned about while living or working in Yarmouth. They were presented with the 11 hazards identified in the Massachusetts State Hazard Plan and could select as many of these hazards as they wanted. These selections were used to determine whether or not a hazard is significant to the town (*see Column 3, Table 2.7*).
- The public was asked to identify steps that the local government could take to reduce risk from natural hazards and protect the buildings and people of Yarmouth. They were presented with a list of mitigation actions to reduce risk and loss and given the opportunity to suggest additional actions. These actions were incorporated into the mitigation actions

of the hazard plan. For example, the majority of respondents said the Town should improve notification and communications systems during emergencies, improve drainage on area roads, continue to work with regional partners to prepare for and recover from natural disasters, and remove debris and hazardous materials on town property, so these were incorporated into the mitigation actions.

Prior to Submission to MEMA/FEMA

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For more than three weeks, the Yarmouth Hazard Mitigation Plan was available to the public for written comments. Notices for public comment were posted on the Town website, the Yarmouth Police Facebook page, the local newspaper, and noted on Channel 18 public access TV (see the Appendix). Notifications were also provided to the Yarmouth Chamber of Commerce, a variety of Town Committees and Boards, and active local civic groups for distribution to their members. Respondents to the previous survey who expressed an interest in staying up to date on hazard planning in Yarmouth and who provided an email address were emailed directly inviting them to review and comment on the draft plan. Following this comment period, the Yarmouth Hazard Mitigation Plan was presented at the Board of Selectmen’s meeting on July 25, 2017. During the Board of Selectmen’s meeting, the public also had

Outreach Strategy

the opportunity to provide verbal comments. Below is a summary of comments received from the public and how they were addressed.

- Cathy Taylor, a Yarmouth Resident, expressed concern that people with disabilities were not specifically identified in the vulnerable populations sections for all hazards and for Mitigation Action #8. The appropriate vulnerable population sections were updated to include people with disabilities and a statement about accessible transportation was added to Mitigation Action #8.
- Dan Hamilton, a Yarmouth Resident, asked for clarification regarding the wildfire mitigation focus areas, and also suggested that just because a waterfront property has a high assessed value does not mean the owner has sufficient funds to privately mitigate natural hazard damage to these properties. Language in response to both of these comments was added to the appropriate sections of the plans.
- Dennis Cryan, commented that his main concern is what to do following a problem with the Pilgrim Nuclear Power Plant. The Town follows Barnstable County Emergency Planning Committee suggestions for responses to such a hazard. Requiring educational information for responding to such an emergency was included in Mitigation Action #2.

With Stakeholders

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

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

1. Stakeholders were identified by the Planning Team
2. The Planning Team designed a strategy to engage and gather input from stakeholders
3. Stakeholders were given opportunities to provide input during the planning process by taking the survey and providing comments on a completed draft of the Plan

Identification of Stakeholders

Members of the Planning Team identified stakeholders and staff at the Cape Cod Commission assisted in identifying stakeholders at the County, State, and Federal levels.

Outreach Strategy

Name	Affiliation
Town Administrator	Chairman, Yarmouth Affordable Housing Trust (AHT)
Dr. Hillard Boskey	Chair, Yarmouth Board of Health
Mary Vilbon	Executive Director, Yarmouth Chamber of Commerce
Peter Smith	Chairman, Yarmouth Community Economic and Development Committee (CEDC)
Nate Small	Chairman, Yarmouth Community Housing Committee (CHC)
Gary Ellis	Chairman, Yarmouth Community Preservation Committee (CPC)
Rick Bishop	Chairman, Yarmouth Conservation Commission
Norm Weare	Chairman, Yarmouth Planning Board
Steve DeYoung	Chairman, Yarmouth Zoning Board of Appeals
Tom Roche Sr.	President, Bass River Civic Association

Table 1.3 | Stakeholders for the Yarmouth Hazard Mitigation Plan

Stakeholders included employees and volunteers from many different organizations and groups in Yarmouth and across Cape Cod, including:

- Yarmouth Affordable Housing Trust
- Yarmouth Board of Health
- Yarmouth Chamber of Commerce

Name	Affiliation
Chris Greeley	Member, Lewis Bay Group
Linda Bolliger	Member, Past President, Hyannis Park Civic Association
Gail Staff	Member, Past President, South Yarmouth Association
Phil Simonian	Co-Chairman, Barnstable County Regional Emergency Planning Committee (BCREPC)
Sean O'Brien	Interim Director, Barnstable County Health and Environment
Michael Maguire	Director, Cape Cod Cooperative Extension
Jennifer Gardner	Animal Rescue Program Officer, Disaster Response, International Fund for Animal Welfare
Kristen Patchett	Stranding Coordinator, Marine Mammal Rescue and Research, International Fund for Animal Welfare

- Yarmouth Community & Economic Development Committee
- Yarmouth Community Housing Committee
- Yarmouth Community Preservation Committee
- Yarmouth Conservation Commission
- Yarmouth Planning Board

Outreach Strategy

- Yarmouth Zoning Board of Appeals
- Bass River Civic Association
- Hyannis Park Civic Association
- Lewis Bay Group (Civic Association)
- South Yarmouth Association (Civic Association)
- Barnstable County Regional Emergency Planning Committee
- Barnstable County Health and Environment
- Cape Cod Cooperative Extension
- International Fund for Animal Welfare (IFAW)

Table 1.3 is a list of individuals from these organizations who were contacted for input during the development and review of the 2017 Yarmouth Hazard Mitigation Plan.

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Stakeholder Participation

Stakeholders were engaged twice during the planning process – once during plan development and again just prior to submission of the draft plan to MEMA and FEMA.

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During plan development, stakeholders were invited to complete an online survey (to view the survey, see “Public Survey on Hazard Mitigation” in **Appendix 1**).

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Through the survey, stakeholders could:

- Provide data on whether or not specific hazards were significant to the town (**See Table 2.7**)
- Identify problem areas in town and specific projects that they wanted to see implemented and those actions were incorporated into the Mitigation Actions of the Hazard Plan

Prior to plan submission, the Planning Team distributed a draft of the 2017 Yarmouth Hazard Mitigation Plan to the stakeholder group. Below is a summary of the comments received from identified stakeholders.

- A member of the Yarmouth Conservation Commission felt that the level of involvement of town residents in the planning process needed clarification. The plan was modified to better describe this process.
- Shannon Jarbeau, CRS Coordinator for the Cape Cod Cooperative Extension, asked for clarification about the public comment process and the repetitive loss properties, and provided further information on the impact of flooding on buildings and some of the mitigation action items; these comments were incorporated into the plan.

With Neighboring Communities

Neighboring communities were given the opportunity to participate in the planning process during the Barnstable County Regional Emergency Planning Committee’s monthly meetings.

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Barnstable County Regional Emergency Planning Committee (BCREPC)

The Planning Team gathered input from towns across Cape Cod during the March 2, 2016 meeting of the Barnstable County Regional Emergency Planning Committee. During the meeting, Cally Harper, Planner at the Cape Cod Commission, informed the committee that several towns on Cape Cod, including Yarmouth, are updating their hazard plans and asked committee members to comment on the history and impact of specific hazards on Cape Cod and their level of concern for future hazard events. The presentation and survey results are located in the “BCREPC Presentation” and “BCREPC survey results” section in **Appendix 1**.

The process for incorporating input from the BCREPC meeting into the hazard plan was as follows:

1. The Police Chief and Planner from the Cape Cod Commission reviewed the impact and probability ranking and the comments from the BCREPC meeting
2. Those rankings and comments were incorporated into the plan and used to determine whether or not a hazard is significant to the town (*see Column 3, Table 2.1*).

Continuing Outreach Efforts During Plan Maintenance

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Once the 2017 Yarmouth Hazard Mitigation Plan is approved by MEMA and FEMA, it will be forwarded to the Yarmouth Board of Selectmen for adoption. Once adopted, the 2017 Yarmouth Hazard Mitigation Plan enters into the “Maintenance Period” and will be active for five years. During this maintenance period, FEMA requires the Planning Team to continue engaging with the public.

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

A5a

- **Online surveys** to gather data on whether or not Yarmouth residents are prepared for nor’easters, hurricanes, and severe winter weather. These surveys will be posted on the Town website and on the Police Department’s Facebook page.
- **Presentations** to school and community groups about the science of hazards and/or how to prepare for specific weather events.

Incorporation with Other Town Plans and Reports

Incorporation with Other Town Plans and Reports

A4a

Technical Information Used in the Plan

The 2017 Yarmouth Hazard Mitigation Plan 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.

Below is a list of the resources from federal, state, and local agencies that were used and incorporated into the 2017 Yarmouth Hazard Mitigation Plan:

■ 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

Incorporation with Other Town Plans and Reports

- 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
 - 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

Incorporation with Other Town Plans and Reports

■ Technical Information from Yarmouth:

- Yarmouth Local Comprehensive Plan (1997-2015) prepared by the Town of Yarmouth
- Town of Yarmouth Zoning Bylaws
- Town of Yarmouth Wetland Protection Regulations
- Town of Yarmouth Conservation Commission Stormwater Management Regulations
- Yarmouth Waterways Management Plan (2006)
- Town of Yarmouth Open Space and Recreation Plan (2015)

- 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
- Yarmouth specific documents were used to:
 - ensure that mitigation actions in the 2017 plan were consistent with current activities and plans already in place in Yarmouth
 - provide technical data for the hazard profiles, risk assessment, and mitigation actions

A4b

How Technical Information was Incorporated

The technical information listed above was incorporated into the 2017 Yarmouth Hazard Mitigation Plan in the following ways:

- Federal documents, especially all 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

Integrating the Hazard Plan into other Town Plans

C6

The mitigation goals and objectives identified in the 2017 Yarmouth Hazard Mitigation Plan will be incorporated into the objectives and policies of the Yarmouth Local Comprehensive Plan (LCP).

- **Yarmouth Local Comprehensive Plan:** The update process for the LCP is currently in progress. The Yarmouth LCP describes 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, objectives, and actions will be incorporated in the Natural Resources and Open Space and Recreation sections of the LCP. Below are a few examples of Mitigation Goals that will be integrated in the update of the Yarmouth LCP:

- Reduce the potential for loss of life, property, infrastructure, environmental, cultural, and economic resources in Yarmouth from natural disasters
- Mitigate repetitive damage caused by natural hazard events
- Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Yarmouth

C6

New FEMA guidance requires that the 2017 Yarmouth Hazard Mitigation Plan describes how the plan was integrated with other plans over the last five years. Because this is a new requirement, Yarmouth does not have a process in place to collect such information. Going forward, Yarmouth will keep a running list of the new and updated town plans on their website and the Town Planner will be responsible for ensuring that town planning efforts are consistent with the 2017 Yarmouth Hazard Mitigation Plan.

Contents of Chapter 1 Appendix

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Contents in the Chapter 1 Appendix include:

- Meeting Attendance
- Public Survey
- Public Survey Results
- Public Survey Notices
- Draft Plan Comment Website
- Draft Plan Comment Notices
- Barnstable County Regional Emergency Planning Committee (BCREPC) Meeting Notes (March 2, 2016)
- BCREPC Presentation (March 2, 2016)
- BCREPC Survey Results

Natural Hazards

CHAPTER TWO

Yarmouth is vulnerable to a wide 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. Yarmouth has included an assessment of natural hazards only in the 2017 Yarmouth Hazard Mitigation Plan. **Chapter 2 provides a detailed description of the natural hazards that could impact Yarmouth in the future or have impacted Yarmouth in the past.**

Hazard Identification

Hazard Identification

State Hazards

The 2013 Massachusetts State Hazard Plan identifies 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
- 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 Yarmouth

As suggested under FEMA planning guidance, the Planning Team reviewed the full range of natural hazards identified in the 2013 Massachusetts State Hazard Plan and identified natural hazards that could impact Yarmouth in the future or that have impacted Yarmouth in the past (**Table 2.1**). This determination was made using local expertise from Planning Team members, input from the Barnstable County Regional Emergency Planning Committee, data from the 2013 Massachusetts State Hazard Plan, and other resources. All resources are referenced in the text of each hazard profile.

Larger versions of the maps of Yarmouth in this chapter are included in the Appendix.

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Hazard Identification

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Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Yarmouth?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Yarmouth?	Why was this determination made?
Coastal Erosion and Shoreline Change	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan 2015 Coastal Erosion Commission Draft Report Massachusetts Coastal Zone Management Storm Coasts application Local knowledge from Town Staff 	Yes	There is a history of erosion and shoreline change in Yarmouth
Dam (Culvert) Failure	No	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There are aging culverts in Yarmouth therefore increasing the probability of failure
Earthquake	No	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is no history of earthquakes in Yarmouth but there is a history of earthquakes in Massachusetts
Fire (Urban and Wildland)	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff www.capecodfd.com Barnstable County Wildfire Preparedness Plan 	Yes	Fire-adapted vegetation puts the town at risk for wildfire
Flood	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan FEMA 480 Local knowledge from Town Staff Newspaper articles 	Yes	There is a history of flooding in Yarmouth
Hurricane and Tropical Storms	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan National Hurricane Center Local knowledge from Town Staff 	Yes	There is a history of hurricanes and tropical storms in Yarmouth
Landslide	No	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	Loose soils and likelihood of flooding pose a risk for landslides

Table 2.1 | List of relevant natural hazards for Yarmouth

Hazard Identification

Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Yarmouth?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Yarmouth?	Why was this determination made?
Nor'easters	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a strong history of nor'easters in Yarmouth
High Winds	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a history of high winds in Yarmouth
Thunderstorms	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a history of thunderstorms in Yarmouth
Extreme Temperatures	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a history of extreme cold and hot temperatures in Yarmouth
Tornadoes	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is no history of tornadoes in Yarmouth, but there has been a water spout in Yarmouth in Lewis Bay and there have been tornado warnings in Barnstable County
Drought	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a history of drought in Barnstable County
Severe Winter Weather	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Yes	There is a history of severe winter weather in Yarmouth
Tsunami	No	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff 	Unknown	The probability of a damaging tsunami impacting Massachusetts is unknown
Sea Level Rise	Yes	<ul style="list-style-type: none"> 2013 Massachusetts Hazard Mitigation Plan Local knowledge from Town Staff Cape Cod Commission Sea Level Rise Viewer 	Yes	There is a history of sea level rise in Yarmouth

Table 2.1 | List of relevant natural hazards for Yarmouth (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.¹ 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, transportation, 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 at the Massachusetts Office of Coastal Zone Management (CZM), the ocean-facing shorelines of Massachusetts were delineated and statistically analyzed 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/>

Using the data from the Shoreline Change Project, the Planning Team concluded that the entire coastline of the planning area is vulnerable to shoreline change.

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

1 Massachusetts Coastal Erosion Commission Draft Report, January 2015

Hazard Profiles



Figure 2.1 | Historic shoreline change along the coast of Yarmouth. Map created using data from the Massachusetts Ocean Resource Information System.

B1c,
B2a,c

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.² 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 Massachusetts Coastal Erosion Commission's 2015 Draft Report³ states the average shoreline change rates for Yarmouth, where positive values indicate accretion and negative values indicate erosion, as the following:

■ Entire Town:

- Short-Term Rate: -0.8 ± 3.9 ft/year
- Long-Term Rate: -0.3 ± 1.3 ft/year

■ Cape Cod Bay Shoreline:

- Short-Term Rate: -8.7 ± 6.5 ft/year
- Long-Term Rate: -2.8 ± 1.9 ft/year

² Massachusetts State Hazard Plan, Coastal Erosion and Shoreline Change, 2013

³ Massachusetts Coastal Erosion Commission Draft Report, January 2015

■ Nantucket Sound Shoreline:

- Short-Term Rate: 0.3 ± 1.6 ft/year
- Long-Term Rate: 0.0 ± 0.8 ft/year

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

Impact

While erosion is a natural process, it causes damage to coastal property and related infrastructure—particularly when development is sited close to the shoreline in unstable or low-lying areas. Below is a list of possible damages that could result from shoreline change⁴:

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

⁴ Massachusetts Coastal Erosion Commission Draft Report, January 2015

B3a

Hazard Profiles

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, there could be loss of business function; damage to inventory; relocation costs; wage losses
- **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:** roadways can become damaged due to shoreline recession

Probability—Coastal Erosion and Shoreline Change

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, 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

⁵ Massachusetts State Hazard Mitigation Plan, 2013

failure is a catastrophic type of failure characterized by a sudden, rapid and uncontrolled release of impounded water.⁶

There are several dams in Yarmouth and culverts that could act like dams during flooding events (shown in **Figure 2.2** and **Figure 2.3**). Therefore the Planning Team decided to profile culvert failure in the Yarmouth Hazard Mitigation Plan. The text below focuses on the definition of culverts and how they fail.

A culvert is a structural opening under a roadway that allows water to pass from one side of a roadway to the other.^{7,8}

Water flowing under the road typically comes from two sources – streams and road runoff – and these water resources require different types of culverts⁹:

- 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. Typically, 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).¹⁰ 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. There are several reasons why culverts fail, including but not limited to¹¹:

- 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>)

6 Massachusetts State Hazard Mitigation Plan, 2013

7 Massachusetts Highway Department: Project Development and Design Guide 2006

8 http://water.epa.gov/polwaste/nps/urban/upload/2003_07_24_NPS_unpavedroads_ch3.pdf

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

10 http://water.epa.gov/polwaste/nps/urban/upload/2003_07_24_NPS_unpavedroads_ch3.pdf

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

Hazard Profiles

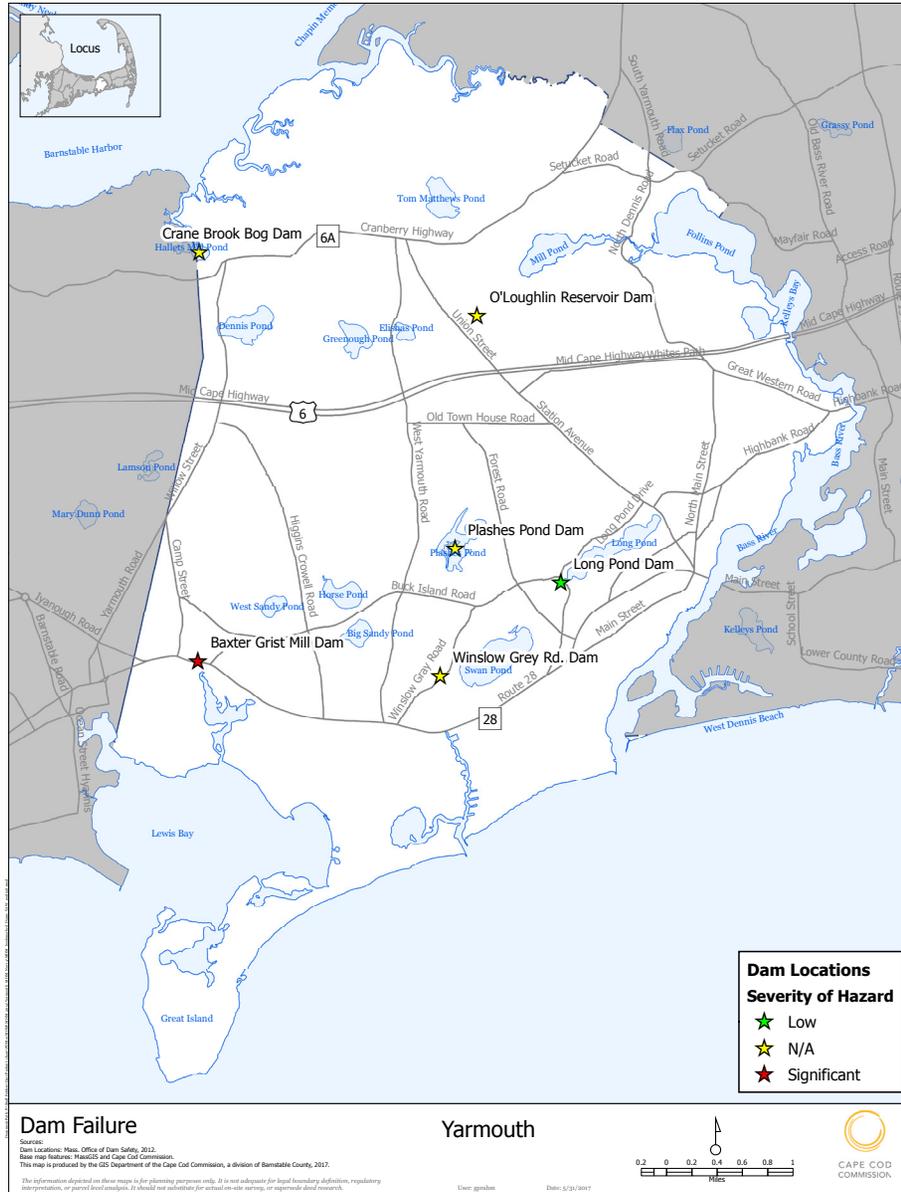


Figure 2.2 | Map of Yarmouth showing the locations of dams

Hazard Profiles

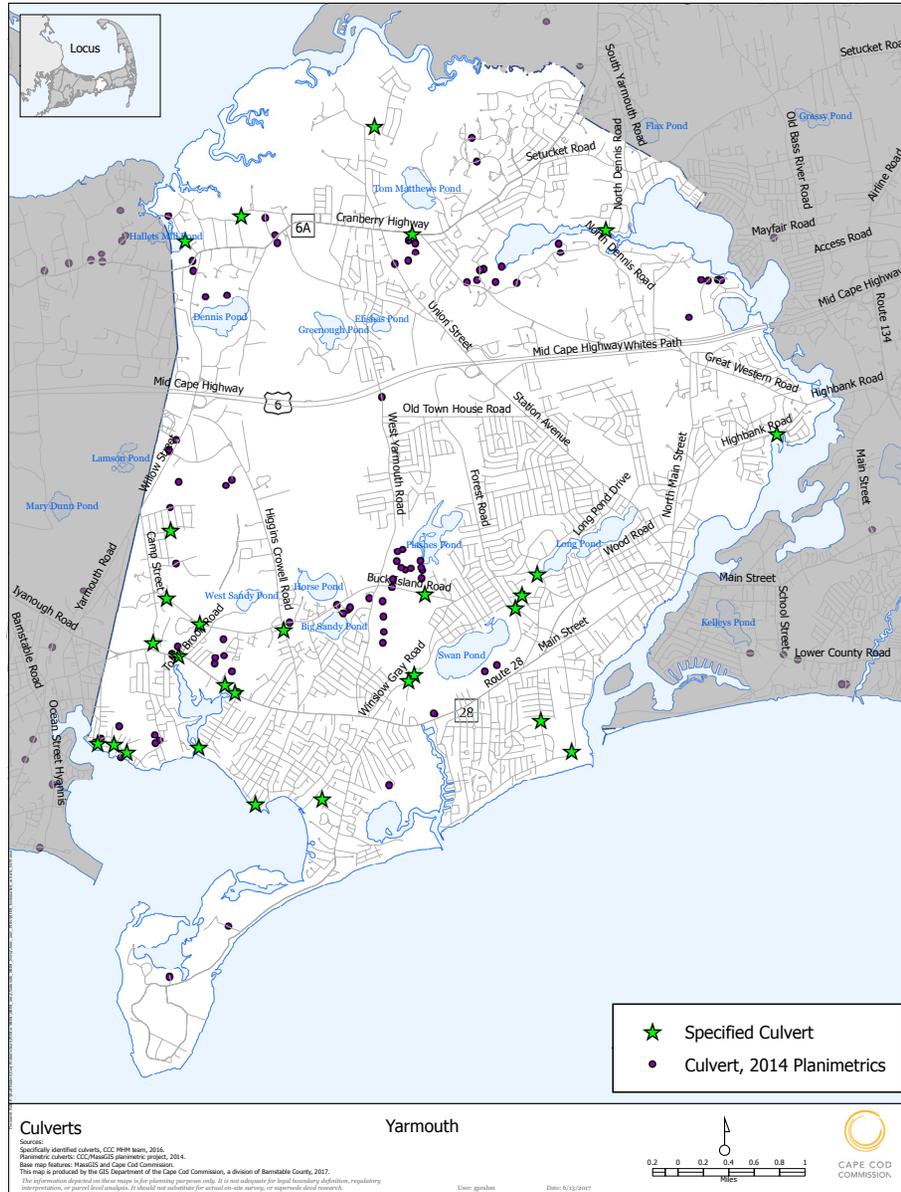


Figure 2.3 | Map of Yarmouth showing the locations of culverts

Hazard Profiles

- the pipe inside the culvert becomes obstructed because of debris or improper maintenance
- the pipe inside the culvert loses its structural integrity and begins to cave in
- 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.

B1c

Hazard Location

There are 6 dams (*Figure 2.2*) and 28 culverts in Yarmouth (locations shown in *Figure 2.3*).

B1c,
B2a,c

Previous Occurrences and Extent

There is no record of dam or culvert failure for the culverts mapped in Yarmouth.

Since Yarmouth has not experienced culvert failure, the following description of the extent of culvert failure is taken from events that occurred in the state of Vermont during Tropical Storm Irene.¹² In August of 2011, Tropical Storm Irene brought heavy precipitation to

¹² 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

New England and eastern New York. During Irene, the state of Vermont incurred damages to state and local infrastructure:

- 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.

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

B3a

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

Probability—Dam and Culvert Failure

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

Culvert age was used to make this probability determination.

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 to explain the causes of earthquakes but the theory of plate tectonics is commonly used to explain much of the earthquake activity in the world.¹³

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. Now the earth's surface 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.

¹³ Earthquake Causes and Characteristics, FEMA Emergency Management Institute Training Guide, <https://training.fema.gov/emiweb/is/is8a/is8a-unit3.pdf>

Hazard Profiles

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 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

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

B1c

Hazard Profiles

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 (sloped) 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

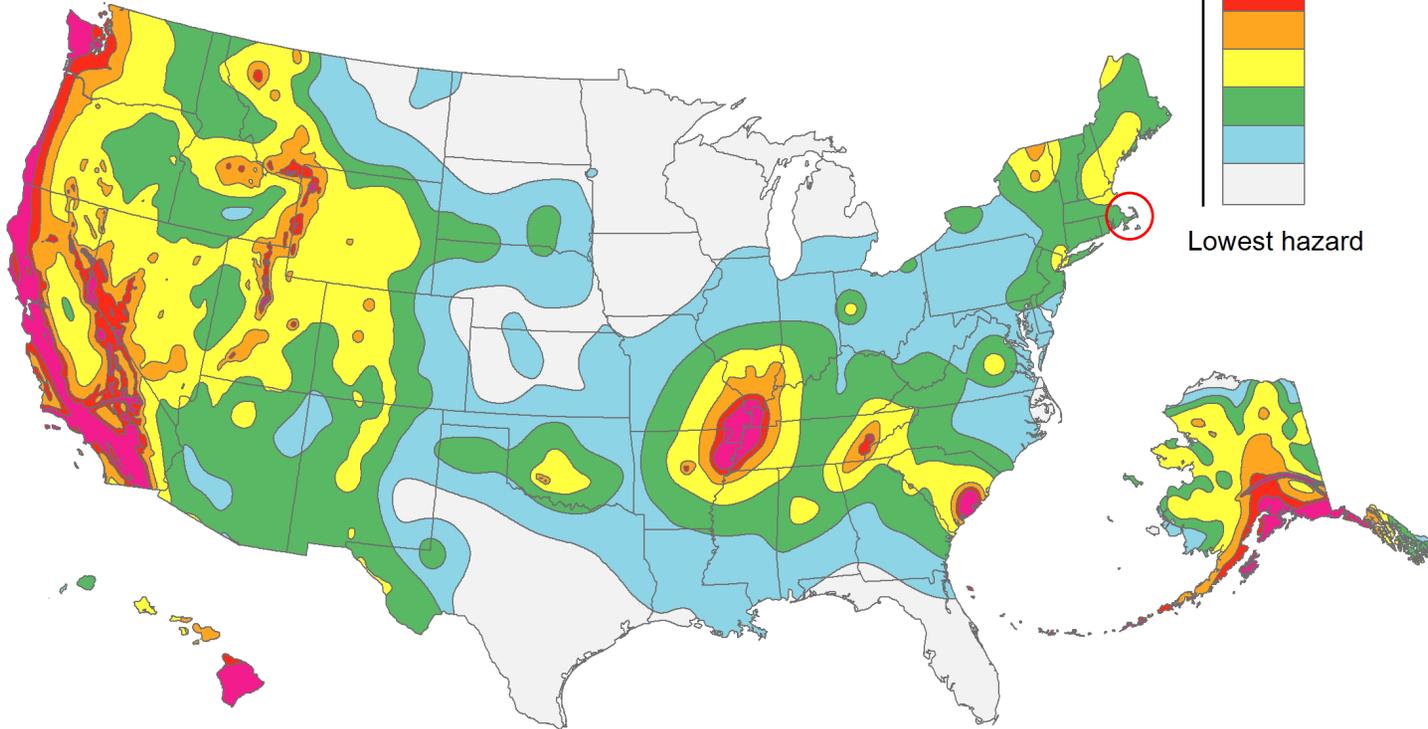


Figure 2.4 | 2014 simplified earthquake hazard risk map for the United States; a circle is used to identify the planning area on the map

States does experience earthquakes, but they are less frequent and less intense than the ones in the central and western U.S. *Figure 2.4* shows relative seismic risk for the United States.

B1c,
B2a,c

Previous Occurrences and Extent

Between 1627 and 2008, there were 366 earthquakes recorded in Massachusetts.¹⁴ Generally, most earthquakes that occur in the Northeast region of the United States tend to be small in magnitude and cause little damage, however, 104 earthquakes between 1924 and 2012 have 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.

Below is a list of earthquakes that affected eastern Massachusetts¹⁵:

B2c

- **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

¹⁴ Massachusetts State Hazard Mitigation Plan, 2013

¹⁵ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

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

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

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. See **Table 2.2** for a list of possible damages from earthquakes.

Earthquakes can also cause large and sometimes disastrous landslides. Sand dunes, like the ones located along Route 6 in Yarmouth, 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.¹⁶

Probability—Earthquakes

Earthquakes cannot be predicted and may occur at any time of the day and any time of the year.¹⁷ The Planning Team determined that it is **UNLIKELY** that an earthquake will impact Yarmouth. 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.

B2b

¹⁶ Massachusetts State Hazard Mitigation Plan, 2013

¹⁷ Massachusetts State Hazard Mitigation Plan, 2013

Fire: Urban and Wildland

Overview

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

Urban fires occur when buildings and structures catch fire and there is 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 like 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.¹⁸ 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 camp fires), or prescribed burns (intentional, controlled burns that are started under the supervision of experienced fire personnel).¹⁹

In 2012, the Cape Cod Cooperative Extension and many 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 Cape Cod region has a long history of wildfires. As a result, most of Cape Cod has fire-adapted ecosystems and therefore they 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 residents of Barnstable County 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

A team of fire professionals developed the Barnstable County Wildfire Preparedness Plan and conducted a town-wide risk assessment for wildfire in Yarmouth (*Figure 2.5*). The eight numbered areas are areas of suggested mitigation focus based on this risk assessment.

B1c

¹⁸ Massachusetts State Hazard Mitigation Plan, 2013

¹⁹ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

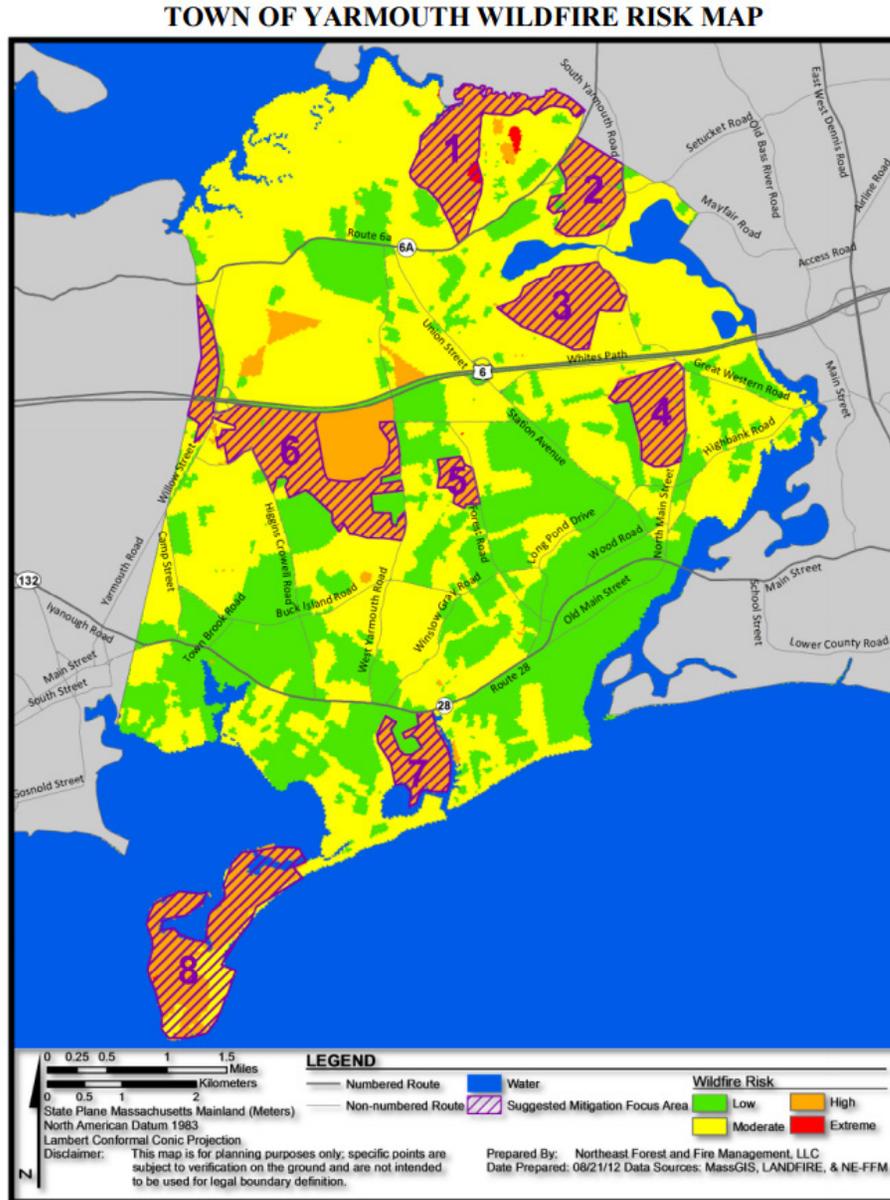


Figure 2.5 | Town of Yarmouth Wildfire Risk Map from the Barnstable County Wildfire Preparedness Plan

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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 7 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:** A 5,000-acre wildfire killed three Sandwich firefighters on Route 130. (<http://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. (<http://www.mashpeema.gov/sites/mashpeema/files/uploads/mashpeewildlife.pdf>)
- **June 1949:** After a fire started at the Truro Town Dump, 75 acres or more of brush and woodland burned. Firefighters from Truro, Wellfleet, Brewster and Orleans helped bring it under control. (Provincetown Banner, June 16, 1949)

The following is a list of notable urban fires that occurred in Yarmouth since 1930:

- **October 13, 1930:** A major fire destroyed the home of Dr. Hart on Main Street in Yarmouth Port across from the library. Since Yarmouth did not have any fire equipment, apparatus came from as far away as Hyannis, Centerville, Brewster, Harwich, and Falmouth. The Centerville pumper pumped for 2 hours. (www.capecodfd.com)
- **February 9, 1985:** The 130-year-old 2 1/2 story Lukes Market at Main Street & Route 28 was destroyed by a 4 alarm fire at 0530 hours. A bitter cold morning hampered efforts of 50 firefighters from several departments. (www.capecodfd.com)
- **January 30, 1988:** A 3 alarm fire at Huntington Ave damaged a 210-foot-long space metal building effecting 5 businesses. (www.capecodfd.com)

Hazard Profiles

- **June 17, 1989:** A military helicopter crashed in foggy conditions when it ran out of fuel trying to find Barnstable Airport. It crashed in a wooded area off Tall Pines Drive in Yarmouth Port at 0003 hours killing all 6 on board. (www.capecodfd.com)
- **June 10, 1991:** A 10-inch-high pressure gas main leak and explosion injured 4 workers on Whites Path. (www.capecodfd.com)
- **February 16, 1995:** A fast moving fire took the life of an 8-year-old boy at 14 Sullivan Road, West Yarmouth at 23:37 hours. (www.capecodfd.com)

B3a

Impact

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

- size of the fire
- landscape
- 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, which can weaken soils and cause failure on slopes; wildfires can impact the land for many years, including causing changes to the soil and therefore increasing the risk of future flooding

and contamination of reservoirs, and change the permeability of the ground. When fires burn hot and for long periods of time, the soil will bake and become impermeable, increasing the risk of flooding.

- **Transportation:** transportation may be temporarily disrupted

Probability—Urban and Wildland Fires

The Planning Team determined that it is **HIGHLY LIKELY** that an urban fire will impact Yarmouth and **LIKELY** that a wildfire will impact the planning area. 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, the 2012 Barnstable County Wildfire Preparedness Plan, and local knowledge of the town to make this probability determination.

Flood

Overview

There are several types of flood hazards that frequently impact Yarmouth:

- **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.²⁰
- **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.²¹
- **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 stores runoff and carries it into a receiving stream, lake, or ocean. When most of these systems were built, they were

²⁰ National Flood Insurance Program, Floodplain Management Requirements, FEMA 480

²¹ National Hurricane Center Outreach and Education, <http://www.nhc.noaa.gov/climo/>

Hazard Profiles

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.²²

B1c

Hazard Location

Flooding in Yarmouth is also the direct result of coastal storms, nor'easters, heavy rains, tropical storms, and hurricanes. **Figure 2.6** shows the 2014 FEMA Flood Insurance Rate Map (FIRM) for Yarmouth. This map depicts areas of Yarmouth in V and A zones and the 0.2% annual flood areas (500 year flood).

B1c,
B2a,c

Previous Occurrences and Extent

Below is a list of rain, flooding, and coastal flooding events experienced in the planning area from 1970 - 2015. Data was collected from NOAA's National Climatic Data Center.

- **February 1, 1970:** Rain storm causes thousands of cellars and roads to flood throughout Massachusetts. Traffic hampered by flooded streets and trees down.
- **November 2, 1970:** Wind damage across Cape Cod from winds up to 72 MPH. Fallen limbs, utility failures, structural damage to homes and businesses. Flooded streets (up to 3 feet).
- **October 8, 1982:** Gusts 50-70 MPH, damaged small boats on Cape Cod; street and cellar flooding.
- **May 28, 1984:** Basements and cellars flooded, roads due to flooding from 407 inches of rain recorded over 4 days.
- **July 21, 1984:** Up to 3 inches of rain in an hour caused street flooding and sporadic power outages.
- **August 9, 1992:** Thunderstorms and torrential rain caused street flooding. Numerous vehicles disabled on the highway due to flooding and several streets were closed.
- **March 30, 2001:** 4.25 inches of rain fell in Sandwich, MA, causing renewed minor flooding on some rivers in eastern Massachusetts, primarily since river flows were still high.
- **September 2, 1996:** Minimal coastal flooding from heavy rainfall. Some coastal roads closed due to overwash from large swells.
- **January 23, 2005:** Blizzard conditions caused major power outages for an extended amount of time. Vulnerable populations were caused to evacuate to local shelters. Snow fall totals up to 3 feet in some areas. Wind gusts up to 65 MPH at times. Power

²² National Hurricane Center Outreach and Education, <http://www.nhc.noaa.gov/climo/>

Hazard Profiles

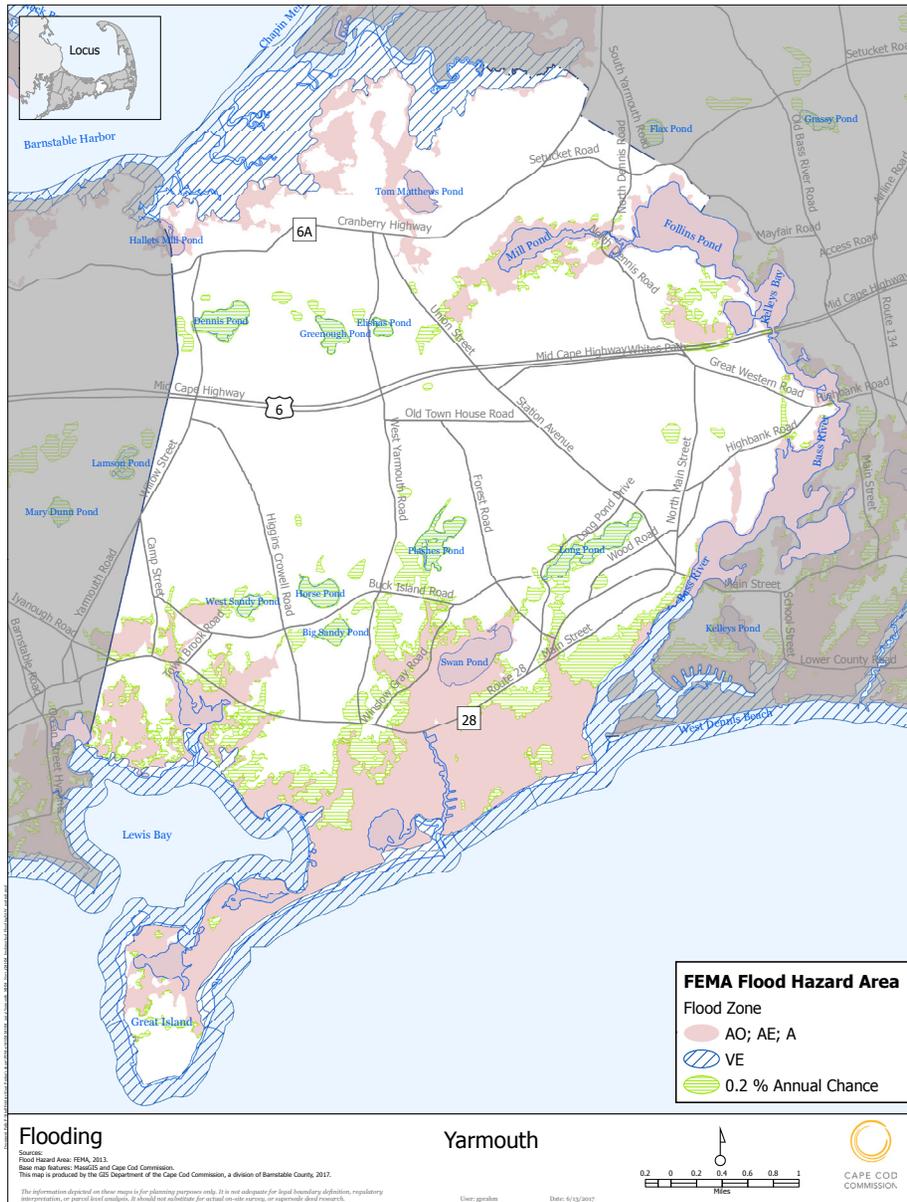


Figure 2.6 | 2014 FEMA Flood Hazard Area map for Yarmouth

Hazard Profiles

lines and trees down all over roads and travel was extremely dangerous. Coastal flooding caused major damages to homes along the vulnerable areas.

- **July 1, 2015:** A strong upper level disturbance and cold air aloft moved into southern New England resulting in showers and thunderstorms. Several streets were flooded and impassable in West Yarmouth.

B3a

Impact

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

- **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, urban drainage flooding near Town Hall in Yarmouth prevents residents and municipal employees from accessing Town Hall
- **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, MacMillan Pier was submerged during Hurricane Bob

- **Buildings:** moving water can damage the walls of buildings; mold and mildew can develop; 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; roadway 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

B2b

Probability—Floods

The Planning Team determined that it is **HIGHLY LIKELY** flooding 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 hurricanes, tropical storms, nor'easters in Yarmouth 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.²³ In the Atlantic Basin, the hurricane season “officially” runs from June 1 to November 30; peak activity is in early to mid-September.²⁴

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 winds or higher, corresponding to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale

²³ National Hurricane Center Outreach and Education, <http://www.nhc.noaa.gov/climo/>

²⁴ National Hurricane Center Outreach and Education, http://www.srh.noaa.gov/jetstream/tropics/tc_basins.htm

Hazard Profiles

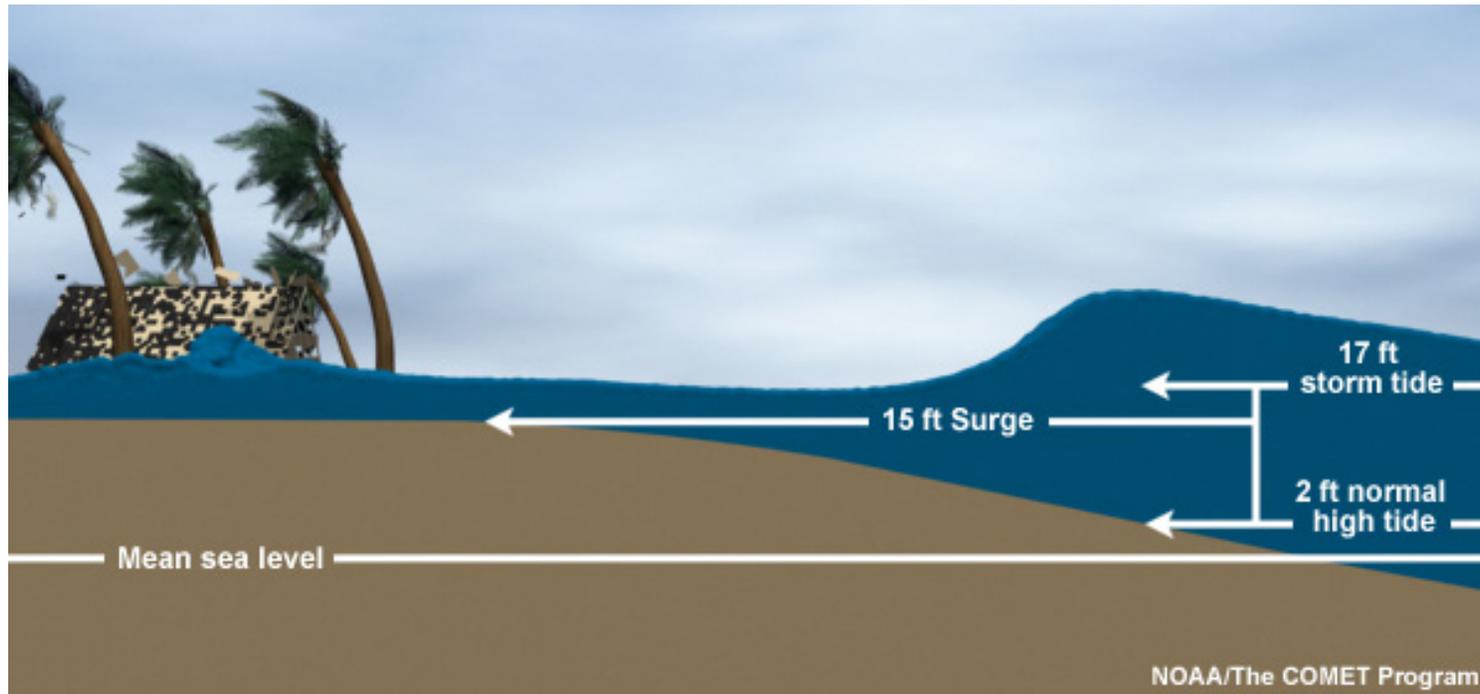


Figure 2.7 | Schematic of the generic differences between mean sea level, normal high tide, storm surge and storm tide. This graphic is for educational purposes only. The numbers shown (2, 15, 17 feet) are not specific to Yarmouth.

Hazard Profiles

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph	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.
	64-82 kt	
	119-153 km/h	
2	96-110 mph	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.
	83-95 kt	
	154-177 km/h	
3 (major)	111-129 mph	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.
	96-112 kt	
	178-208 km/h	
4 (major)	130-156 mph	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.
	113-136 kt	
	209-251 km/h	
5 (major)	157 mph 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.
	137 kt or higher	
	252 km/h or higher	

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

Hazard Profiles

There are two data sets 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.²⁵ This scale estimates potential property damage (*Table 2.4*). 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.²⁶ 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 rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides (*Figure 2.7*).

The US Army Corps of Engineers New England Division, in cooperation with FEMA, prepared Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation

²⁵ <http://www.nhc.noaa.gov/aboutsshws.php>

²⁶ National Weather Service Jetstream – Online School for Weather, Tropical Weather, Tropical Hazards, www.srh.noaa.gov/jetstream/tropics/tc_hazards.htm

maps.²⁷ 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

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 winds, and heavy

B1c

²⁷ Massachusetts State Hazard Mitigation Plan, 2013

rain associated with tropical cyclones. *Figure 2.8* shows the predicted storm surge in the planning area for the Category 1-4 storms.

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Previous Occurrences and Extent

The National Hurricane Center created maps showing the tracks of all known North Atlantic hurricanes and major hurricanes between the years 1851 – 2013 (*Figure 2.9*). These maps indicate that there is 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 2.10*).

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

Impact

B3a

The National Hurricane Center describes the types of damages that a community could experience during a Category 1-5 storm.²⁸

CATEGORY 1: 74-95 mph 1 minute sustained winds

■ **Impact to People/Pets/Livestock:**

- Could result in injury or death from flying or falling debris.

■ **Impact 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.

²⁸ National Hurricane Center Outreach and Education, Saffir-Simpson Hurricane Wind Scale Extended Table, <http://www.nhc.noaa.gov/aboutsshws.php>

Hazard Profiles

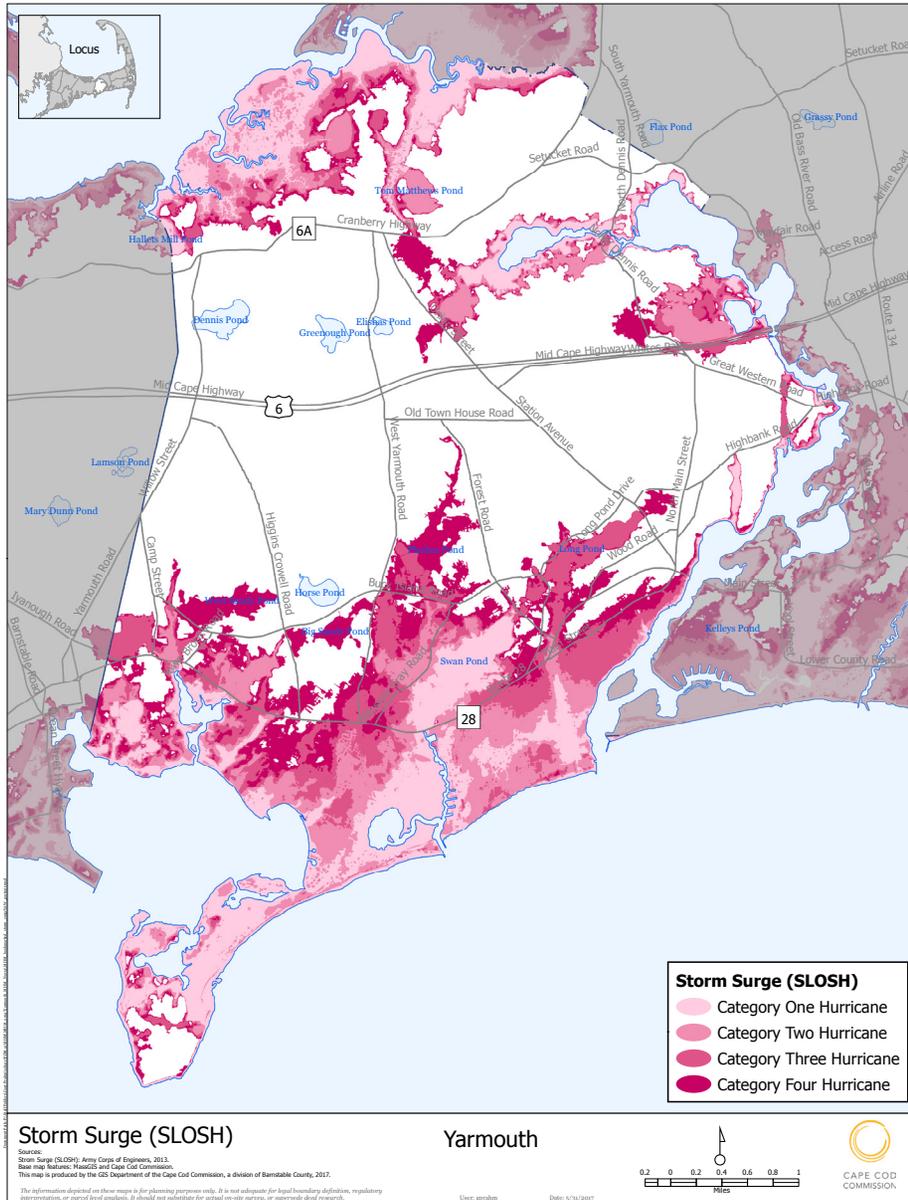


Figure 2.8 | SLOSH Map for Yarmouth

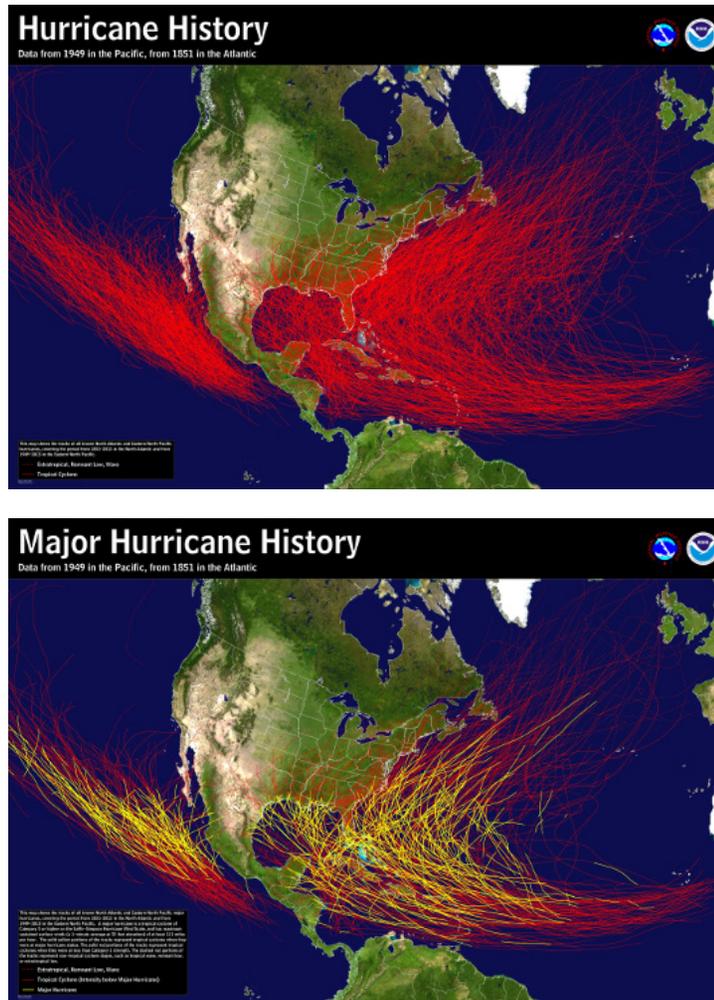


Figure 2.9 | Hurricanes and major hurricanes in the Atlantic Basin from 1851-2013, National Hurricane Center

- **Impact 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 a few to several days.

CATEGORY 2: 96-110 mph 1 minute sustained wind

- **Impact to People/Pets/Livestock:**
 - There is substantial risk of injury or death due to flying or falling debris.

Hazard Profiles

■ Impact to Frame Homes:

- 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.

■ Impact 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:

- 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

■ Impact to People/Pets/Livestock:

- There is high risk of injury or death due to flying and falling debris.

■ Impact 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.

■ Impact 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.

Hazard Profiles

- 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

- **Impact to People/Pets/Livestock:**
 - There is a very high risk of injury or death due to flying and falling debris.
- **Impact 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.
- **Impact 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:**

Hazard Profiles

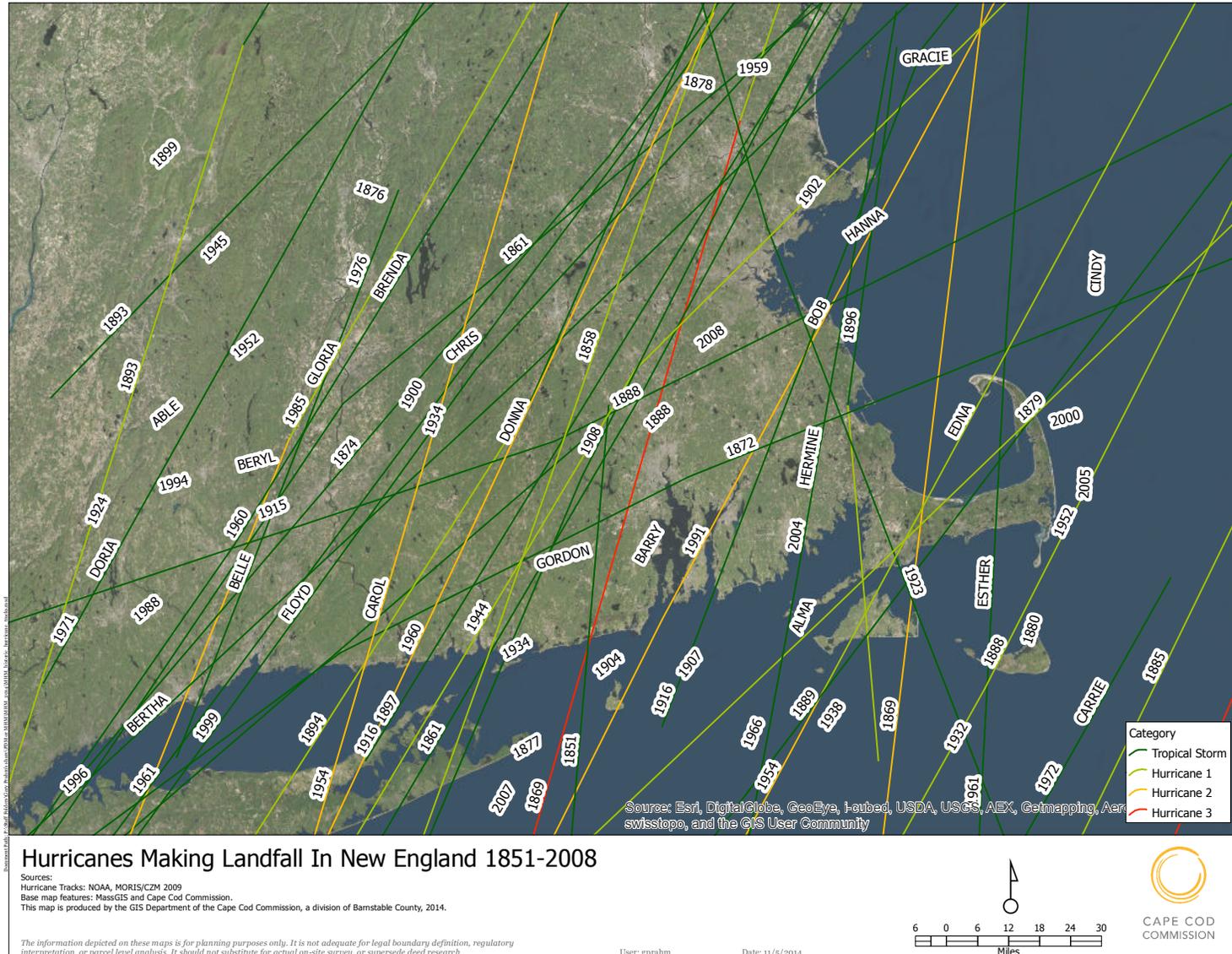


Figure 2.10 | Hurricanes making landfall in New England, 1851-2008

Hazard Profiles

Major Disaster Declarations and Most Memorable 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

Hazard Profiles

- 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

■ **Impact to People/Pets/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.

■ **Impact 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.

■ **Impact 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.

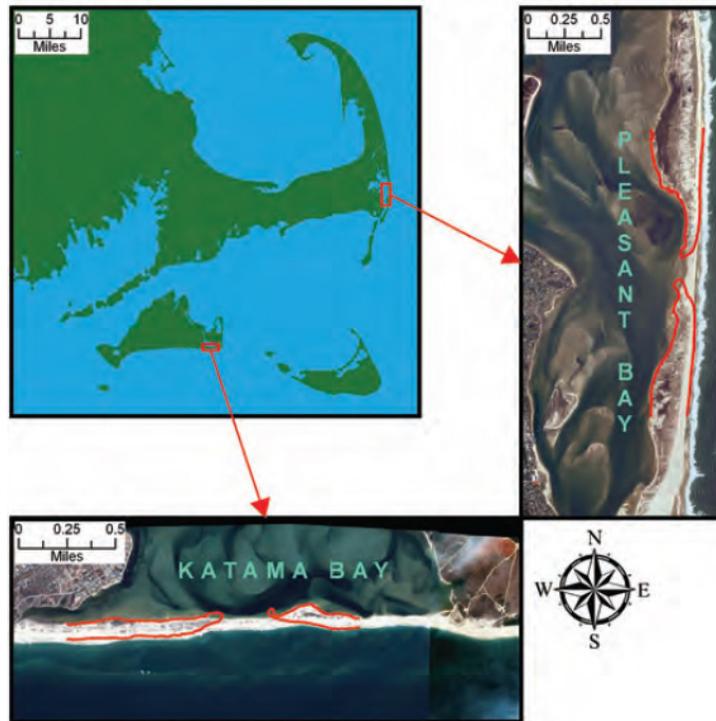


Figure 2.11 | Locations of barrier island breaches that occurred during the April 2007 storm. The Joint Airborne LiDAR Bathymetry Technical Center of Expertise (JALBTCX) collected the aerial photograph shortly before the storm and the red lines were extracted from JALBTCX LiDAR flown shortly after the storm (Berman and Nemunaitis-Monroe, 2012).

Probability—Hurricanes and Tropical Storms

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 cyclones in Barnstable County and local knowledge to make this probability designation.

Hazard Profiles

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.²⁹

Below is a list of the most common causes of landslides in Massachusetts³⁰:

- **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.³¹
- **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.³²

Hazard Location

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

B1c

Previous Occurrences and Extent

There have been no federally declared landslide disasters in Massachusetts from 1954 - 2012. To date, there have been no significant landslides in Yarmouth.

B1c,
B2a,c

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. There is no history of a landslide in Yarmouth, therefore there is no data on the worst conditions experienced in Yarmouth from a landslide.

Impact

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

B3a

²⁹ The Landslide Handbook – A Guide to Understanding Landslides USGS Circular 1325, 2008

³⁰ Massachusetts State Hazard Mitigation Plan, 2013

³¹ Massachusetts State Hazard Mitigation Plan, 2013

³² Landslide Loss Reduction: A Guide for State and Local Government Planning, FEMA-182, 1989

- **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—Landslides

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.³³ 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. These storms 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.³⁴

³³ NOAA: Know the dangers of nor'easters, http://www.noaa.gov/features/O3_protecting/noreasters.html

³⁴ "Storm of the Century" by Susan Milton, Cape Cod Times, reported in the February 3, 2008 issue

Hazard Profiles

The east coast of North America provides an ideal breeding ground for nor'easters.³⁵ During the winter, the 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.³⁶ 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).

³⁵ NOAA: Know the dangers of nor'easters, http://www.noaa.gov/features/O3_protecting/noreasters.html

³⁶ Massachusetts State Hazard Mitigation Plan, 2013

Traditionally, nor'easters are not given names like hurricanes and tropical storms. This changed recently as a result of The Weather Channel 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

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

Previous Occurrences and Extent

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,³⁷ making it especially difficult to track the history of nor'easters in a particular area.

³⁷ "Storm of the Century" by Susan Milton, Cape Cod Times, reported in the February 3, 2008 issue

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The following is a list of some of the nor'easters that affected Barnstable County, but it is not a complete list because of the reasons mentioned above³⁸:

- **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.³⁹ 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 Yarmouth 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 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 3 and 6 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

38 Massachusetts State Hazard Mitigation Plan, 2013

39 “Storm of the Century” by Susan Milton, Cape Cod Times, reported in the February 3, 2008 issue

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drifts of up to 3 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-blizzard conditions were reported in areas and brought between 1 and 3 feet of snow and produced wind gusts of up to 65 mph. The highest snowfall totals were reported in eastern Massachusetts (between 2 and 3 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 the 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 (*Figure 2.11*). While some breaches will

close by themselves in a short amount of time, both of these 2007 breaches became new inlets for the bays.⁴⁰ 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.⁴¹ 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 canceled; winds gusted to 75 mph; rain/snow mix transitioning to 15-18 inches of snow; 5,700 out of the 9,500 customers were without power on Cape Cod; 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).

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

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

B3a

Impact

Below is a list of possible impacts that could occur in Yarmouth 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; during the nor'easters of January 2015 the internet and phone lines went down in Yarmouth, see also damages to infrastructure in the Flood Hazard Profile
- **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—Nor'easter

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 Yarmouth to make this probability designation.

High Winds

Overview

Wind is air in motion relative to the ground surface.⁴² High winds can occur as an isolated event or can accompany other weather events such as:

- before and after frontal systems
- hurricanes and tropical storms

⁴² Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

- severe thunder and lightning storms
- tornadoes
- nor'easters

The National Weather Service issues warnings and advisories for high wind events as follows⁴³:

- **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

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 2.12*).

The map shows that Yarmouth is located in Wind Zone II with maximum wind speeds of 160 mph. Since this map includes 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.

The planning team decided that the entire planning area is vulnerable to high winds, especially the coastline of Yarmouth.

Previous Occurrences and Extent

According to the NOAA National Climatic Data Center (NCDC), Barnstable County experienced the following wind events between January 1, 1950 and July 21, 2015:

- 71 days of High Wind
- 28 days of Thunderstorm Wind

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⁴³ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

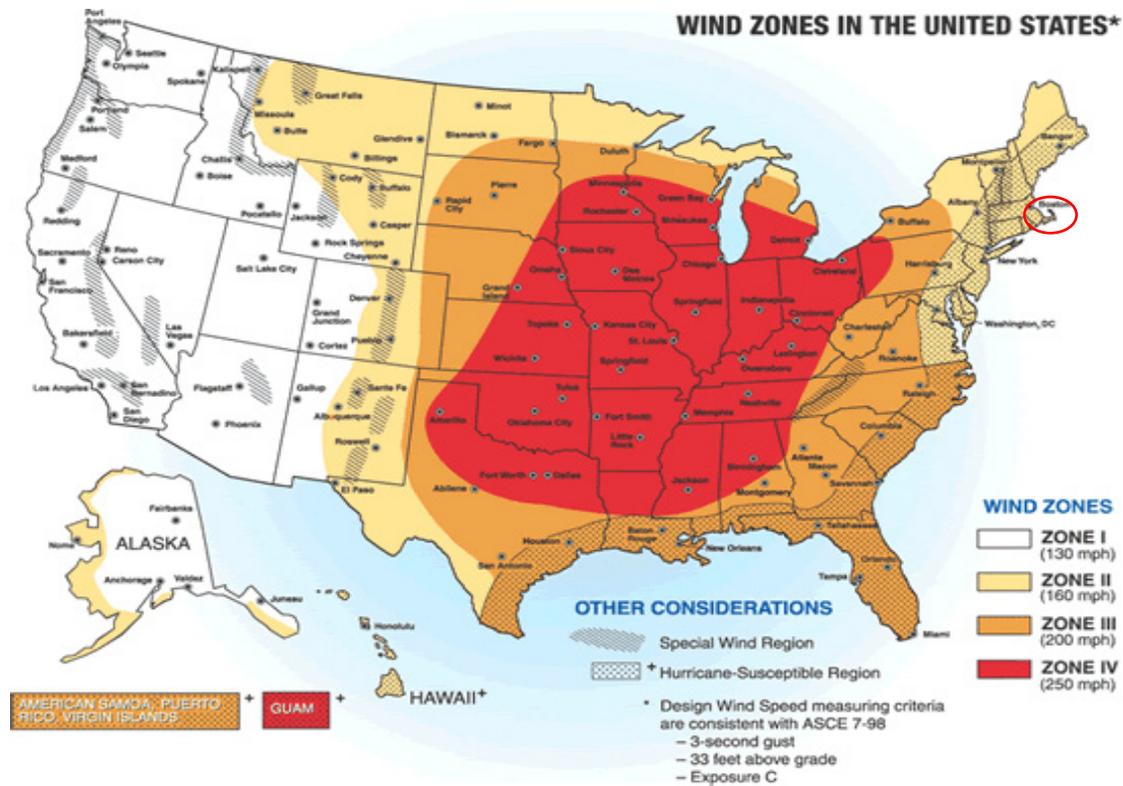


Figure 2.12 | Map of frequency and strength of windstorms in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan.

Hazard Profiles

B2c

However, specific information on the extent of these NCDC wind events in Yarmouth is not available.

B3a

Impact

Table 2.4 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; the air horn on the roof of the Yarmouth Fire Department was damaged during Hurricane Earl
- **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

B2b

Probability—High Wind

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 Yarmouth's history of high wind, hurricanes/tropical storms, and nor'easters as well as the town's proximity to the ocean to make this probability determination.

Thunderstorms

Overview

A thunderstorm is a storm that produces lightning and thunder and is usually accompanied by gusty winds, heavy rain, and sometimes hail.⁴⁴ The National Weather

⁴⁴ Massachusetts State Hazard Mitigation Plan, 2013

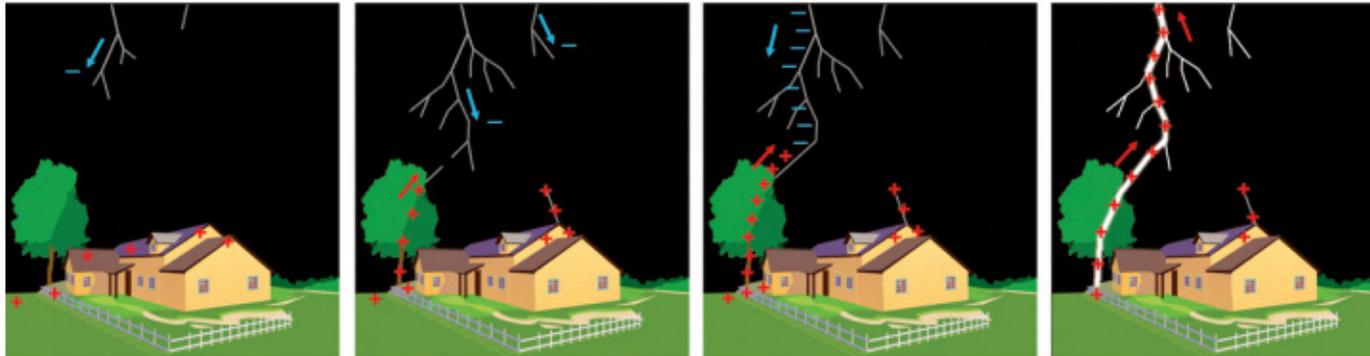


Figure 2.13 | Schematic of how lightning develops, from Thunderstorms, Tornadoes and Lightning: Nature's Most Violent Storms

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.⁴⁵ 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 2.13**). This discharge is seen as a bright, visible flash of lightning. The channel of air through which lightning passes can be heated to 50,000°F. The

⁴⁵ Thunderstorms, Tornadoes, Lightning: Nature's Most Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service

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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.⁴⁶

B1c

Hazard Location

According to a map presented in the Massachusetts State Hazard Plan, Barnstable County experiences approximately 20 thunderstorm days per year (see *Figure 2.14*).

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Previous Occurrences and Extent

Using local knowledge, the Planning Team concluded that at least 1-2 thunderstorms occur every year in Yarmouth. However, data on these storm events are 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 historical thunderstorms that occurred in Yarmouth; although it is not a complete list:

⁴⁶ Thunderstorms, Tornadoes, Lightning: Nature's Most Violent Storms, A Preparedness Guide, US Department of Commerce, NOAA, and the National Weather Service

- **August 19, 2008:** A cold front moved through Southern New England producing showers and thunderstorms that became severe as they moved through the Commonwealth. Large hail and damaging winds affected Cape Cod. Trees were downed by thunderstorm winds.
- **August 4, 2015:** A line of thunderstorms developed across Long Island, NY and raced towards Rhode Island and southeastern Massachusetts. These storms caused significant wind damage knocking down a significant number of trees.

Impact

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

B3a

- **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

Hazard Profiles

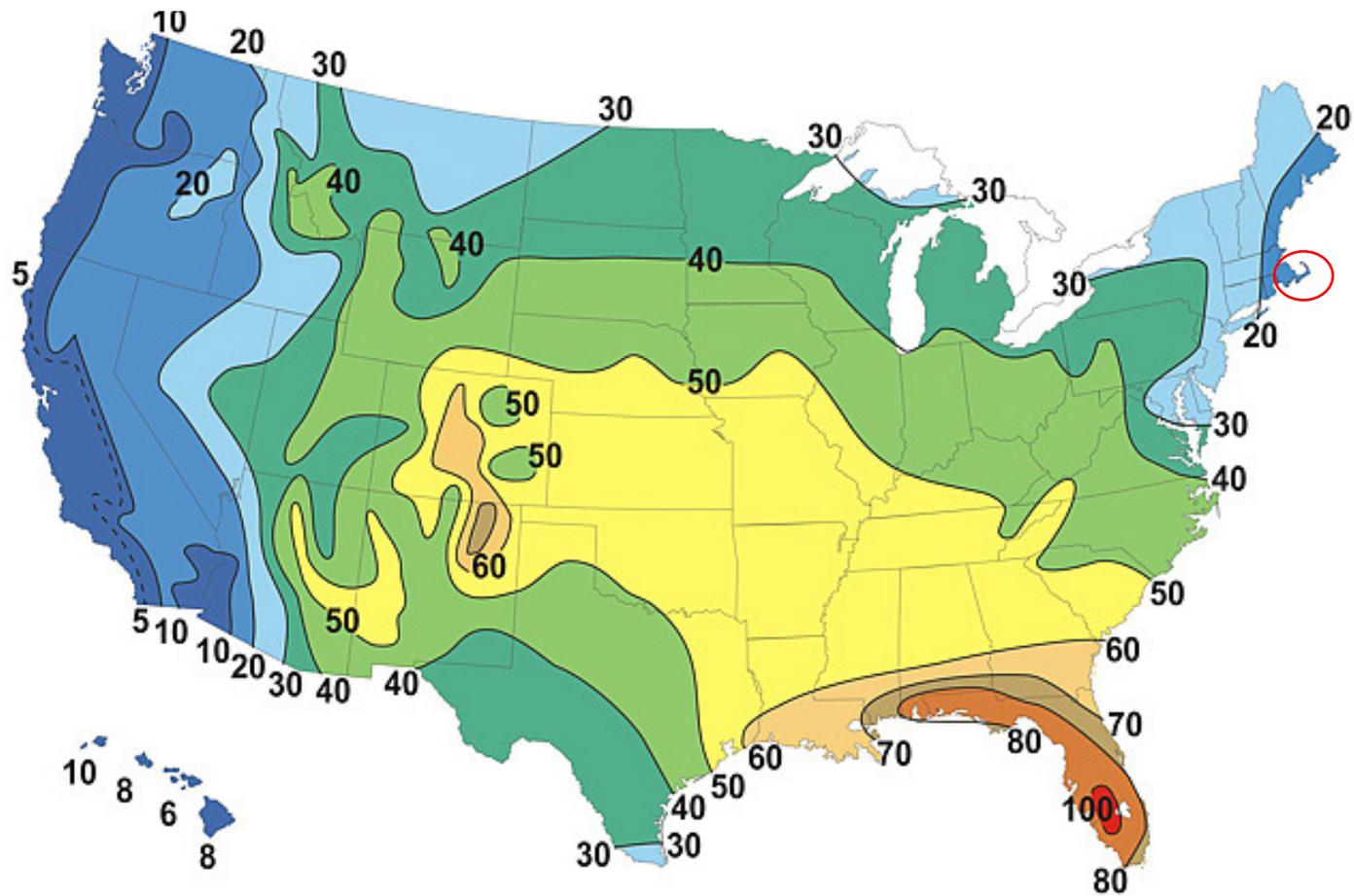


Figure 2.14 | Map of the average number of thunderstorms per year in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Plan

Hazard Profiles

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

B2b

Probability—Thunderstorms

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 Yarmouth's history of thunderstorms and the town's proximity to the ocean 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.

Hazard Location

The entire planning area is vulnerable to extreme temperatures.

B1c

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 January 1, 1950 and July 31, 2015:

- **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

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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 Yarmouth Municipal Airport (KPVC) also recorded heat indexes of 105 during this time frame.

B3a

Impact

Below is a list of possible impacts that could occur during extreme temperature events⁴⁷:

- **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 operations and the transport of goods and services
- **Natural Systems:** saltwater freezing can occur in coastal bays and harbors
- **Transportation:** icy roads make travel difficult

Probability—Extreme Temperatures

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 Yarmouth's history of extreme temperatures in town to make this probability determination.

B2b

⁴⁷ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

Tornadoes

Overview

A tornado is a violently rotating column of air extending from a thunderstorm cloud to the ground.⁴⁸ 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.

There are a variety of sources for tornadoes. Tornadoes can:

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

⁴⁸ NOAA's National Weather Service, Storm Prediction Center: <http://www.spc.noaa.gov/faq/tornado/f-scale.html>

Hazard Location

B1c

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 2.15*).⁴⁹

Previous Occurrences and Extent

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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

⁴⁹ Massachusetts State Hazard Mitigation Plan, 2013

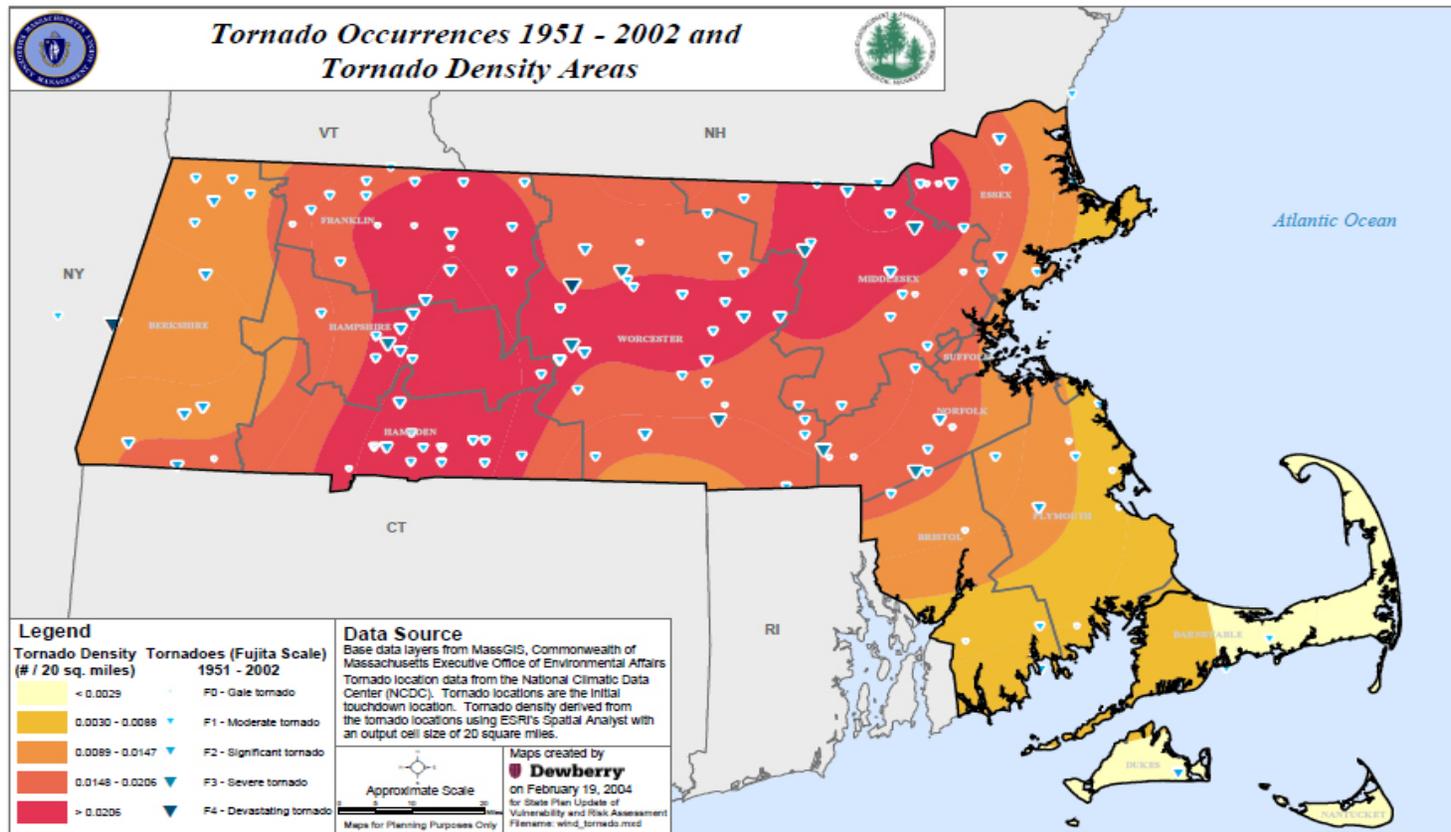


Figure 2.15 | Tornado occurrence and density for Massachusetts. Map is from the 2013 Massachusetts State Hazard Plan.

Hazard Profiles

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.

According to the NOAA National Climatic Data Center (NCDC), there were no specific reports of tornadoes in Yarmouth from 1950 to the July 31, 2015.

B3a

Impact

Below is the Fujita Tornado Damage Scale developed in 1971 by T. Theodore Fujita⁵⁰:

- **Scale F0, <73 mph winds, light damage:** some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged

⁵⁰ NOAA's National Weather Service, Storm Prediction Center: <http://www.spc.noaa.gov/faq/tornado/f-scale.html>

- **Scale F1, 73- 112 mph winds, moderate damage:** peels surface 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—Tornado

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:

B2b

Hazard Profiles

- **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 Yarmouth’s propensity for tropical weather and Cape Cod’s history of tornadoes to make this probability determination.

Drought

Overview

Drought is a period characterized by long durations of below normal precipitation.⁵¹ 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

The entire planning area could be affected by drought. **Figure 2.16** shows how Barnstable County compares to the rest of the Commonwealth of Massachusetts for the number of months in a drought emergency per 100 years.

B1c

Previous Occurrences and Extent

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

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- **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

⁵¹ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

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 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.

Using these indices, the Massachusetts Drought Management Plan uses five levels to characterize drought severity. (See *Table 2.5*)

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, to increased assessment and proactive education during a watch.

The following list of dates and drought levels and descriptions for Barnstable County was compiled from data from the Massachusetts State Hazard Mitigation Plan, US Drought Monitor website, 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

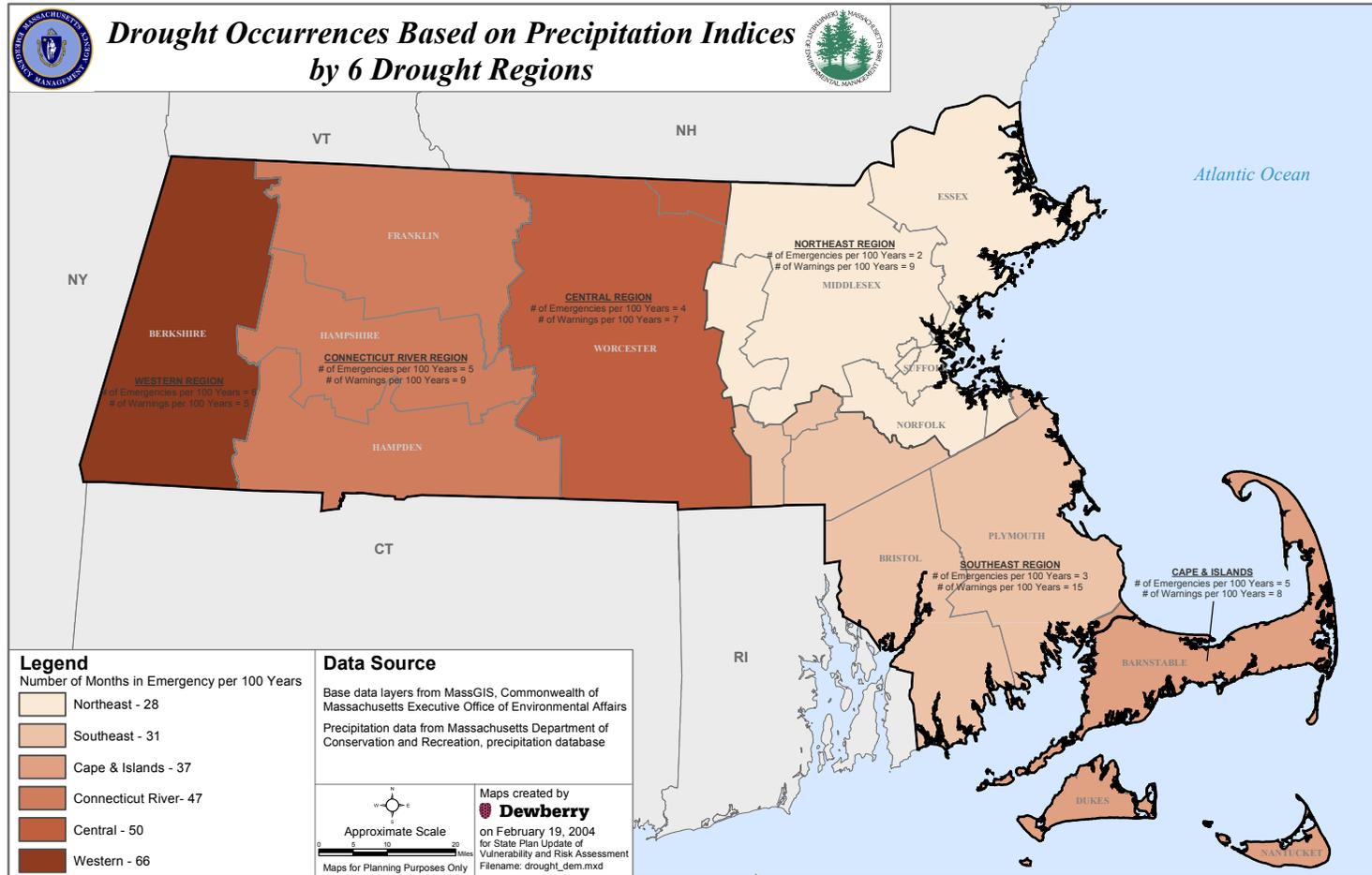


Figure 2.16 | Number of drought emergencies per 100 years for Massachusetts. Map is from the 2013 Massachusetts State Hazard Plan

Hazard Profiles

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. Thus, 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

There is no data on the extent of drought for Yarmouth specifically; all drought levels are reported at the County level.

B3a

Impact

The following is a list of impacts that are possible with drought⁵²:

- **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
- **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

Probability—Drought

The Planning Team determined that it is **LIKELY** 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

B2b

⁵² Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

Drought Level	Standardized Precipitation Index	Crop Moisture Index*	Keetch-Byram Drought Index*	Precipitation	Groundwater	Streamflow	Reservoir***
Normal	3-month > -1.5 <u>or</u> 6-month > -1.0 <u>or</u> 12-month > -1.0	0.0 to -1.0 slightly dry	< 200	1 month below normal	2 consecutive months below normal**	1 month below normal**	Reservoir levels at or near normal for the time of year
Advisory	3-month = -1.5 to -2.0 <u>or</u> 6-month = -1.0 to -1.5 <u>or</u> 12-month = -1.0 to -1.5	-1.0 to -1.9 abnormally dry	200-400	2 month cumulative below 65% of normal	3 consecutive months below normal**	At least 2 out of 3 consecutive months below normal**	Small index Reservoirs below normal
Watch	3-month < -2.0 <u>or</u> 6-month = -1.5 to -3.0 <u>or</u> 12-month = -1.5 to -2.0	-2.0 to -2.9 excessively dry	400-600	1 of the following criteria met: 3 month cum. < 65% <u>or</u> 6 month cum. < 70% <u>or</u> 12 month cum. < 70%	4-5 consecutive months below normal**	At least 4 out of 5 consecutive months below normal**	Medium index Reservoirs below normal
Warning	6-month < -3.0 <u>or</u> 12-month = -2.0 to -2.5	< -2.9 severely dry	600-800	1 of the following criteria met: 3 month cum. < 65% and 6 month cum. < 65%, <u>or</u> 6 month cum. < 65% and 12 month cum. < 65%, <u>or</u> 3 month cum. < 65% and 12 month cum. < 65%	6-7 consecutive months below normal**	At least 6 out of 7 consecutive months below normal**	Large index reservoirs below normal
Emergency	12-month < -2.5	< -2.9 severely dry	600-800	Same criteria as Warning and previous month was Warning or Emergency	>8 months below normal**	>7 months below normal**	Continuation of previous month's conditions

* The Crop Moisture Index is subject to frequent change. The drought level for this indicator is determined based on the repeated or extended occurrence at a given level.

** Below normal for groundwater and streamflow are defined as being within the lowest 25th percentile of the period of record.

*** Water suppliers should be consulted to determine if below normal reservoir conditions are due to operational issues.

Table 2.5 | Drought Indices as defined in the 2013 Massachusetts Drought Management Plan

Hazard Profiles

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.⁵³ Winter storms typically occur from early autumn to late spring and can include any of the following events^{54,55}:

- **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.⁵⁶
- **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.

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

54 Massachusetts State Hazard Mitigation Plan, 2013

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

56 Massachusetts State Hazard Mitigation Plan, 2013

There are many ways for winter storms to form; however, all three have key components.

COLD AIR: For snow and ice to form, the temperature must be below freezing in the clouds and near the ground.

MOISTURE: Water evaporating from bodies of water, such as a large lake or the ocean, is an excellent source of moisture.

LIFT: Lift causes moisture to rise and form clouds and precipitation. An example of lift is warm air colliding with cold air and being forced to rise. Another example of lift is air flowing up a mountainside.

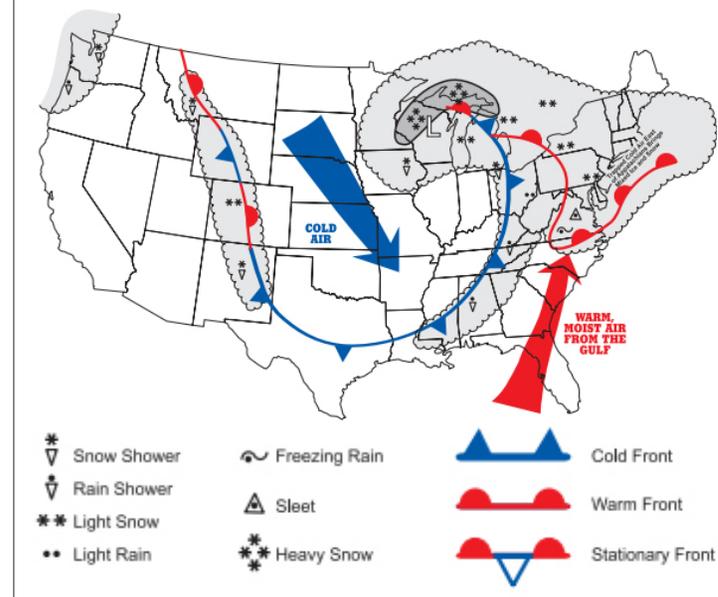


Figure 2.17 | How winter storms form. Graphic from Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008.

- **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
- **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 as severe flooding.
- **Snow melt:** sudden thaw of a heavy snow pack, often leads to flooding.

Winter storms form when cold air, moisture, and lift are present (*Figure 2.17*).

Hazard Location

B1c

The entire planning area is at risk for snow, blizzards and ice storms. During these events, the coastline of Yarmouth experiences higher snow accumulations and higher winds than other areas of town.

Previous Occurrences and Extent

B1c,
B2a,c

Snow and other forms of winter precipitation occur frequently in Sandwich. The Northeast Regional Climate Center compiled normal 30-year average annual snow totals in New England and in the eastern U.S. (*Figure 2.18*). These maps show normal snow totals for Yarmouth to be within 14-40 inches per year from 1971-2000 and from 1981-2010.⁵⁷

Below is a list of federally-declared disasters from winter storm events in Barnstable County (*Table 2.6*). 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 were:

⁵⁷ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

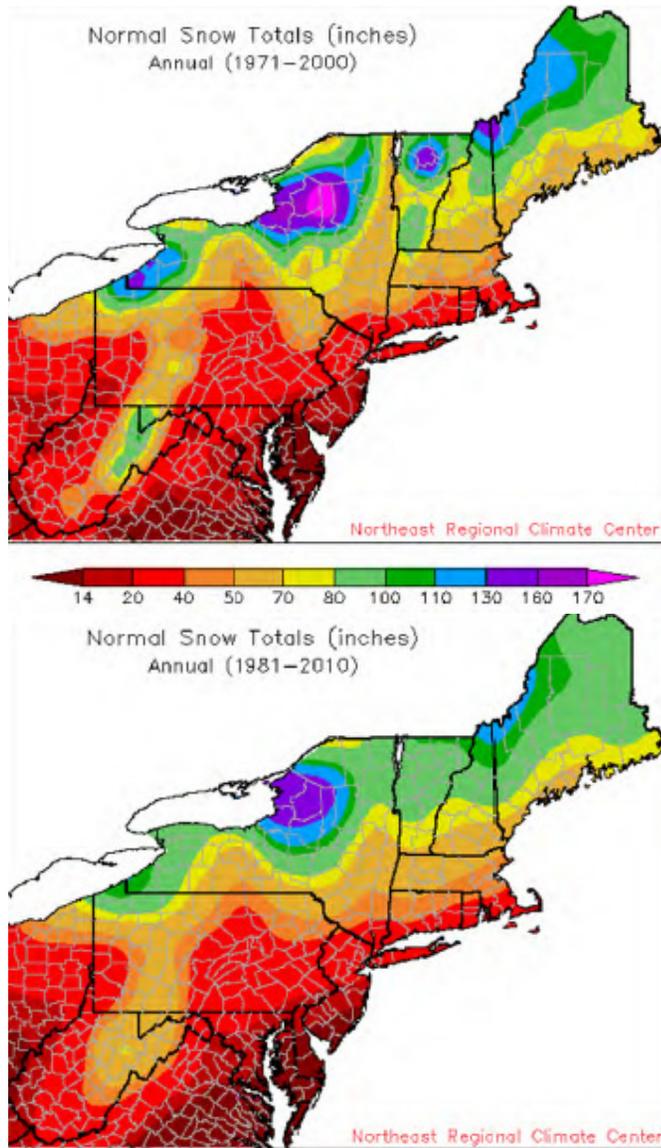


Figure 2.18 | Annual snow totals in inches from 1971-2000 (top) and 1981-2010 (bottom). Maps are from the 2013 Massachusetts State Hazard Plan

- 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

A winter storm deposited tremendous amounts of snow over all of southern New England, mainly from the mid-afternoon on Friday, February 8 and lasting into the daylight hours of Saturday, February 9. Along the southeast Massachusetts coast, average amounts ranged from 1 to 2 feet. It lingered during the whole afternoon over Cape Cod and Nantucket, aided by some ocean-effect bands of snowfall. The Blizzard of 2013 also produced a prolonged period of very strong winds Friday night along the Massachusetts and Rhode Island coasts. Gusts exceeded hurricane force (74 mph) at a few locations. The strong winds, combined with a wet snow, led to extensive power outages from downed trees and wires in southeast coastal Massachusetts and in southern Rhode Island. The strongest wind gust observed was 69 mph at a Weatherflow measuring site at Sagamore Beach.

In addition, moderate to major coastal flooding occurred, most notably during the time of the high tide Saturday morning along the Massachusetts east coast. At the storm's height near the early morning low tide, the storm surge reached 3 to 4 feet along much of the MA east coast from Boston south. Consequently, many coastal

Hazard Profiles

Major Disaster Declarations for Winter Storms in Barnstable County from 1954 - 2015

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

Table 2.6 | Major disaster declarations for Barnstable County for winter storms. Data is from the FEMA Disaster Declaration website and from the 2013 Massachusetts State Hazard Plan.

Hazard Profiles

roadways were impassable from Salisbury and Gloucester to Marshfield and Scituate on the south shore and on parts of Cape Cod.

B3a

Impact

Below is a list of impacts likely to occur during a winter storm event^{58,59}:

- **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.

It is important to note that not all winter storms affecting Yarmouth were declared federal disasters. Therefore, Yarmouth likely experienced more severe winter weather than documented in *Table 2.6*.

58 Massachusetts State Hazard Mitigation Plan, 2013

59 Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S.

Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008

B2b

Probability—Severe Winter Weather

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

The Planning Team used Yarmouth'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 floor, seismic or volcanic activity, or underwater landslides. Tsunamis generate a devastating onshore surge of water.⁶⁰ 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.

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.⁶¹

Previous Occurrences and Extent

According to the NOAA National Climatic Data Center, Barnstable County did not experience any tsunamis between January 1, 1950 and July 31, 2015.

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⁶⁰ Massachusetts State Hazard Mitigation Plan, 2013

⁶¹ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

Only a total of six tsunamis have been reported in the US Atlantic coast and Gulf coast states in the last 200 years⁶²:

- 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 Yarmouth.

B3a

Impact

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;

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; disruption of coastal systems will have far-reaching economic effects, especially for the fishing industry
- **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—Tsunami

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

B2b

⁶² Massachusetts State Hazard Mitigation Plan, 2013

- **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.⁶³ 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.

⁶³ Sea level rise: understanding and applying trends and future scenarios for analysis and planning, Massachusetts Office of Coastal Zone Management, December 2013

- **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 (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.⁶⁴

⁶⁴ United States Environmental Protection Agency, 2006

Hazard Profiles

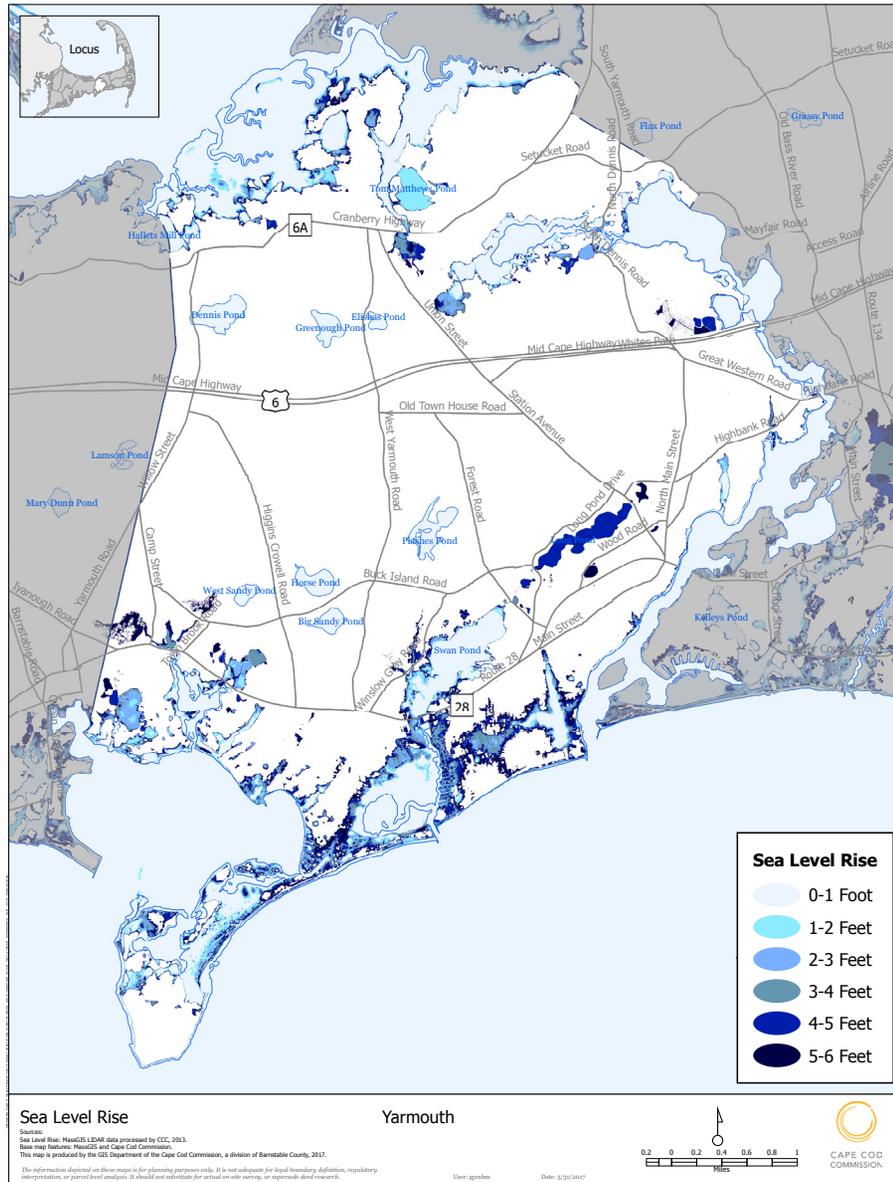


Figure 2.19 | Sea level rise map for Yarmouth

B1c

Hazard Location

The entire coast of Yarmouth is vulnerable to sea level rise (*Figure 2.19*).

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 www.capecodcommission.org/blackbox). 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 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.

B1c,
B2a,c

Previous Occurrences and Extent

Mean sea level trends from the Boston, Woods Hole and Nantucket long-term stations are listed below⁶⁵:

⁶⁵ Sea level rise: understanding and applying trends and future scenarios for analysis and planning, Massachusetts Office of Coastal Zone Management, December 2013

■ Boston, MA tide gauge station:

- 0.11 ± .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 ± .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

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

B3a

Hazard Profiles

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.⁶⁶

B2b

Probability—Sea Level Rise

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.

⁶⁶ United States Environmental Protection Agency, 2006

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.⁶⁷

The following changes in hazard frequency and intensity are expected to occur with changes in climate⁶⁸:

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 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.

⁶⁷ United States Environmental Protection Agency, 2006

⁶⁸ Massachusetts State Hazard Mitigation Plan, 2013

Hazard Profiles

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 change, 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

Hazard Profiles

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 reached out to members of the public and stakeholders through an online survey. In the survey, the public was asked if they had experienced any of the hazards identified in the 2013 Massachusetts State Hazard Plan (Question 2 and 3 of the online survey – see “Public Survey on Hazard Mitigation” in **Appendix 1**). Public and stakeholder input was then used to determine if specific hazards were significant to Yarmouth (see **Table 2.7**)

Table 2.7 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

- a significant amount of the public and stakeholders have experienced the hazard in the past

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

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

Hazard Profiles

Type of Natural Hazard	What is the future probability of the hazard as determined by the Planning Team?	Did the public/stakeholders/ neighboring communities experience the hazard in the past?	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	UNLIKELY	No	No
		(<2% said yes)	
Urban Fire	HIGHLY LIKELY	Yes	Yes
Wildfire	LIKELY	Yes	No
Flood	HIGHLY LIKELY	Yes	Yes
Hurricane and Tropical Storms	HIGHLY LIKELY	Yes	Yes
Landslide	POSSIBLE	No	No
		(<1% said yes)	
Nor'easters	HIGHLY LIKELY	Yes	Yes
High Winds	HIGHLY LIKELY	Yes	Yes
Thunderstorms	HIGHLY LIKELY	Yes	Yes
Extreme Temperatures	LIKELY	Yes	No
Tornadoes	POSSIBLE	Yes	No
Drought	LIKELY	Yes	No
Severe Winter Weather	HIGHLY LIKELY	Yes	Yes
Tsunami	UNLIKELY	No	No
		(<1% said yes)	
Sea Level Rise	HIGHLY LIKELY	Yes	Yes

Table 2.7 | List of hazards selected for a risk assessment

Asset Inventory

CHAPTER THREE

Chapter 2 profiled natural hazards that have affected Yarmouth 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 located in Yarmouth. Once this asset inventory is 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 Yarmouth.**

People

People

Population: Year-round and Seasonal

There are approximately 23,581 year-round residents in Yarmouth (according to the 2011-2015 U.S. Census American Community Survey estimate). The median household income for this population is \$57,569 and the average household income is \$72,328.

There is no one estimate of Yarmouth's seasonal population because this statistic is difficult to determine. For the purposes of this plan, seasonal population seeks to address how many individuals may need to be accounted for within the Town of Yarmouth, regardless of resident, visitor, or transient status.

The peak season estimate of additional individuals in Yarmouth with overnight accommodations, in either lodging or vacation homes, is approximately 24,510. There is no good estimate for the effect of day-trippers and other transient visitors to Yarmouth.

There are approximately 3,560 rooms available to book at Yarmouth's hotels, motels, bed and breakfasts, inns and lodging houses.¹ Using a conservative estimate of two occupants per available room and the Cape Cod Chamber of Commerce's peak occupancy rate of 80%

for the month of July, there could be an additional 5,690 individuals with overnight accommodations in Yarmouth during the peak tourism season.

In addition, an accounting of Yarmouth's high percentage of seasonally-used second homes is needed. Using an occupancy rate of 4.5 individuals for each unit and an 81.6% summer occupancy rate, as determined in the Cape Cod Commission Second Homeowner Survey (2008), Yarmouth's 5,200 seasonally-vacant homes represent the possibility of another 18,820 individuals with overnight accommodations at peak times.² Based on this estimate, and the ACS year-round population estimate, peak population in Yarmouth may be as much as approximately 48,091 people.

Base Map of Yarmouth

Figure 3.1 is a base map for the Town of Yarmouth. It shows the geographic area of Yarmouth and includes features such as roads, rivers, coastlines. The base map acts as a frame of reference for the reader and reviewer of the Yarmouth Hazard Mitigation Plan.

¹ Town of Yarmouth

² American Community Survey Estimate, 2009-2013

Base Map of Yarmouth



Figure 3.1 | Base map of Yarmouth

Natural Environment

Natural Environment

Located in the middle of Cape Cod, the Town of Yarmouth possesses diverse natural beauty and historical significance. Yarmouth encompasses 28.2 square miles of land bounded on the east by the Town of Dennis, on the West by the Town of Barnstable, on the north by Cape Cod Bay, and on the south by Nantucket Sound. During the summer, the population swells with people enjoying the town's natural and cultural resources including miles of beaches and several fine art galleries, restaurants, and historic sites.

Three villages make up the Town of Yarmouth: West Yarmouth, Yarmouth Port, and South Yarmouth. Each village has a distinguishing character formed by over 350 years of history, which is shaped by the Town's seaside heritage.

Built Environment

Homes

Yarmouth has 17,158 total housing units. *Table 3.1* is a list of the type and number of housing units in Yarmouth.

Units in Structure	Estimate
1-unit, detached	13,236
1-unit, attached	1,001
2 units	849
3 or 4 units	363
5 to 9 units	441
10 to 19 units	245
20 or more units	1,005
Mobile home	18
Boat, RV, van, etc.	0
Total Housing Units	17,158

Table 3.1 | Number and type of housing units in Yarmouth, U.S. Census American Community Survey Estimate (2011-2015)

More than 86 percent of the town's housing units were built after 1950. The median number of rooms in Yarmouth residences is 5.2, compared to 5.6 Cape-wide.³

Businesses and Employment

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

³ U.S. Census American Community Survey Estimate (2011-2015)

Built Environment

Industry	Number	Values
Utilities	4	Q
Wholesale trade	20	54,774
Retail trade	123	290,226
Transportation and warehousing	11	36,567
Information	13	N
Finance and insurance	22	N
Real estate and rental and leasing	27	48,416
Professional, scientific, and technical services	56	28,661
Administrative and support and waste management and remediation services	60	45,230
Educational services	8	2,205
Health care and social assistance	104	166,465
Arts, entertainment, and recreation	26	26,699
Accommodation and food services	131	117,616
Other services (except public administration)	59	57,410

Table 3.2a| Estimated number and value of Yarmouth businesses by industry, 2012 Economic Census of the United States

Q=Revenue not collected at this level of detail for multiestablishment firms

N=Data not available or not comparable

Industry	Number Employed
Utilities	c
Wholesale trade	136
Retail trade	1,116
Transportation and warehousing (104)	307
Information	238
Finance and insurance	c
Real estate and rental and leasing	288
Professional, scientific, and technical services	258
Administrative and support and waste management and remediation services	467
Educational services	16
Health care and social assistance	1,975
Arts, entertainment, and recreation	251
Accommodation and food services	1,764
Other services (except public administration)	503

Table 3.2b| Estimated number and value of Yarmouth businesses by industry, 2012 Economic Census of the United States

When sales and other data must be withheld due to disclosure, a range for the employment data can be shown:

c=100 to 249 employees

Built Environment

Critical Facilities

Table 3.3 is a list of the Critical Facilities in Yarmouth.

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	Police Station/EOC
	Yarmouth Housing Authority (Offices and Homes)
	Dennis-Yarmouth Regional High School/Regional Shelter
	Yarmouth Natural Resources Department/Parks Department
	Mattacheese Middle School
	Yarmouth Water Department and DPW
	Station Avenue Elementary School
	Yarmouth Senior Center
	Marguerite E. Small Elementary School
	Simpkins School Residences (55+)
Yarmouth Fire Headquarters	
Maplewood at Mayflower Place Senior Living/Memory Care Facility	
Yarmouth Port Fire Station #2	
Windsor Nursing and Rehabilitation Center/Thirwood Place Asstd Living	
West Yarmouth Fire Station #3	
St. Pius Life Center/St Pius K-8	
Yarmouth Town Hall	
MA State Police Troop D-2	
South Yarmouth Public Library	
Cape Cod Hospital	
West Yarmouth Public Library	
Highway Department	

Table 3.3 | List of critical facilities in Yarmouth

Built Environment

Type of Critical Facility		Name of Critical Facility	
Lifeline Utilities	Includes wastewater, water, oil, natural gas, electric power, and communication systems.	Yarmouth Septic Treatment Plant	Water Pump Station - 11
		Yarmouth Regional Transfer Station	Water Pump Station - 13, 18 & 19
		Yarmouth Residential Transfer Station/Disposal Area & Fuel Depot	Water Pump Station - 14
		Eversource Headquarters	Water Pump Station - 15 & 16
		National Grid	Water Pump Station - 17
		Cell Tower on Whites Path	Water Pump Station - 20
		Prospect Hill Water Tank	Water Pump Station - 21 & 22
		German Hill Water Tank	Water Pump Station - 23
		Sandy Pond Water Tank	Water Pump Station - 24
		Water Pump Station - 1M	Two Microwave Telecommunications Links and Generators
		Water Pump Station - 1, 2 & 3	Signal Hill Communications Tower
		Water Pump Station - 4 & 5	Comcast Service Center
		Water Pump Station - 6, 7 & 8	Fueling Depot at Yarmouth Highway Department
		Water Pump Station - 9	FAA Beacon (Walden Way)
Water Pump Station - 10			

Table 3.3 | List of critical facilities in Yarmouth (continued)

Built Environment

Type of Critical Facility	Name of Critical Facility
Transportation Critical assets in all 5 modes of transportation (air, road, transit, rail, sea). Source: FEMA How-to Guide 2/ FEMA 386-2	Packet Landing Route 28
	Englewood Beach Marina (fuel and landing) Route 6A
	Englewood Beach Parking Buck Island Road
	Bass Hole Parking Lot Winslow Gray Road
	Bass River Beach, Parking and Boat Access (Smugglers Beach) Willow Street
	Parkers River Beach Parking West Yarmouth Road
	Sea View Beach Parking Station Avenue/Union St
	Wilbur Park Parking Lot and Boat Access Forest Road
	Windmill Beach Parking Higgins-Crowell Road
	Bayview Beach Parking Bayview Street - to the Hospital
	Colonial Acres Beach East Main Street - to the Hospital
	Seagull Beach Parking Lot Camp Street - to the Hospital
	Bass River Bridges (Route 6 and Route 28) Highbank Road
	Parkers River Bridge (Route 28) Old Town House
	Highbank Road Bridge North Dennis Road/North Main Street
Route 6 White's Path	

Table 3.3 | List of critical facilities in Yarmouth (continued)

Built Environment

Type of Critical Facility		Name of Critical Facility
Transportation	Critical assets in all 5 modes of transportation (air, road, transit, rail, sea). Source: FEMA How-to Guide 2/ FEMA 386-2	South Shore Drive Culvert - North Dennis Rd - Crab Creek drains Mill Pond
		South Street Culvert - Park Ave - Hospital bogs (1)
		Seaview Ave Culvert - Park Ave - Hospital bogs (2)
		Culvert - Bayview St - Private Marsh Culvert - Route 28 - Mill Pond
		Culvert - Buck Island Rd - Plashes Brook Culvert - Route 28 - Bogs to Mill Creek (1)
		Culvert - Buck Island Rd - Town Brook drains Big Sandy Pond Culvert - Route 28 - Bogs to Mill Creek (2)
		Culvert - Buck Island Rd - Hawes Run Culvert - Route 6A - Whites Brook
		Culvert - Camp St - Wetland to Mill Pond Culvert - Run Pond Rd - Wetlands
		Culvert - Clifford St - Herring Run Culvert - Shore Rd - Marsh
		Culvert - Forest Rd - Herring Run Culvert - South St - Run Pond
		Culvert - Higgins Crowell Rd - Thorton Brook drains Jabez Neds Culvert - Standish Way - Lagoon
		Culvert - Highbank Rd - Wetlands Culvert - Thacher Shore - Marsh
		Culvert - Homers Dock - Wetlands Culvert - Washington Ave - Hawes Run
		Culvert - Lewis Bay Rd - Wetlands Culvert - Winslow Gray Rd - Wetlands to Parkers River
		Culvert - Long Pond Dr - Herring Run and Pond Outlet Culvert - Winslow Gray Rd - Plashes Brook
Culvert - Mill Lane - Halleys Mill Pond drains marshes		

Table 3.3 | List of critical facilities in Yarmouth (continued)

Built Environment

B4a

Repetitive Loss Properties

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.

The Town of Yarmouth has 12 Repetitive Loss Properties plus 1 Severe Repetitive Loss Property. All 13 properties are residential, with one condominium.

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Vulnerability Assessment

CHAPTER FOUR

Chapter 2 of the Yarmouth Hazard Mitigation Plan profiled natural hazards that could impact the town in the future or have impacted Yarmouth in the past. Chapter 3 inventoried 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 Yarmouth could experience during a natural hazard event. **Essentially, Chapter 4 answers the question: How will assets in Yarmouth be affected by hazard events?**

Methodology: Vulnerability Assessments

Methodology: Vulnerability Assessments

There are two assessments included in Chapter 4 of the 2017 Yarmouth Hazard Mitigation Plan:

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

1. To estimate the total number of parcels and value of buildings located in Yarmouth, the Planning Team used Town Assessing data from 2015. This 2015 data set contains information about parcels such as use codes, building characteristics and assessed value. The 2015 parcel data is also linked to geometry data for specific parcels on the ground. The 2015 data was used because it 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 were not selected by members of the Planning Team; instead category names are based on the State's Classification Code. 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
- **Multifamily Dwelling:** includes condos, 2-3 family homes, multiple houses on a single property, 4-8 unit homes, and 8+ units

¹ Property type classification codes, non-arm's length codes and sales report spreadsheet specifications, prepared by the Bureau of Local Assessment, revised March 2015, <http://www.mass.gov/dor/docs/dls/bla/classificationcodebook.pdf>

Methodology: Vulnerability Assessments

- **Non-Profit/Municipal:** government or town owned properties, public parking lots, libraries, museums, fraternal offices
 - **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
2. Next, the Planning Team used GIS to overlay maps of hazard areas onto parcel and value data. Only a subset of natural hazards were identified for further vulnerability assessment (see **Table 2.7** 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 Yarmouth 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 Yarmouth.
 - **Sea Level Rise:** Bathtub model developed by the Cape Cod Commission was used to model the impacts of sea level rise on Yarmouth. **Figure 2.23** in Chapter 2 shows a Sea Level Rise map for the Town of Yarmouth.
 - **Coastal Erosion/Shoreline Change:** The Planning Team used GIS to identify which properties had a physical connection to saltwater. Properties that share a boundary with saltwater were identified as “coastal property.” Parcel and building values were identified. The Planning Team recognizes that this method is not perfect.
 - **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.

Methodology: Vulnerability Assessments

- **Severe Winter Weather:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **Thunderstorms:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **Urban Fire:** Data is not available. A detailed vulnerability assessment could not be completed at this time.
- **Wildfire:** A wildfire vulnerability assessment was already completed for Yarmouth in 2012 by wildfire professionals. This assessment exists as part of the Barnstable County Wildfire Preparedness Plan. To view this assessment see: http://ne-ffm.com/Barn_Co._CWPP_Final.pdf.

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 models have their strengths and their weaknesses:

- **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 by taking into account the atmospheric pressure, size, forward speed,

and track data.² 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.³

- **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

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

³ <http://www.nhc.noaa.gov/surge/slosh.php>

Methodology: Vulnerability Assessments

to as a “bathtub” model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

Methods of Exposure Assessment of Critical Facilities:

For this exposure assessment, the planning team compiled a list of critical facilities list and mapped them in GIS. Sea level rise, flooding, and 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 if the parcel boundary of the critical facility was adjacent to salt water. As mentioned in the previous section, maps for nor'easters, high winds, severe winter weather, thunderstorms, and urban fire are not available and therefore their impact on critical facilities was not determined.

Results: Vulnerability Assessment

Results: Vulnerability Assessment Parcels and Buildings in Hazard Areas

Parcels and Buildings Vulnerable to Flooding

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	4	2	50%	\$248,600	\$195,800	79%
Banks	6	1	17%	\$3,923,600	\$366,800	9%
Church/Non-Profit Offices	38	7	18%	\$16,821,300	\$4,119,300	24%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	16	36%	\$43,673,500	\$3,148,100	7%
General Services	76	14	18%	\$63,962,400	\$6,963,300	11%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	2	12%	\$3,525,900	\$158,000	4%
Medical Office/Clinic	14	1	7%	\$5,830,400	\$602,100	10%
Multi-family Dwelling	772	263	34%	\$206,496,655	\$56,206,123	27%
Parking	17	3	18%	\$183,300	\$12,900	7%
Personal/Repair Services	13	1	8%	\$1,339,000	\$104,200	8%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	33	22%	\$55,373,200	\$9,979,500	18%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	2,980	23%	\$2,169,684,808	\$550,918,139	25%
Temporary Lodging	69	28	41%	\$59,700,900	\$25,120,900	42%
Vacant	1,230	453	37%	\$57,711,900	\$536,000	1%
Wholesale Trade	72	4	6%	\$21,298,300	\$299,200	1%
COLUMN TOTAL	15,402	3,812		\$2,777,512,363	\$659,278,662	

Table 4.1 | The proportion of buildings and value of buildings located in an A zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Flooding (V Zone)						
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	4	0	0%	\$248,600	\$0	0%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	0	0%	\$16,821,300	\$0	0%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	6	14%	\$43,673,500	\$429,200	1%
General Services	76	2	3%	\$63,962,400	\$591,100	1%
Heavy Industrial	9	0	0%	\$2,097,000	\$0	0%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	25	3%	\$206,496,655	\$14,419,700	7%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	0	0%	\$55,373,200	\$0	0%
Schools	7	0	0%	\$59,710,600	\$0	0%
Single Family Dwelling	12,849	284	2%	\$2,169,684,808	\$119,671,400	6%
Temporary Lodging	69	10	14%	\$59,700,900	\$9,715,200	16%
Vacant	1,230	119	10%	\$57,711,900	\$345,600	1%
Wholesale Trade	72	0	0%	\$21,298,300	\$0	0%
COLUMN TOTAL	15,402	446		\$2,777,512,363	\$145,172,200	

Table 4.2 | The proportion of buildings and value of buildings located in a V zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Sea Level Rise

Sea Level Rise (1 foot)						
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	4	1	25%	\$248,600	\$43,900	18%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	0	0%	\$16,821,300	\$0	0%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	7	16%	\$43,673,500	\$1,713,200	4%
General Services	76	6	8%	\$63,962,400	\$3,224,700	5%
Heavy Industrial	9	1	11%	\$2,097,000	\$116,600	6%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	43	6%	\$206,496,655	\$24,267,700	12%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	8	5%	\$55,373,200	\$2,841,200	5%
Schools	7	0	0%	\$59,710,600	\$0	0%
Single Family Dwelling	12,849	726	6%	\$2,169,684,808	\$226,304,420	10%
Temporary Lodging	69	17	25%	\$59,700,900	\$21,203,100	36%
Vacant	1,230	288	23%	\$57,711,900	\$661,100	1%
Wholesale Trade	72	2	3%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	1,099		\$2,777,512,363	\$280,520,820	

Table 4.3 | The proportion of buildings and value of buildings exposed to 1 foot of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Sea Level Rise (2 feet)						
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	4	1	25%	\$248,600	\$43,900	18%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	0	0%	\$16,821,300	\$0	0%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	7	16%	\$43,673,500	\$1,713,200	4%
General Services	76	6	8%	\$63,962,400	\$3,224,700	5%
Heavy Industrial	9	1	11%	\$2,097,000	\$116,600	6%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	62	8%	\$206,496,655	\$28,159,900	14%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	8	5%	\$55,373,200	\$2,841,200	5%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	889	7%	\$2,169,684,808	\$260,590,620	12%
Temporary Lodging	69	18	26%	\$59,700,900	\$21,285,000	36%
Vacant	1,230	318	26%	\$57,711,900	\$761,100	1%
Wholesale Trade	72	2	3%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	1,313		\$2,777,512,363	\$319,245,220	

Table 4.4 | The proportion of buildings and value of buildings exposed to 2 feet of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Sea Level Rise (3 feet)						
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	4	1	25%	\$248,600	\$43,900	18%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	0	0%	\$16,821,300	\$0	0%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	9	20%	\$43,673,500	\$1,713,200	4%
General Services	76	6	8%	\$63,962,400	\$3,224,700	5%
Heavy Industrial	9	2	22%	\$2,097,000	\$184,200	9%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	92	12%	\$206,496,655	\$32,601,798	16%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	11	7%	\$55,373,200	\$3,693,100	7%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	1,158	9%	\$2,169,684,808	\$304,969,320	14%
Temporary Lodging	69	19	28%	\$59,700,900	\$21,801,200	37%
Vacant	1230	361	29%	\$57,711,900	\$763,000	1%
Wholesale Trade	72	2	3%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	1,662		\$2,777,512,363	\$369,503,418	

Table 4.5 | The proportion of buildings and value of buildings exposed to 3 feet of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Sea Level Rise (4 feet)						
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	4	1	25%	\$248,600	\$43,900	18%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	1	3%	\$16,821,300	\$777,000	5%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	11	25%	\$43,673,500	\$1,713,200	4%
General Services	76	8	11%	\$63,962,400	\$5,978,400	9%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	124	16%	\$206,496,655	\$37,982,398	18%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	11	7%	\$55,373,200	\$3,693,100	7%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	1,459	11%	\$2,169,684,808	\$349,752,960	16%
Temporary Lodging	69	19	28%	\$59,700,900	\$21,801,200	37%
Vacant	1,230	391	32%	\$57,711,900	\$771,700	1%
Wholesale Trade	72	3	4%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	2,032		\$2,777,512,363	\$423,207,058	

Table 4.6 | The proportion of buildings and value of buildings exposed to 4 feet of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Sea Level Rise (5 feet)						
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	4	2	50%	\$248,600	\$195,800	79%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	3	8%	\$16,821,300	\$3,670,800	22%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	15	34%	\$43,673,500	\$2,846,500	7%
General Services	76	9	12%	\$63,962,400	\$6,184,700	10%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	162	21%	\$206,496,655	\$42,985,798	21%
Parking	17	1	6%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	15	10%	\$55,373,200	\$4,745,600	9%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	1,846	14%	\$2,169,684,808	\$413,926,060	19%
Temporary Lodging	69	25	36%	\$59,700,900	\$24,552,100	41%
Vacant	1,230	436	35%	\$57,711,900	\$794,900	1%
Wholesale Trade	72	3	4%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	2,521		\$2,777,512,363	\$500,595,458	

Table 4.7 | The proportion of buildings and value of buildings exposed to 5 feet of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Sea Level Rise (6 feet)						
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	4	2	50%	\$248,600	\$195,800	79%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	5	13%	\$16,821,300	\$4,360,100	26%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	16	36%	\$43,673,500	\$3,095,800	7%
General Services	76	12	16%	\$63,962,400	\$6,740,000	11%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	1	7%	\$5,830,400	\$602,100	10%
Multi-family Dwelling	772	188	24%	\$206,496,655	\$49,025,898	24%
Parking	17	1	6%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	1	8%	\$933,500	\$0	0%
Retail Trade	150	20	13%	\$55,373,200	\$6,172,300	11%
Schools	7	2	29%	\$59,710,600	\$2,331,400	4%
Single Family Dwelling	12,849	2,188	17%	\$2,169,684,808	\$465,798,985	21%
Temporary Lodging	69	26	38%	\$59,700,900	\$24,652,100	41%
Vacant	1,230	470	38%	\$57,711,900	\$898,300	2%
Wholesale Trade	72	4	6%	\$21,298,300	\$299,200	1%
COLUMN TOTAL	15,402	2,939		\$2,777,512,363	\$564,356,183	

Table 4.8 | The proportion of buildings and value of buildings exposed to 6 feet of sea level rise. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Storm Surge During Hurricanes

SLOSH (Category 1 Storm)						
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	4	0	0%	\$248,600	\$0	0%
Banks	6	0	0%	\$3,923,600	\$0	0%
Church/Non-Profit Offices	38	0	0%	\$16,821,300	\$0	0%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	11	25%	\$43,673,500	\$1,713,200	4%
General Services	76	5	7%	\$63,962,400	\$3,192,700	5%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	0	0%	\$3,525,900	\$0	0%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	144	19%	\$206,496,655	\$39,014,798	19%
Parking	17	0	0%	\$183,300	\$0	0%
Personal/Repair Services	13	0	0%	\$1,339,000	\$0	0%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	12	8%	\$55,373,200	\$4,300,100	8%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	1,391	11%	\$2,169,684,808	\$323,077,220	15%
Temporary Lodging	69	20	29%	\$59,700,900	\$23,357,100	39%
Vacant	1,230	326	27%	\$57,711,900	\$581,500	1%
Wholesale Trade	72	1	1%	\$21,298,300	\$47,400	0%
COLUMN TOTAL	15,402	1,914		\$2,777,512,363	\$395,832,318	

Table 4.9 | The proportion of buildings and value of buildings located in Category 1 SLOSH zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

SLOSH (Category 2 Storm)						
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	4	2	50%	\$248,600	\$195,800	79%
Banks	6	1	17%	\$3,923,600	\$366,800	9%
Church/Non-Profit Offices	38	5	13%	\$16,821,300	\$2,461,400	15%
Emergency Response	2	0	0%	\$4,997,500	\$0	0%
Entertainment and Recreation	44	14	32%	\$43,673,500	\$2,644,700	6%
General Services	76	13	17%	\$63,962,400	\$5,143,700	8%
Heavy Industrial	9	3	33%	\$2,097,000	\$184,200	9%
Light Industrial	17	2	12%	\$3,525,900	\$158,000	4%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	255	33%	\$206,496,655	\$57,626,223	28%
Parking	17	3	18%	\$183,300	\$12,900	7%
Personal/Repair Services	13	1	8%	\$1,339,000	\$27,600	2%
Professional/Tech. Services	13	0	0%	\$933,500	\$0	0%
Retail Trade	150	33	22%	\$55,373,200	\$10,567,200	19%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	3,019	23%	\$2,169,684,808	\$568,503,239	26%
Temporary Lodging	69	27	39%	\$59,700,900	\$24,887,600	42%
Vacant	1,230	391	32%	\$57,711,900	\$766,700	1%
Wholesale Trade	72	3	4%	\$21,298,300	\$144,900	1%
COLUMN TOTAL	15,402	3,773		\$2,777,512,363	\$674,055,062	

Table 4.10 | The proportion of buildings and value of buildings located in Category 2 SLOSH zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

SLOSH (Category 3 Storm)						
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	4	3	75%	\$248,600	\$248,600	100%
Banks	6	1	17%	\$3,923,600	\$366,800	9%
Church/Non-Profit Offices	38	7	18%	\$16,821,300	\$4,631,300	28%
Emergency Response	2	1	50%	\$4,997,500	\$770,100	15%
Entertainment and Recreation	44	13	30%	\$43,673,500	\$3,290,400	8%
General Services	76	23	30%	\$63,962,400	\$8,212,200	13%
Heavy Industrial	9		0%	\$2,097,000		0%
Light Industrial	17	3	18%	\$3,525,900	\$207,400	6%
Medical Office/Clinic	14	1	7%	\$5,830,400	\$602,100	10%
Multi-family Dwelling	772	253	33%	\$206,496,655	\$62,559,032	30%
Parking	17	2	12%	\$183,300	\$34,600	19%
Personal/Repair Services	13	3	23%	\$1,339,000	\$315,500	24%
Professional/Tech. Services	13	1	8%	\$933,500	\$336,900	36%
Retail Trade	150	60	40%	\$55,373,200	\$24,233,000	44%
Schools	7	1	14%	\$59,710,600	\$364,100	1%
Single Family Dwelling	12,849	3,237	25%	\$2,169,684,808	\$595,182,861	27%
Temporary Lodging	69	35	51%	\$59,700,900	\$25,980,400	44%
Vacant	1230	375	30%	\$57,711,900	\$934,700	2%
Wholesale Trade	72	3	4%	\$21,298,300	\$222,100	1%
COLUMN TOTAL	15,402	4,022		\$2,777,512,363	\$728,492,093	

Table 4.11 | The proportion of buildings and value of buildings located in Category 3 SLOSH zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

SLOSH (Category 4 Storm)						
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	4	4	100%	\$248,600	\$248,600	100%
Banks	6	1	17%	\$3,923,600	\$480,200	12%
Church/Non-Profit Offices	38	13	34%	\$16,821,300	\$10,931,400	65%
Emergency Response	2	1	50%	\$4,997,500	\$770,100	15%
Entertainment and Recreation	44	10	23%	\$43,673,500	\$3,097,500	7%
General Services	76	25	33%	\$63,962,400	\$15,642,300	24%
Heavy Industrial	9	0	0%	\$2,097,000	\$0	0%
Light Industrial	17	4	24%	\$3,525,900	\$318,300	9%
Medical Office/Clinic	14	0	0%	\$5,830,400	\$0	0%
Multi-family Dwelling	772	207	27%	\$206,496,655	\$52,351,900	25%
Parking	17	5	29%	\$183,300	\$39,200	21%
Personal/Repair Services	13	8	62%	\$1,339,000	\$794,100	59%
Professional/Tech. Services	13	3	23%	\$933,500	\$800,700	86%
Retail Trade	150	61	41%	\$55,373,200	\$24,337,700	44%
Schools	7	2	29%	\$59,710,600	\$2,173,800	4%
Single Family Dwelling	12,849	2,963	23%	\$2,169,684,808	\$521,388,897	24%
Temporary Lodging	69	30	43%	\$59,700,900	\$25,305,300	42%
Vacant	1230	360	29%	\$57,711,900	\$4,374,900	8%
Wholesale Trade	72	4	6%	\$21,298,300	\$365,600	2%
COLUMN TOTAL	15,402	3,701		\$2,777,512,363	\$663,420,497	

Table 4.12 | The proportion of buildings and value of buildings located in Category 4 SLOSH zone. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Shoreline Change

Coastal Properties		
	# of Buildings in Hazard area	\$ of Buildings in Hazard area
Coastal	726	\$239,071,800
Not Coastal	14,980	\$2,853,345,200
COLUMN TOTAL	15,706	\$3,092,417,000

Table 4.13 | The number of parcels and value of buildings on parcels that share a physical boundary with sea water. If a parcel shares a boundary with sea water, it is assumed to be vulnerable to coastal hazards such as shoreline change and erosion. Table generated using 2015 Yarmouth Assessing Data.

Results: Vulnerability Assessment

Exposure Assessment of Critical Facilities by the Planning Team

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Police Station/EOC	N	N	N	N	N	N	N	N	N	N	N	N	N
Dennis-Yarmouth Regional High School/ Regional Shelter	N	N	N	N	N	N	N	N	N	N	N	N	N
Mattacheese Middle School	N	N	N	N	N	N	N	N	N	N	N	N	N
Station Avenue Elementary School	N	N	N	N	N	N	N	N	N	N	N	N	N
Marguerite E. Small Elementary School	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Fire Headquarters	N	N	N	Y	N	N	N	N	N	N	N	N	N
Yarmouth Port Fire Station #2	N	N	N	N	N	N	N	N	N	N	N	N	N
West Yarmouth Fire Station #3	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Town Hall	N	N	N	Y	N	N	N	N	N	N	N	N	N
South Yarmouth Public Library	N	N	N	N	N	N	N	N	N	N	N	N	N
West Yarmouth Public Library	N	N	N	Y	N	N	N	N	N	N	N	N	N
Highway Department	N	N	N	Y	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities. In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Yarmouth Natural Resources Department/Parks Department	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Water Department and Department of Public Works	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Housing Authority (Offices and Homes)	N	N	N	Y	N	N	N	N	N	N	N	N	N
Yarmouth Senior Center	N	N	N	N	N	N	N	N	N	N	N	N	N
Simpkins School Residences (55+)	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Maplewood at Mayflower Place Senior Living/Memory Care Facility	N	N	N	N	N	N	N	N	N	N	N	N	N
Windsor Nursing and Rehabilitation Center/Thirwood Place Asstd Living	N	N	N	N	N	N	N	N	N	N	N	N	N
St. Pius Life Center/St Pius K-8	N	N	N	N	N	N	N	N	N	N	N	N	N
MA State Police Troop D-2	N	N	N	Y	N	N	N	N	N	N	N	N	N
Cape Cod Hospital	N	N	N	N	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Yarmouth Septic Treatment Plant	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Regional Transfer Station	N	N	N	N	N	N	N	N	N	N	N	N	N
Yarmouth Residential Transfer Station/ Disposal Area & Fuel Depot	N	N	N	N	N	N	N	N	N	N	N	N	N
Eversource Headquarters	N	N	N	N	N	N	N	N	N	N	N	N	N
National Grid	N	N	N	N	N	N	N	N	N	N	N	N	N
Cell Tower on Whites Path	N	N	N	N	N	N	N	N	N	N	N	N	N
Prospect Hill Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
German Hill Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
Sandy Pond Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 1M	N	N	N	Y	N	N	N	N	N	N	N	N	N
Water Pump Station - 1, 2 & 3	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 4 & 5	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 6, 7 & 8	N	N	N	N	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Water Pump Station - 9	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 10	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 11	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 13, 18 & 19	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 14	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 15 & 16	N	N	N	Y	N	N	N	N	N	N	N	N	N
Water Pump Station - 17	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 20	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 21 & 22	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 23	N	N	N	N	N	N	N	N	N	N	N	N	N
Water Pump Station - 24	N	N	N	N	N	N	N	N	N	N	N	N	N
Two Microwave Telecommunications Links and Generators	N	N	N	N	N	N	N	N	N	N	N	N	N
Signal Hill Communications Tower	N	N	N	N	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Comcast Service Center	N	N	N	N	N	N	N	N	N	N	N	N	N
Fueling Depot at Yarmouth Highway Department	N	N	N	Y	N	N	N	N	N	N	N	N	N
FAA Beacon (Walden Way)	N	N	N	N	N	N	N	N	N	N	N	N	N
Packet Landing	Y	Y	Y	Y	N	Y, Coast	Y	N	Y				
Englewood Beach Marina (fuel and landing)	Y	Y	Y	Y	N	N	Y, Coast	Y, Coast	Y, Coast	Y, Coast	N	Y	N
Englewood Beach Parking	Y	Y	Y	Y	N	Y, Coast	Y	N	Y				
Bass Hole Parking Lot	N	N	Y	Y	N	N	N	N	N	Y	N	Y	Y
Bass River Beach, Parking and Boat Access (Smugglers Beach)	N	Y	Y	Y	N	N	N	N	N	Y	N	Y	Y
Parkers River Beach Parking	N	N	Y	Y	N	N	N	N	N	N	Y	N	Y
Sea View Beach Parking	N	N	Y	Y	N	N	N	N	N	N	N	N	Y
Wilbur Park Parking Lot and Boat Access	N	Y	Y	Y	N	N	N	N	N	Y	Y	N	Y
Windmill Beach Parking	N	N	Y	Y	N	N	N	N	N	N	N	N	Y
Bayview Beach Parking	Y	Y	Y	Y	N	Y, Coast	N	Y	Y				

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Colonial Acres Beach	Y	Y	Y	Y	N	Y, Coast	N	Y	N				
Seagull Beach Parking Lot	Y	Y	Y	Y	N	N	N	Y, Coast	Y, Coast	Y, Coast	N	Y	Y
Bass River Bridges (Route 6 and Route 28)	N	N	N	N	N	N	N	N	N	N	Y	N	N
Parkers River Bridge (Route 28)	Y	Y	Y	Y	N	Y, Coast	Y	N	N				
Highbank Road Bridge	N	N	N	N	N	N	N	N	N	N	Y	N	N
Route 6	N	N	Partial	Partial	N	N	N	N	N	N	N	N	N
Route 28	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	Partial	N	Partial
Route 6A	N	N	Partial	Partial	N	N	N	N	N	Partial	Partial	N	N
Buck Island Road	N	N	Partial	Partial	N	N	N	N	N	N	Partial	N	N
Winslow Gray Road	N	Partial	Partial	Partial	N	N	N	N	N	Partial	Partial	N	N
Willow Street	N	N	N	N	N	N	N	N	N	N	N	N	N
West Yarmouth Road	N	N	Partial	Partial	N	N	N	N	N	N	N	N	N
Station Avenue/Union St	N	N	N	Partial	N	N	N	N	N	N	N	N	N
Forest Road	N	Partial	Partial	Partial	N	N	N	N	N	N	Partial	N	N
Higgins-Crowell Road	N	N	N	Partial	N	N	N	N	N	N	N	N	N
Bayview Street (to the Hospital)	Partial	Partial	Partial	Partial	N	N	Partial	Partial	Partial	Partial	Partial	Partial	N
East Main Street - to the Hospital	N	N	N	Partial	N	N	N	N	N	N	N	N	N
Camp Street - to the Hospital	N	N	Partial	Partial	N	N	N	N	N	N	Partial	N	N
Highbank Road	N	Partial	Partial	Partial	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Old Town House	N	N	N	N	N	N	N	N	N	N	N	N	N
North Dennis Road/ North Main Street	Partial	Partial	Partial	Partial	N	N	Partial	Partial	Partial	Partial	N	Partial	Partial
White's Path	N	N	N	Partial	N	N	N	N	N	N	N	N	N
South Shore Drive	Partial	Partial	Partial	Partial	N	N	Partial	Partial	Partial	Partial	Y	Partial	Partial
South Street	Partial	Partial	Partial	Y	N	Partial	Partial	Partial	Partial	Partial	Partial	N	Partial
Seaview Ave	Partial	Y	Y	Y	N	N	Partial	Partial	Partial	Partial	Y	N	N
Culvert - Bayview St - private marsh	Y	Y	Y	Y	N	N	Y, Coast	Y, Coast	Y, Coast	Y, Coast	N	Y	Y
Culvert - Buck Island Rd - Plashes Brook	N	N	N	Y	N	N	N	N	N	N	N	N	N
Culvert - Buck Island Rd - Town Brook drains Big Sandy Pond	N	N	N	Y	N	N	N	N	N	N	Y	N	N
Culvert - Buck Island Rd - Hawes Run	N	N	N	Y	N	N	N	N	N	N	N	N	N
Culvert - Camp St - wetland to Mill Pond	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Culvert - Clifford St - Herring Run	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Culvert - Forest Rd - Herring Run	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Culvert - Higgins Crowell Rd - Thornton Brook drains Jabez Neds	N	N	N	Y	N	N	N	N	N	N	N	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Culvert - Highbank Rd - wetlands	N	N	N	Y	N	N	N	N	N	N	N	N	Y
Culvert - Homers Dock - wetlands	N	N	Y	Y	N	N	N	N	Y, Coast	Y, Coast	Y	N	Y
Culvert - Lewis Bay Rd - wetlands	Y	Y	Y	Y	N	N	N	N	Y, Coast	Y, Coast	Y	N	N
Culvert - Long Pond Dr - Herring Run and Pond Outlet	N	N	Y	N	N	N	N	N	N	N	N	N	N
Culvert - Mill Lane - Hallets Mill Pond drains marshes	N	N	Y	N	N	N	N	Y, Coast	Y, Coast	Y, Coast	Y	N	N
Culvert - North Dennis Rd - Crab Creek drains Mill Pond	N	N	N	N	N	N	N	N	N	N	Y	N	Y
Culvert - Park Ave - hospital bogs	Y	N	N	N	N	N	N	N	Y, Coast	Y, Coast	Y	N	Y
Culvert - Park Ave - hospital bogs	N	N	N	N	N	Y, Coast	N	Y	N				
Culvert - Route 28 - Mill Pond	N	Y	Y	Y	N	N	N	N	N	N	Y	N	Y
Culvert - Route 28 - bogs to Mill Creek	N	Y	Y	Y	N	N	N	N	N	Y, Coast	Y	N	Y
Culvert - Route 28 - bogs to Mill Creek	N	Y	Y	Y	N	N	N	N	N	N	Y	N	Y
Culvert - Route 6A - Whites Brook	N	N	N	Y	N	N	N	N	N	N	Y	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Results: Vulnerability Assessment

Name of Critical Facility	SLOSH Cat 1	SLOSH Cat 2	SLOSH Cat 3	SLOSH Cat 4	Sea Level Rise 1 foot	Sea Level Rise 2 feet	Sea Level Rise 3 feet	Sea Level Rise 4 feet	Sea Level Rise 5 feet	Sea Level Rise 6 feet	Special Flood Hazard Area (AE)	Special Flood Hazard Area (VE)	COASTAL (boundary with salt water)
Culvert - Run Pond Rd - wetlands	Y	Y	Y	Y	N	Y, Coast	Y	N	N				
Culvert - Shore Rd - marsh	Y	Y	Y	Y	Y, Coast	N	Y	N	Y				
Culvert - South St - Run Pond	Y	Y	Y	Y	N	N	Y, Coast	Y, Coast	Y, Coast	Y, Coast	Y	N	Y
Culvert - Standish Way - lagoon	Y	Y	Y	Y	N	N	Y, Coast	Y, Coast	Y, Coast	Y, Coast	N	Y	Y
Culvert - Thacher Shore - marsh	N	N	Y	Y	N	N	N	N	Y, Coast	Y, Coast	Y	N	Y
Culvert - Washington Ave - Hawes Run	N	N	N	N	N	N	N	N	N	N	N	N	N
Culvert - Winslow Gray Rd - wetlands to Parkers River	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N
Culvert - Winslow Gray Rd - Plashes Brook	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N

Table 4.14 | Exposure assessment for critical facilities (continued). In the Sea Level Rise section of the table, “Y coast” represents facilities that are inundated by water from the coast, “Y depression” represents facilities that are inundated because they are in low-lying areas.

Vulnerable Populations

B3b

Vulnerable Populations

Below is a description of segments of the population who are vulnerable to the impacts of natural hazard events⁴:

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.⁵

Earthquake: The entire population of Massachusetts 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.⁶

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.⁷

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.⁸ 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

4 Massachusetts State Hazard Mitigation Plan, 2013

5 <http://www.nhc.noaa.gov/surge/slosh.php>

6 Massachusetts State Hazard Mitigation Plan, 2013

7 Massachusetts State Hazard Mitigation Plan, 2013

8 <http://www.nhc.noaa.gov/surge/slosh.php>

Vulnerable Populations

evacuating.⁹ People with disabilities are also vulnerable during a flood event as they may have difficulty evacuating or obtaining necessary assistance.

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 received 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.¹⁰ 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.¹¹ People with disabilities are also vulnerable during a flood event as they may have difficulty evacuating or obtaining necessary assistance.

⁹ <http://www.nhc.noaa.gov/surge/slosh.php>

¹⁰ Massachusetts State Hazard Mitigation Plan, 2013

¹¹ Massachusetts State Hazard Mitigation Plan, 2013

Landslides: It is difficult to determine demographics of populations vulnerable to landslides.¹²

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 or not residents received adequate warning time. It is assumed that the entire Commonwealth's population is exposed to this hazard (wind and rain/snow). 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.¹³ People with disabilities are also vulnerable during a Nor'easter as they may have difficulty evacuating or obtaining necessary assistance.

Severe Weather (wind, thunderstorms, tornadoes, extreme temperatures, drought): For the purposes of this plan, the entire population of Yarmouth 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

¹² Massachusetts State Hazard Mitigation Plan, 2013

¹³ Massachusetts State Hazard Mitigation Plan, 2013

Vulnerable Populations

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 disabilities and 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.¹⁴

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.¹⁵

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).¹⁶ People with disabilities are also vulnerable as they may have difficulty receiving necessary assistance or evacuating from their residences.

Tsunami: It is difficult to determine demographics of populations vulnerable to tsunamis.¹⁷

14 Massachusetts State Hazard Mitigation Plan, 2013

15 Massachusetts State Hazard Mitigation Plan, 2013

16 Massachusetts State Hazard Mitigation Plan, 2013

17 Massachusetts State Hazard Mitigation Plan, 2013

Summary of Vulnerable Infrastructure

B3b

Summary of Vulnerable Infrastructure

According to the analysis performed, most of the essential critical facilities in Yarmouth are not in the floodplain and not susceptible to sea level rise or hurricanes. Below is a description of Yarmouth infrastructure that is vulnerable to the impacts of natural hazard events:

- Overhead power lines are vulnerable to high winds.
- Several culverts are located within the floodplain.
- Many of the primary access roads in Yarmouth, such as Route 6 and Route 28, and some of the roads providing access to the hospital are partially in the floodplain and susceptible to sea level rise and hurricanes.
- The Town has several beach parking lots that are susceptible to sea level rise, hurricanes, and are located within the flood zones.
- There are three water pump stations, the Yarmouth Fire Headquarters, Town Hall, Highway Department, West Yarmouth Library, Mass State Police Barracks and one fuel depot that would be vulnerable during a category 4 hurricane.
- The Simpkins Residences (elderly housing) would be vulnerable during a category 3 and 4

hurricane, while the Yarmouth Housing Authority Offices and low income housing would be vulnerable during a category 4 hurricane.

- Storm water pipes located at the water's edge become clogged with sand and debris. These pipes require continual maintenance.

Mitigation Strategy

CHAPTER FIVE

Chapter 2 profiled specific hazards that could affect Yarmouth and Chapter 4 assessed the losses that could result from those hazard events. The next step in the hazard planning process is to identify actions to reduce risk and loss of life and to develop way 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 mitigation strategy for the Town of Yarmouth for the next five years.**

Mitigation Goals

Mitigation Goals

Mitigation goals are broad guidelines that articulate Yarmouth's desire to protect people and structures, reduce the cost of disaster response and recovery, and minimize disruption to the community following a disaster.¹

C3a,b

Mitigation Goals

Mitigation Goals for the 2017 Yarmouth Hazard Mitigation Plan are:

1. Reduce the potential for loss of life and injury resulting from natural hazards.
2. Mitigate financial losses incurred by municipal, residential, industrial, agricultural, and commercial establishments due to natural hazards.
3. Reduce the damage to public infrastructure resulting from natural hazards including but not limited to critical facilities, roadways and culverts, and water facilities.
4. Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Yarmouth.

5. Increase public awareness through education of potential hazards that threaten the community and outline mitigation measures that can be taken to lessen impacts and increase preparedness.
6. Encourage hazard mitigation planning as part of the overall municipal planning process.
7. Competitively position the Town to seek and apply for funding opportunities to implement the actions identified in the Yarmouth Hazard Mitigation Plan.

Mitigation Actions for the 2017 Hazard Mitigation Plan

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 Yarmouth.

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 routinely updated to ensure that it remains consistent with current Town priorities. The mitigation actions are in no particular order, but they have been prioritized by the planning team.

¹ FEMA How-to Guide 3: Developing the Mitigation Plan: Identifying mitigation actions and implementation strategies, FEMA 386-3, April 2003

Mitigation Actions for the 2017 Hazard Mitigation Plan

The planning team considered the following to prioritize the mitigation actions:

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 Yarmouth'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 Yarmouth's Mitigation Goals and Objectives?
- Does Yarmouth 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?

The Planning Team prioritized the mitigation actions into three categories:

- **High priority:** Town will begin or complete the action within 3 years
- **Medium priority:** Town will begin or complete the action within 4 years
- **Low priority:** Town will begin or complete the action within 5 years

C5a

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #1

Improve Yarmouth's emergency notification system by increasing number of subscribers to CodeRED, pursue town-owned variable message boards at the fire station and transfer station; consider reinstating emergency alert sirens

Project Type

Planning and Development

Responsible Dept

Police Department, Fire Department

Funding Sources

Town Staff Budget,
<\$50,000

Timeframe

2 years

Consistency with Mitigation Goals

Reduce the potential for loss of life and injury; mitigate financial losses; increase public awareness through education

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015);
Yarmouth Emergency Operations Plan

Priority: High

All Hazards

Mitigation Action #2

Develop and update educational materials, displays and events to inform residents about natural hazards that threaten the town and mitigation measures they can take to lessen the impact and be better prepared; foster public awareness about securing debris, propane tanks, yard items and stored objects prior to extreme weather events; continue to maintain website and channel 18; require BCREPC's information for responding to a radiation emergency be included in educational materials and posted on the Town website

Project Type

Outreach

Responsible Dept

Health Department,
Conservation Department,
Planning Department,
Department of Natural
Resources, Fire Department

Funding Sources

Town Staff Budget,
<\$50,000

Timeframe

1 year, annual thereafter

Consistency with Mitigation Goals

Increase public awareness through education

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #3

Obtain multiple inspection kits for Building Department staff and others to conduct post-disaster inspections of buildings; pursue public safety grants

Project Type	Responsible Dept
Mitigation	Building Department

Funding Sources	Timeframe
Town Staff Budget, Public Safety Grant from Target <\$100,000	3 years

Consistency with Mitigation Goals

Reduce the potential for loss of life and injury; reduce the damage to public infrastructure

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015);
Yarmouth Emergency Operations Plan

Priority: High

All Hazards

Mitigation Action #4

Continue to coordinate with the Barnstable County Regional Emergency Planning Committee, Massachusetts Emergency Management Agency, Massachusetts Department of Transportation

Project Type	Responsible Dept
Outreach	Police Department, Fire Department, Department of Public Works

Funding Sources	Timeframe
Town Staff Budget, <\$50,000	1 year, annual thereafter

Consistency with Mitigation Goals

Increase public awareness through education; encourage hazard mitigation planning as part of the overall municipal planning process

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015);
Yarmouth Emergency Operations Plan

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #5

Continue to monitor assets and infrastructure that are vulnerable to the effects of climate change

Project Type

Planning and Development

Responsible Dept

Department of Public Works, Fire, Conservation, Department of Natural Resources

Funding Sources

Town Staff Budget, <\$50,000

Timeframe

1 year, annual thereafter

Consistency with Mitigation Goals

Reduce the damage to public infrastructure

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

All Hazards

Mitigation Action #6

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

Project Type

Planning and Development

Responsible Dept:

Police Department, Fire Department, Building Department, Department of Natural Resources, Department of Health

Funding Sources

Town Staff Budget, <\$50,000

Timeframe

3 years

Consistency with Mitigation Goals

Reduce the potential for loss of life and injury; mitigate financial losses; reduce the damage to public infrastructure

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015); Yarmouth Emergency Operations Plan

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #7

Conduct an assessment of local infrastructure and critical facilities that are subject to damage from flooding or storm surge or that is likely to cause damage to surrounding areas should it fail or flood; develop, prioritize, and seek funding for a list of needed infrastructure improvement projects

Project Type

Mitigation

Responsible Dept

Department of Public Works, Fire Department, Department of Natural Resources, Conservation Commission

Funding Sources

FEMA HMA grants (25% appropriation from Town Meeting), CZM grants, <\$100,000

Timeframe

3 years

Consistency with Mitigation Goals

Reduce the potential for loss of life and injury; reduce the damage to public infrastructure; competitively position the Town to seek and apply for funding opportunities to implement the Yarmouth Hazard Mitigation Plan

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

All Hazards

Mitigation Action #8

Continue to coordinate rides to regional shelters for those in need, ensuring accessible transportation options are available to those with disabilities and limited mobility

Project Type

Planning and Development

Responsible Dept

Police Department, Department of Health, Senior Services

Funding Sources

Town Staff Budget, <\$50,000

Timeframe

1 year, annual thereafter

Consistency with Mitigation Goals

Reduce the potential for loss of life and injury

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding

Mitigation Action #9

Evaluate the Town of Yarmouth entering into the Community Rating System (CRS) at Level 9; conduct a cost-benefit analysis comparing the Town resources and Consultant required to apply for and maintain compliance with CRS compared to the total flood insurance savings to residents who have flood insurance; evaluate the need for supplemental funding

Project Type

Planning and Development

Responsible Dept

Building Department, Conservation Commission, Planning Department

Funding Sources

Town Staff Budget, \$100,000+

Timeframe

4 years

Consistency with Mitigation Goals

Mitigate financial losses; competitively position the Town to seek and apply for funding opportunities to implement the actions identified in the Yarmouth Hazard Mitigation Plan

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Flooding

Mitigation Action #10

Educate the public about MEMA's "Know Your Zone" Campaign and sheltering in place

Project Type

Outreach

Responsible Dept

Police Department, Fire Department, Planning Department, Department of Health, Senior Services

Funding Sources

Town Staff Budget, <\$50,000

Timeframe

1 year

Consistency with Mitigation Goals

Increase public awareness through education

Consistency with Other Town Plans

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding

Mitigation Action #11

Annually contact all owners of repetitive loss properties and inform them of financial assistance available for structural mitigation such as elevation and acquisition. Those structures substantially damaged (more than 50% of market value) must be brought up to code, which will reduce their flood risk and flood insurance premiums.

Project Type: **Responsible Dept:**

Planning and Development Planning Department

Funding Sources: **Timeframe:**

Town Staff Budget, 1 year
<\$50,000

Consistency with Mitigation Goals:

Mitigate financial losses; increase public awareness through education

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Low

Flooding

Mitigation Action #12

Identify if any repetitive loss properties have been mitigated by reviewing Building Department records. If so, work with FEMA to remove them from the repetitive loss list.

Project Type: **Responsible Dept:**

Planning and Development Planning Department,
Building Department

Funding Sources: **Timeframe:**

Town Staff Budget, 2 years
<\$50,000

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding

Mitigation Action #13

Evaluate whether drainage problems may have contributed to flood damage to repetitive loss properties

Project Type:

Planning and Development

Responsible Dept:

Planning Department,
Department of Public Works

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

2 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #14

Consider the suitability of green infrastructure including beach grass plantings as mitigation for proposed coastal projects

Project Type:

Planning and Development

Responsible Dept:

Department of Public Works,
Department of Natural
Resources, Conservation

Funding Sources:

FEMA HMA grants (25%
appropriation from Town
Meeting), CZM grants,
\$100,000+

Timeframe:

3 years

Consistency with Mitigation Goals:

Ensure that mitigation measures are sensitive to the natural features, historic resources, and community character of Yarmouth

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise**Mitigation Action #15**

Maintain and regularly update inventory of stormwater systems for age, material, and condition

Project Type:

Mitigation

Responsible Dept:

Department of Public Works

Funding Sources:

FEMA HMA grants (25% appropriation from Town Meeting), CZM grants, \$100,000+

Timeframe:

3 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; reduce the damage to public infrastructure; competitively position the Town to seek and apply for funding opportunities to implement the Yarmouth Hazard Mitigation Plan

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise**Mitigation Action #16**

Monitor shoreline and beach conditions for possible nourishment and beach stabilization

Project Type:

Mitigation

Responsible Dept:

Department of Natural Resources

Funding Sources:

Town Staff Budget, \$100,000+

Timeframe:

2 year

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; reduce the damage to public infrastructure; competitively position the Town to seek and apply for funding opportunities to implement the Yarmouth Hazard Mitigation Plan

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #17

Educate the public about litter and debris in stormwater systems

Project Type:

Planning and Development

Responsible Dept:

Department of Public Works

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

2 years

Consistency with Mitigation Goals:

Increase public awareness through education

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Shoreline Change and Erosion

Mitigation Action #18

Assess and monitor shoreline conditions and evaluate all vulnerable shoreline areas for possible future nourishment and beach stabilization projects; re-permit Town-wide 10-year dredging and beach nourishment permits

Project Type:

Planning and Development

Responsible Dept:

Department of Health,
Conservation Commission,
Department of Public
Works, Department of
Natural Resources, Parks &
Recreation

Funding Sources:

FEMA HMA grants (25%
appropriation from Town
Meeting), CZM grants,
\$100,000+

Timeframe:

4 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; mitigate financial losses; reduce the damage to public infrastructure

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Urban Fire

Mitigation Action #19

Continue to work with residents and developers to implement fire code and incorporate sprinkler systems into new developments and redevelopments

Project Type:

Outreach

Responsible Dept:

Fire Department, Building Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

All Hazards

Mitigation Action #20

Continue weather monitoring station at the Police Station and reporting system to gather accurate data on the location, history, extent and impact of natural hazards in Yarmouth

Project Type:

Data Collection

Responsible Dept:

Police Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Competitively position the Town to seek and apply for funding opportunities to implement the Yarmouth Hazard Mitigation Plan

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Wildfire

Mitigation Action #21

Continue to pursue funding for the prescribed burn program on town owned woodlands

Project Type:

Mitigation

Responsible Dept:

Department of Natural Resources, Fire Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; mitigate financial losses; reduce the damage to public infrastructure

Consistency with Other Town Plans:

Prescribed Burn Management Plan

Priority: High

All Hazards

Mitigation Action #22

Continue the Town's efforts to scan documents and have them backed up and stored in multiple off-site locations, including the scanning of vital statistics data

Project Type:

Planning and Development

Responsible Dept:

All Departments

Funding Sources:

Town Staff Budget,
\$100,000+

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Reduce damage to public infrastructure; encourage hazard mitigation planning as part of the overall municipal planning process

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #23

Work toward obtaining or upgrading generators at all Town owned critical facilities; maintain existing generators to ensure back-up power for the regional shelter

Project Type:

Mitigation

Responsible Dept:

Department of Public Works,
Fire Department

Funding Sources:

Town Staff Budget,
\$100,000+

Timeframe:

3 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; Mitigate financial losses; reduce the damage to public infrastructure

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015);
Yarmouth Emergency Operations Plan

Priority: High

All Hazards

Mitigation Action #24

Coordinate with realtors to include educational information for rental properties, on where to obtain information and how to stay informed, prepared, and safe in the event of a storm (list of phone numbers, radio stations, websites, etc.)

Project Type:

Outreach

Responsible Dept:

Planning Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Increase public awareness through education

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #25

Explore development of higher standards for stormwater treatment, recharge, and flood control throughout the community

Project Type:

Planning and Development

Responsible Dept:

Department of Public Works,
Conservation Commission,
Planning Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

3 years

Consistency with Mitigation Goals:

Reduce damage to public infrastructure; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Open Space and Recreation Plan (2015),
Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #26

Pursue grant funding to mitigate identified point source discharges of Town stormwater systems into surface waters; incorporate point discharge mitigation into municipal and state roadway projects

Project Type:

Mitigation

Responsible Dept:

Department of Public Works

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

3 years

Consistency with Mitigation Goals:

Reduce damage to public infrastructure; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Mitigation Actions for the 2017 Hazard Mitigation Plan

Flooding

Mitigation Action #27

Maintain a regular debris removal schedule for Town-owned culverts and drainage basins

Project Type:

Mitigation

Responsible Dept:

Department of Public Works

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Reduce damage to public infrastructure; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #28

Investigate acquisition of flood prone properties for un-development, stormwater enhancement, conservation, recreation and protection of scenic vistas

Project Type:

Planning and Development

Responsible Dept:

Planning Department,
Conservation Commission,
Department of Public Works

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

1 year, annual thereafter

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; Reduce damage to public infrastructure; Mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015);
Yarmouth Open Space and Recreation Plan (2015)

Priority: Medium

Mitigation Actions for the 2017 Hazard Mitigation Plan

All Hazards

Mitigation Action #29

Incorporate Multi-Hazard Mitigation Goals into the Local Comprehensive Plan (LCP)

Project Type:

Planning and Development

Responsible Dept:

Planning Department

Funding Sources:

Town Staff Budget,
<\$50,000

Timeframe:

3 years

Consistency with Mitigation Goals:

Encourage hazard mitigation planning as part of the overall municipal planning process

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: Medium

Flooding, Hurricanes, Tropical Storms, Severe Winter Weather, Nor'easters, Sea Level Rise

Mitigation Action #30

Pursue restoration of tidal flows under roads and through undersized culverts by incorporating improvements into planned road and bridge work and seeking funding and partnering opportunities

Project Type:

Mitigation

Responsible Dept:

Department of Public Works

Funding Sources:

Town Staff Budget,
\$100,000+

Timeframe:

5 years

Consistency with Mitigation Goals:

Reduce the potential for loss of life and injury; reduce damage to public infrastructure; mitigate financial losses

Consistency with Other Town Plans:

Yarmouth Local Comprehensive Plan (1997-2015)

Priority: High

Participation in NFIP

A6c

Participation in NFIP

B4a

Repetitive Loss Properties

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.

The Town of Yarmouth has 12 Repetitive Loss Properties plus 1 Severe Repetitive Loss Property. All 13 properties are residential, with one condominium.

An analysis was conducted of the 13 properties identified as repetitive loss or severe repetitive loss. A review of the 2017 Assessors records was conducted to compare improvement values to overall assessed values. The 13 properties have a combined “Improvements” value of \$2.16 million, compared to a total assessment of over \$10.42 million. Eleven of the properties directly abut water bodies resulting in their high land values and their susceptibility to losses from storms and other hazards.

The repetitive loss flooding is caused by a combination of storm surge and heavy precipitation. Eleven of the thirteen properties are waterfront and are susceptible to immediate surge from Nantucket Sound or are affected by funneling effects from various water bodies, including the Bass River, Parker River, Lewis Bay, Lewis Pond, and Mill Creek. The two primary storms that caused

damage were Hurricane Bob in 1991 and the Storm of the Century in 1993, both of which brought significant storm surge and rain. Other claims came from Hurricane Fran as well as several unnamed extra-tropical storms that brought heavy rains, wind, and coastal flooding (on top of astronomical tides). Of the properties that are not directly waterfront, one was affected by the two major storms (Hurricane Bob and Storm of the Century), while the other suffered damage from heavy rainstorms, two of which had strong south southeast winds.

Ten of the property owners have mailing addresses outside Yarmouth indicating that these are second or investment homes and not primary residences. Unfortunately, the high assessed values make it difficult for the Town or non-profits to purchase these properties subject to repetitive loss and restore them to their natural state.

The high assessed values and the small number of properties involved directed the mitigation strategies for repetitive loss properties towards education; evaluation and remediation of other potential sources of flooding such as drainage issues; and tracking and enforcement of mitigation of such properties.

Existing Capabilities Assessment

C2a

Continued compliance with NFIP

To be approved by the Federal Emergency Management Agency (FEMA), the Yarmouth Hazard Mitigation Plan 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 Yarmouth.¹ Federally backed flood insurance is available in Yarmouth as long as the Town agrees to regulate development in their mapped floodplain. To remain compliant with the NFIP, Yarmouth is committed to the following activities:

- Issue or deny floodplain development/building permits.
- Inspect all developments to ensure compliance with local ordinance.
- 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.

¹ National Flood Insurance Program (NFIP) Floodplain Management Requirements: A study guide and desk reference for local officials, FEMA 480, February 2005

Existing Capabilities Assessment

C1

During the development of the 2017 Yarmouth Hazard Mitigation plan, members of the Planning Team reviewed the capabilities of the Town's departments (see **Table 5.1**). This table shows the Town's current capabilities. At this time, the Town cannot expand its current capabilities, but during the maintenance and evaluation stages of the Plan, the Town will reassess the feasibility of expanding its capabilities.

Existing Capabilities Assessment

Natural Hazard	Explanation of Capability	Responsible Department
All Hazards	<p>Educational Materials: The town distributes educational materials from local, county, and state level organizations such as the Barnstable County Regional Emergency Planning Committee (BCREPC) and the Cape Cod Cooperative Extension (CCCE). Materials include but are not limited to: CCCE’s “Questions and Answers on Purchasing Coastal Real Estate in MA” and “Homeowner’s Handbook to Prepare for Coastal Hazards.” The Yarmouth Fire Department conducts a Public Safety Education program involving a wide range of public safety suitable for presentation to businesses, schools, and community groups.</p>	<p>Conservation Commission, Planning Department, Department of Natural Resources, Police and Fire Departments</p>
All Hazards	<p>Mutual Aid: Yarmouth opted-in to the Public Works Mutual Aid Agreement through MEMA. By opting in, Yarmouth can send and/or request assets from any other community within the Commonwealth that has also opted into the agreement. This agreement can be used for everyday use or be activated for any public safety incident or event. Yarmouth also has mutual aid agreements with neighboring communities.</p>	<p>Police and Fire Departments, Department of Public Works, Town Administrator</p>
All Hazards	<p>Emergency Communication: The Town has instituted the CodeRED emergency notification service which distributes emergency messages via telephone. Residents need to sign up for CodeRED and the Town is actively trying to get residents to register for this service. The Town owns one large variable message board that displays 3-4 lines of text. The board is usually placed on Route 6 to notify residents of hazards, lane closures, and parking instructions. The various Town emergency response services utilize hand held radios to maintain communication during emergencies. Open Cape backup communication systems have been located on the German Hill water tower to maintain communication during emergencies.</p>	<p>Police and Fire Departments, Department of Public Works, Town Administrator</p>
All Hazards	<p>Emergency Planning: Continuous review and practice of the Comprehensive Emergency Management Plan. Town staff determine supplies, equipment, and communications needs and prioritize purchases so that Yarmouth is prepared for any needed emergency response to any natural hazard event. The Fire Chief co-chairs and attends the monthly Barnstable County Regional Emergency Planning Committee meetings.</p>	<p>Town Administrator, Police Chief, Fire Chief, Department of Public Works, Building Department</p>

Table 5.1 | Existing capabilities assessment

Natural Hazard	Explanation of Capability	Responsible Department
All Hazards	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. The Town has supplied Eversource with a list of critical facilities to prioritize power restoration.	Police Department, Department of Public Works, Town Administrator
All Hazards	Generators: An inventory of town owned generators is continually reviewed and monitored by Town staff. New generators are being installed at various well pump houses to maintain the water supply during electrical outages.	Police and Fire Departments, Department of Public Works, Town Administrator
All Hazards	Shelter: Equipment inventories and needs for the regional shelter are assessed during monthly meetings of the Barnstable County Regional Emergency Planning Committee. The Town coordinates rides to the Regional Shelter for those in need and has an overflow shelter at the Senior Center already identified. The Town has supplemental equipment for a second shelter.	Police and Fire Departments, Department of Public Works, Town Administrator
All Hazards	Grant Funding: Department of Public Works and Division of Natural Resources have received grant funding for mitigation projects including stormwater, coastal infrastructure, and tidal restoration projects.	Department of Natural Resources, Department of Public Works
Fire	Fire Code: The Town observes state, federal, and local fire codes. New sprinkler system laws are continually enforced. The Building Commissioner and the Fire Department work with businesses to incorporate sprinkler systems into new developments and redevelopment projects.	Fire Department, Building Commissioner
Fire	Fire Prevention: Camp fires are not allowed in conservation areas and only by permit on Town Beaches for a special event. The Town combats the threat of uncontrolled wildland fires through the implementation of land management and prescribed burn programs, dependent upon grant funding.	Fire Department, Department of Natural Resources

Table 5.1 | Existing capabilities assessment (continued)

Existing Capabilities Assessment

Natural Hazard	Explanation of Capability	Responsible Department
Fire	Suppression Systems: Hydrants and sprinkler systems are connected to the municipal water system located throughout town.	Water Department, Building Department, Fire Department
Flooding	Education: Information on Special Flood Hazard Areas and FEMA Flood Insurance Rate Maps are available on the Town Website. The Town has develop GIS maps showing flood zones along with approximate property lines, roads, and building locations. Town staff regularly help the public to identify their flood hazard zone.	Planning Department, IT, Building Department
Flooding	Coastal Infrastructure: Department of Public Works and the Division of Natural Resources assesses infrastructure that is vulnerable to flooding and storm surge in collaboration with the Cape Cod Commission and Federal Highway Administration. Known drainage problems have been prioritized for improvements as funds become available.	Town Administrator, Department of Public Works, Department of Natural Resources
Flooding	State Building Code: Substantial monitoring and compliance activities are performed under administration of the State Building Code. Inspection and certification of lowest floor elevation is required by State Building Code. Elevation certificates are required by State Building Code. Applicants are required to submit plans that include the Special Flood Hazard Area and proposed elevations of the proposed structures.	Town Administrator, Building Commissioner, Conservation Commission, Planning Department
Flooding	Yarmouth Zoning Bylaw: Voters amended the Yarmouth Zoning Bylaw to make it consistent with the newly updated FEMA Flood Insurance Rate Maps (FIRMs) for Barnstable County (effective July 2014). This bylaw was also modified to be consistent with NFIP regulations.	Planning Department
Flooding	Conservation Commission: The Conservation Commission reviews and enforces the MA Wetlands Protection Act as well as the more restrictive Yarmouth Wetland Protection Regulations, and the Yarmouth Stormwater Management Regulations. The Commission reviews the local regulations periodically and regulates development within and adjacent to wetland resource areas including floodplains and stormwater management.	Conservation Commission

Table 5.1 | Existing capabilities assessment (continued)

Existing Capabilities Assessment

Natural Hazard	Explanation of Capability	Responsible Department
Flooding	Planning: The Open Space and Recreation Plan, along with the Local Comprehensive Plan, include goals for identifying land within the floodplain for purchase and preservation. The Town has been successful at doing this, including un-developing a previously developed property.	Planning Department, Open Space Committee, Conservation Commission
Flooding, Sea Level Rise, Severe Winter Storms, Nor'easters, Hurricanes/Tropical Storms	Essential Records: Town electronic files are backed up and stored in a building outside of the Special Flood Hazard Area. The Town is actively working on scanning Town files and records into Laserfiche, eliminating the reliance on paper records.	Board of Selectmen, Town Administrator, IT, Town Clerk
Flooding, Sea Level Rise, Severe Winter Storms, Nor'easters, Shoreline Change, Hurricanes/Tropical Storms	Stormwater: The Department of Public Works regularly cleans municipal catch basins, storm drains, and infiltration structures. The Town will be meeting the new MS4 Permit requirements which will result in more inspection, cleaning, and monitoring requirements for municipal drainage systems.	Board of Selectmen, Town Administrator, Department of Public Works
Shoreline Change, Flooding, Sea Level Rise, Severe Winter Storms, Nor'easters	Dredging: The Town currently has a 10-year permit (2010) for dredging and beach nourishment to allow for the placement of acceptable dredge materials on the north and south side beaches to counteract shoreline erosion and bolster shoreline protection.	Department of Natural Resources
Flooding, Severe Winter Storms, Nor'easters	Tidal Restoration: The Town, along with state and federal partners, is actively work on the elimination of a tidal restriction along the Parkers River by replacing the existing 18' wide Route 28 bridge with a new 30' wide bridge.	Department of Natural Resources, Department of Public Works, Planning, Conservation, Town Administrator
Wind	State Building Code: State Building Code regulates construction for specific wind loads.	Building Commissioner, Building Inspector

Table 5.1 | Existing capabilities assessment (continued)

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Plan Evaluation and Maintenance

CHAPTER SIX

Once the 2017 Yarmouth Hazard Mitigation Plan is adopted by the Board of Selection, the plan enters a five-year “maintenance” phase. **Chapter 6 describes how the Yarmouth Hazard Mitigation Plan will be evaluated, updated, and enhanced over the next five years.**

Plan Maintenance

A6d

Who is involved?

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

The Yarmouth Town Planner, Kathy Williams, 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, extents, 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 Yarmouth Hazard Mitigation Plan.

■ Plan Evaluation:

- Members of the Planning Team will meet annually to evaluate the stated purpose and goals of the Yarmouth Hazard Mitigation Plan. During this annual meeting, the Planning Team will ensure that the plan continues to serve its purpose through the following activities:
 - Review the Mitigation Goals in the 2017 Yarmouth Hazard Mitigation Plan
 - Discuss any recent activities to reduce the loss of life and property in Yarmouth such as grants received/applied for and any completed Mitigation Actions
 - Allow for public comment and input on the Plan and its progress at a Board of Selectmen meeting

A6b

- Discuss ongoing or recent planning efforts that are consistent with the Mitigation Goals and Actions of the 2017 Yarmouth Hazard Mitigation Plan.

A6c

- Plan Update:
 - The Yarmouth Hazard Mitigation Plan will be reviewed and updated every five years to ensure that there is no lapse in plan coverage. The Hazard Plan update process must begin one to one-and-one-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 reconvene annually to discuss progress on the Mitigation Actions.

Following a disaster declaration, the Yarmouth Hazard Mitigation 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 the Local Emergency Planning Committee 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 Yarmouth Hazard Mitigation Plan 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 Yarmouth 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 Yarmouth Board of Selectmen.**

Timeline for Plan Adoption

Timeline for Plan Adoption

The timeline for Plan Adoption is as follows:

- **July 2017:** After approval by the Board of Selectmen, the Planning Team submitted the Yarmouth Hazard Mitigation Plan to the Massachusetts Emergency Management Agency (MEMA) in July 2017. MEMA reviewed the plan and had no required edits. The Yarmouth Hazard Mitigation Plan was then submitted to the Federal Emergency Management Agency (FEMA) for final review.
- **September 2017:** FEMA issued an Approved Pending Adoption status and the Yarmouth Board of Selectmen officially adopted the Yarmouth Hazard Mitigation Plan during its meeting on October 24, 2017.

E1a

Plan Adoption

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



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

Appendix

Introduction: Local Mitigation Plan Review Guide, FEMA



Local Mitigation Plan Review Guide

October 1, 2011



Introduction: Local Mitigation Plan Review Guide, 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
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>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.</p> <p><i>Document</i> means provide the factual evidence for how the jurisdictions developed the plan.</p> <p>b. The plan must list the jurisdiction(s) participating in the plan that seek approval.</p> <p>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.</p> <p>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.</p> <p><i>Involved in the process</i> 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 “<i>opportunity to be involved in the planning process</i>” in A2 below) or only adopting the plan.</p> <p>e. Plan updates must include documentation of the current planning process undertaken to update the plan.</p>
<p>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)</p>	<p>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:</p> <ol style="list-style-type: none"> 1) Local and regional agencies involved in hazard mitigation activities; 2) Agencies that have the authority to regulate development; and 3) Neighboring communities. <p><i>An opportunity to be involved in the planning process</i> means that the stakeholders are engaged or invited as participants and given the chance to provide input to affect the plan’s content.</p>

Introduction: Local Mitigation Plan Review Guide, FEMA

ELEMENT	REQUIREMENTS
<p>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.</p>	<p>b. The Plan must provide the agency or organization represented and the person's position or title within the agency.</p> <p>c. The plan must identify how the stakeholders were invited to participate in the process.</p> <p>Examples of stakeholders include, but are not limited to:</p> <ul style="list-style-type: none"> 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.
<p>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)</p> <p>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.</p>	<p>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.</p> <p>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.</p>

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
<p>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)</p> <p>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.</p>	<p>a. The plan must include a description of the natural hazards that can affect the jurisdiction(s) in the planning area.</p> <p><i>A natural hazard is a source of harm or difficulty created by a meteorological, environmental, or geological event³. 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.</i></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>

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

Introduction: Local Mitigation Plan Review Guide, FEMA

ELEMENT	REQUIREMENTS
	<p>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.</p>
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>a. The plan must include the history of previous hazard events for each of the identified hazards.</p> <p>b. The plan must include the probability of future events for each identified hazard.</p> <p><i>Probability</i> 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.</p> <p>c. Plan updates must include hazard events that have occurred since the last plan was developed.</p>
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>a. For each participating jurisdiction, the plan must describe the potential impacts of each of the identified hazards on the community.</p> <p><i>Impact</i> 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).</p> <p>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).</p> <p>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.</p>

ELEMENT	REQUIREMENTS
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>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.</p> <p><i>Repetitive loss properties</i> 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.</p> <p><i>Severe repetitive loss properties</i> 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.</p> <p>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.</p>

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 <i>mitigation strategy</i> 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) <p><i>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.</i></p>	<p>a. The plan must describe each jurisdiction’s existing authorities, policies, programs and resources available to accomplish hazard mitigation.</p> <p>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.</p>
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) <p><i>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.</i></p>	<p>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 <u>not</u> meet this requirement. The description could include, but is not limited to:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>

Introduction: Local Mitigation Plan Review Guide, FEMA

ELEMENT	REQUIREMENTS
<p>C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? 44 CFR 201.6(c)(3)(i)</p> <p><i>Intent:</i> 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.</p>	<p>a. The plan must include general hazard mitigation goals that represent what the jurisdiction(s) seeks to accomplish through mitigation plan implementation.</p> <p><i>Goals</i> are broad policy statements that explain what is to be achieved.</p> <p>b. The goals must be consistent with the hazards identified in the plan.</p>
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>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.</p> <p><i>Mitigation actions and projects</i> 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.</p> <p>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.</p> <p>A comprehensive range consists of different hazard mitigation alternatives that address the vulnerabilities to the hazards that the jurisdiction(s) determine are most important.</p> <p>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.</p> <p>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.</p>

ELEMENT	REQUIREMENTS
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>a. The plan must describe the criteria used for prioritizing implementation of the actions.</p> <p>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 benefit-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.</p> <p>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.</p>
<p>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)</p> <p><i>Intent:</i> To assist communities in capitalizing on all available mechanisms that they have at their disposal to accomplish hazard mitigation and reduce risk.</p>	<p>a. The plan must describe the community's process to integrate the data, information, and hazard mitigation goals and actions into other planning mechanisms.</p> <p>b. The plan must identify the local planning mechanisms where hazard mitigation information and/or actions may be incorporated.</p> <p><i>Planning mechanisms</i> 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.</p> <p>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.</p> <p>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.</p> <p>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.</p>

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
<p>D1. Was the plan revised to reflect changes in development? 44 CFR 201.6(d)(3)</p> <p><i>Intent:</i> 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.</p>	<p>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.</p> <p>Changes in development means recent development (<i>for example</i>, construction completed since the last plan was approved), potential development (<i>for example</i>, development planned or under consideration by the jurisdiction), or conditions that may affect the risks and vulnerabilities of the jurisdictions (<i>for example</i>, climate variability, declining populations or projected increases in population, or foreclosures). Not all development will affect a jurisdiction’s vulnerability.</p>

ELEMENT	REQUIREMENTS
<p>D2. Was the plan revised to reflect progress in local mitigation efforts? 44 CFR 201.6(d)(3)</p> <p><i>Intent:</i> To evaluate and demonstrate progress made in the past five years in achieving goals and implementing actions outlined in their mitigation strategy.</p>	<p>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.</p>
<p>D3. Was the plan revised to reflect changes in priorities? 44 CFR 201.6(d)(3)</p> <p><i>Intent:</i> To ensure the plan reflects current conditions, including financial, legal, and political realities as well as post-disaster conditions.</p>	<p>a. The plan must describe if and how any priorities changed since the plan was previously approved.</p> <p>If no changes in priorities are necessary, plan updates may validate the information in the previously approved plan.</p>

Introduction: Local Mitigation Plan Review Guide, FEMA

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
<p>E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? 44 CFR 201.6(c)(5)</p> <p><i>Intent:</i> 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.</p>	<p>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.</p> <p>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, <i>Plan Review Procedure</i> for more information on “Approvable Pending Adoption.”</p>

ELEMENT	REQUIREMENTS
<p>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)</p> <p><i>Intent:</i> 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.</p>	<p>a. The plan must include documentation of plan adoption, usually a resolution by the governing body or other authority.</p> <p>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.</p> <p>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.</p> <p>If adopted after FEMA review, adoption must take place within one calendar year of receipt of FEMA’s “Approval Pending Adoption.” See Section 5, <i>Plan Review Procedure</i> for more information on “Approvable Pending Adoption.”</p>

Chapter 1: Planning Team Meeting Attendance

Planning Team Member	Title	August 1, 2016	September 12, 2016	January 12, 2017
JEFF COLBY	Director, Department of Public Works	Attended	Attended	-
FRANK FREDERICKSON	Police Chief	Attended	Attended	-
KELLY GRANT	Conservation Administrator, Community Development Department	Attended	Attended	Attended
RICK KELLEY	Highway Superintendent, Department of Public Works	-	Attended	Attended
JON SAWYER	Deputy Fire Chief	Attended	-	-
PHILIP SIMONIAN	Fire Chief	Attended	Attended	Attended
KARL VON HONE	Director, Natural Resources	Attended	Attended	Attended
ROBY WHITEHOUSE	Administrative Supervisor, Department of Public Works	-	Attended	Attended
KATHY WILLIAMS	Town Planner, Community Development Department	Attended	Attended	Attended
CALLY HARPER	Planner, Cape Cod Commission	Attended	Attended	Attended

Chapter 1: Public Survey

Introduction:

The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to update the Yarmouth Hazard Plan. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take this survey – it is an opportunity for you to share your opinions and participate in the hazard planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that could lessen the impacts of future hazard events. The survey is only 12 questions and it will take just a few minute to complete. Thank you so much for participating!

If you have any questions regarding this survey or would like to learn more ways you can participate in the development of the Yarmouth Hazard Plan, please contact Kathy Williams at kwilliams@yarmouth.ma.us or Cally Harper, Hazard Planner at the Cape Cod Commission. You can reach Cally at cally.harper@capecodcommission.org.

To begin, click the “NEXT” button at the bottom of the screen. Questions labeled with an * are required.

1. Have you experienced a weather-related event or disaster while living, working or visiting Wellfleet?
 - a. Yes
 - b. No

2. Which of the following disasters have you experienced while in Yarmouth? You can select **more than 1** answer. The disasters listed below were taken directly from the State Hazard Plan for the Commonwealth of Massachusetts drafted in 2013.
 - a. Coastal Erosion and Shoreline Change
 - b. Dam Failure
 - c. Drought
 - d. Earthquake
 - e. Fire (structural or wildfires)
 - f. Floods
 - g. Hurricanes and Tropical Storms
 - h. Landslides
 - i. Nor'easter
 - j. High Wind
 - k. Lightning/Thunderstorms
 - l. Tornado
 - m. Extreme Cold and Heat
 - n. Winter Storms (snow storms, blizzards, ice storms)
 - o. Tsunami
 - p. Sea Level Rise

Chapter 1: Public Survey

3. In your opinion, which of the following disasters are you most concerned about? **Choose up to 3 answers.**
- Coastal Erosion and Shoreline Change
 - Dam Failure
 - Drought
 - Earthquake
 - Fire (structural or wildfires)
 - Floods
 - Hurricanes and Tropical Storms
 - Landslides
 - Nor'easter
 - High Wind
 - Lightning/Thunderstorms
 - Tornado
 - Extreme Cold and Heat
 - Winter Storms (snow storms, blizzards, ice storms)
 - Tsunami
 - Sea Level Rise
4. How concerned are you about the possibility of a natural disaster impacting Yarmouth?
- Extremely Concerned
 - Somewhat concerned
 - Not Concerned
5. Which of the following actions have you taken to be more hazard resistant? **Answer yes or no to the following activities:**
- Signed up for the Yarmouth Code Red hosted by Barnstable County
 - Purchased flood insurance
 - Participated in educational activities and trainings about hazard and emergency preparedness
 - Obtained pamphlets from town office buildings
 - Removed debris and hazardous materials from my property
 - Pruned trees on or near my property
 - Obtained an emergency response kit
 - Other (please specify)

Chapter 1: Public Survey

6. What is the most effective way to engage you in hazard planning and emergency preparedness activities? **You can select more than 1 answer.**
 - a. Local newspaper (Cape Cod Times)
 - b. Public Television
 - c. Radio Advertising
 - d. Internet (Yarmouth Police Department Facebook page and Town website)
 - e. Email
 - f. Mail
 - g. Public Workshops and/or meetings
 - h. School meetings
 - i. Other (please specify)

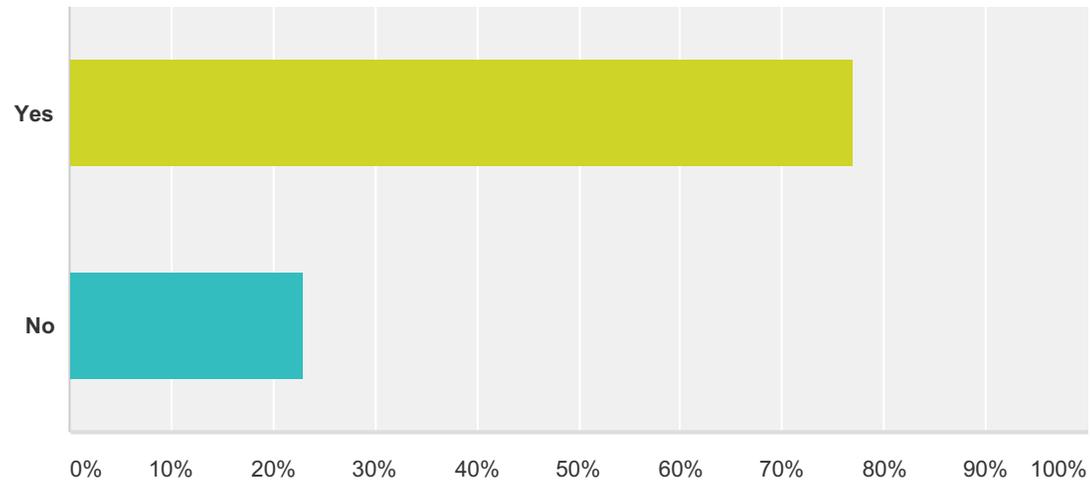
7. What steps can your local government take to reduce risk from natural hazards and protect the buildings and people of Yarmouth? **Please select more than 1 answer.**
 - a. Improve the alert/warning/notification system
 - b. Develop climate change adaptation plans and implement them
 - c. Continue to improve the regional shelter
 - d. Remove debris and hazardous materials as well as prune trees on town property
 - e. Improve drainage on area roads
 - f. Educate the public on evacuation methods
 - g. Apply for funding to reduce Yarmouth's risk to natural hazards
 - h. Perform detailed risk assessments
 - i. Work to reduce flood insurance for residents through the Community Rating System
 - j. Educate the public on the science of natural hazards and emergency preparedness
 - k. Improve the communication system during hazard events (i.e. radio towers, cellular services)
 - l. Review and update the Yarmouth Zoning Bylaws as they relate to flooding
 - m. Continue to work with Regional partners to prepare for and recover from natural disasters
 - n. Other (please specify)

8. If you would like to be more involved in the hazard planning process, please provide your name, email and/or alternate contact information:
 - a. Name:
 - b. Email:
 - c. Alternate Contact:

Chapter 1: Public Survey Results

Q1 Have you experienced a weather-related event or disaster while living, working or visiting Yarmouth?

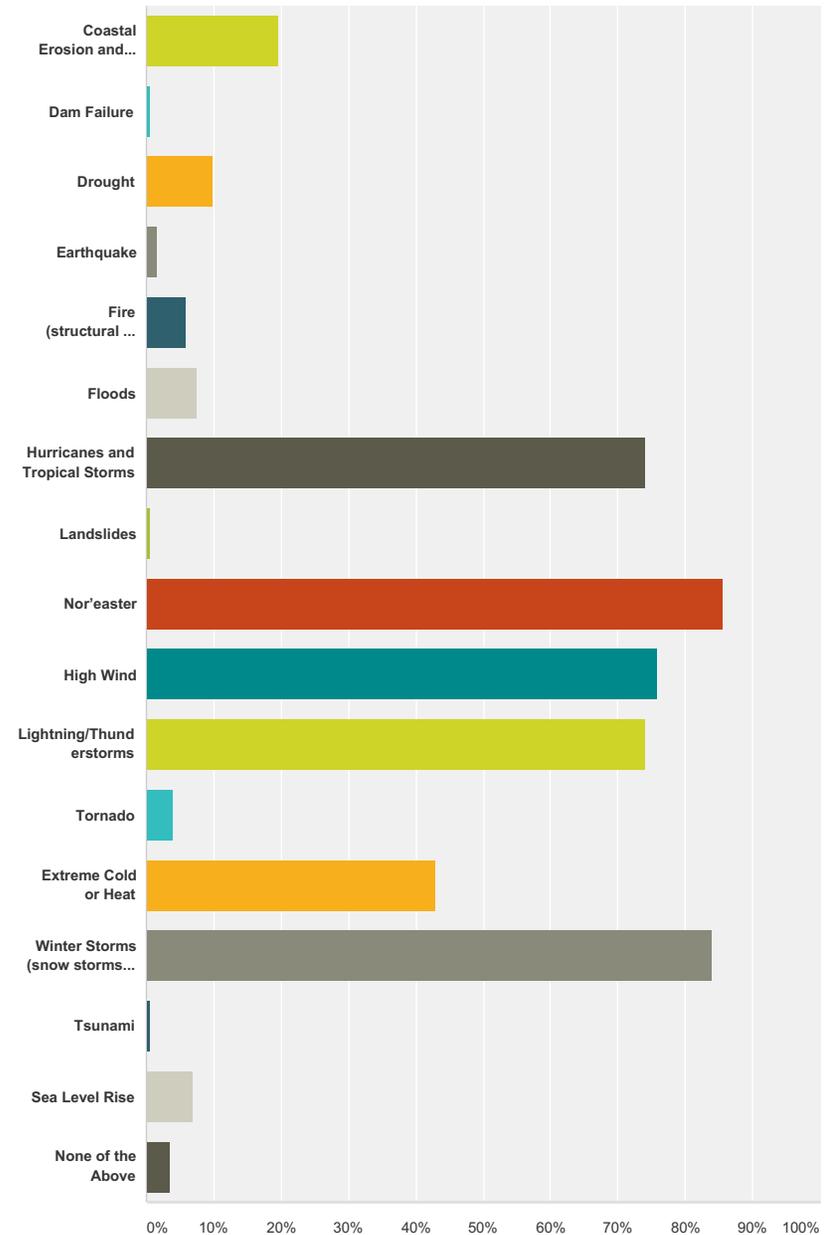
Answered: 174 Skipped: 0



Chapter 1: Public Survey Results

Q2 Which of the following events have you experienced while in Yarmouth? You can select more than 1 answer. The hazard types listed below were taken directly from the State Hazard Plan for the Commonwealth of Massachusetts drafted in 2013.

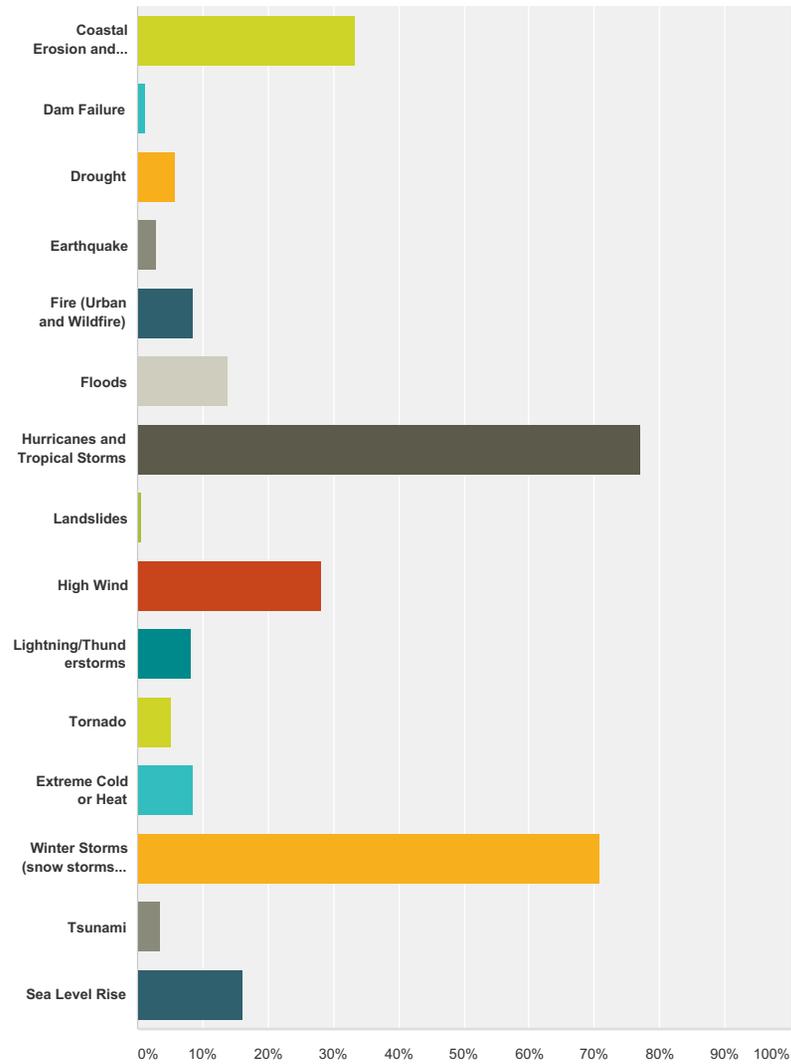
Answered: 174 Skipped: 0



Chapter 1: Public Survey Results

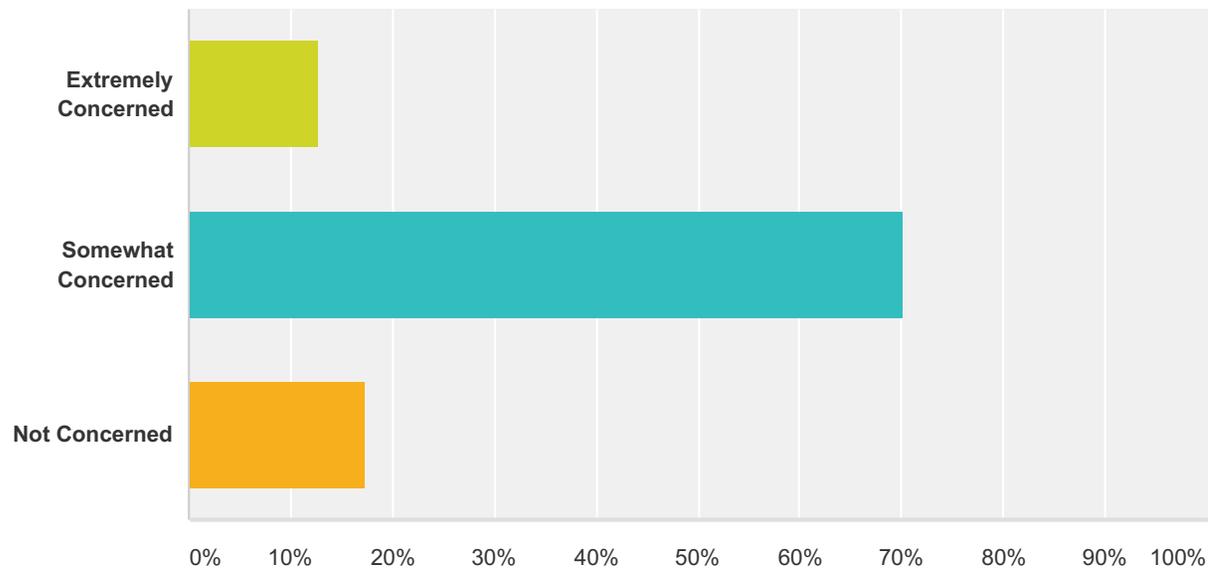
Q3 In your opinion, which of the following hazard events are you most concerned about? Choose up to 3 answers.

Answered: 174 Skipped: 0



Q4 How concerned are you about the possibility of a natural disaster impacting Yarmouth?

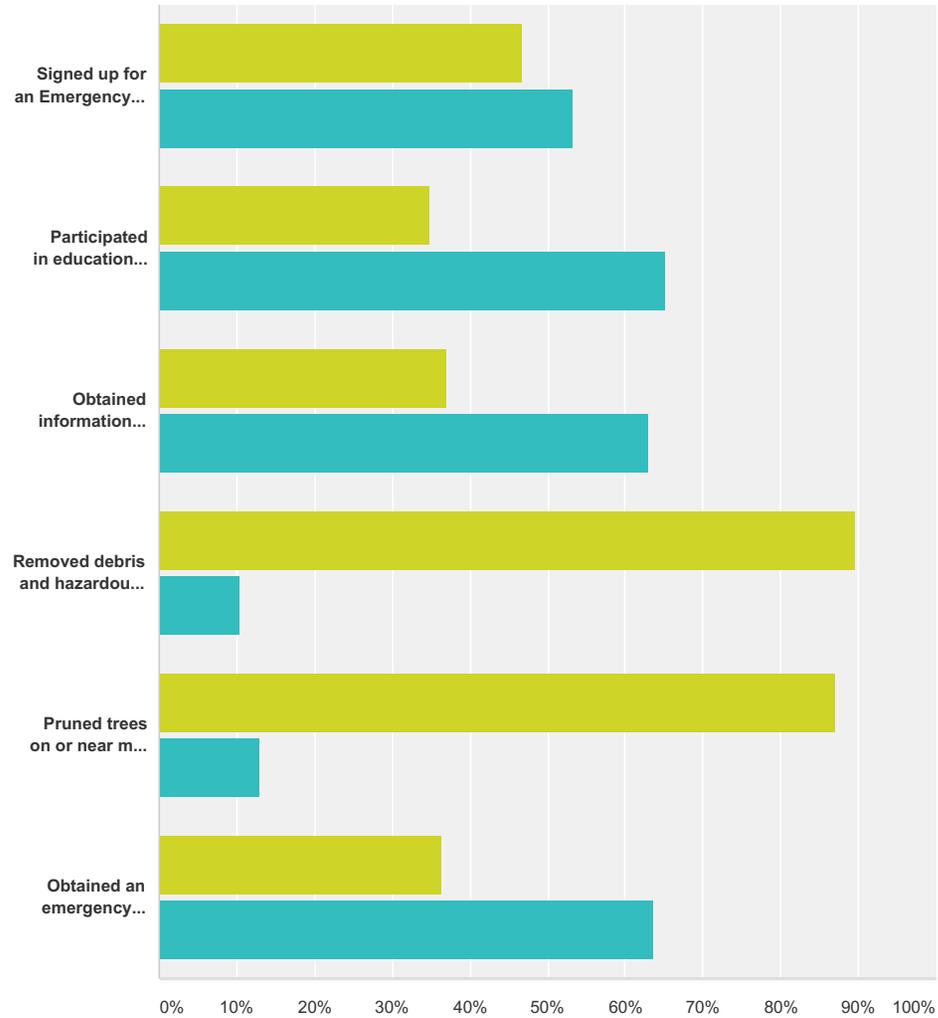
Answered: 174 Skipped: 0



Chapter 1: Public Survey Results

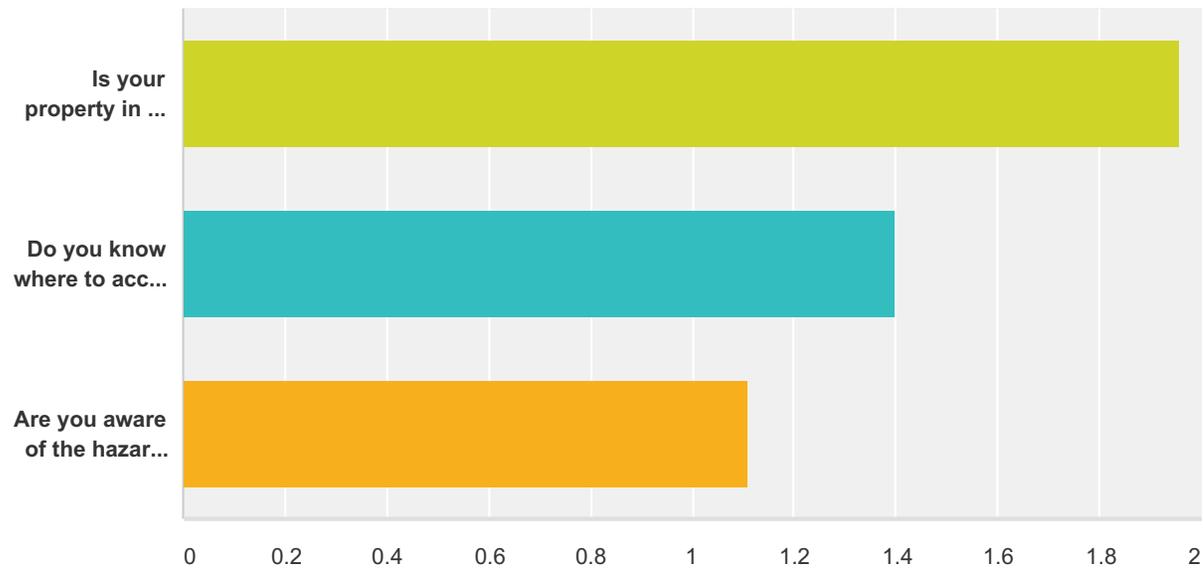
Q5 Which of the following actions have you taken to be more hazard resistant? Answer yes or no to the following activities:

Answered: 157 Skipped: 17



Q6 Please answer the questions below on flood zones.

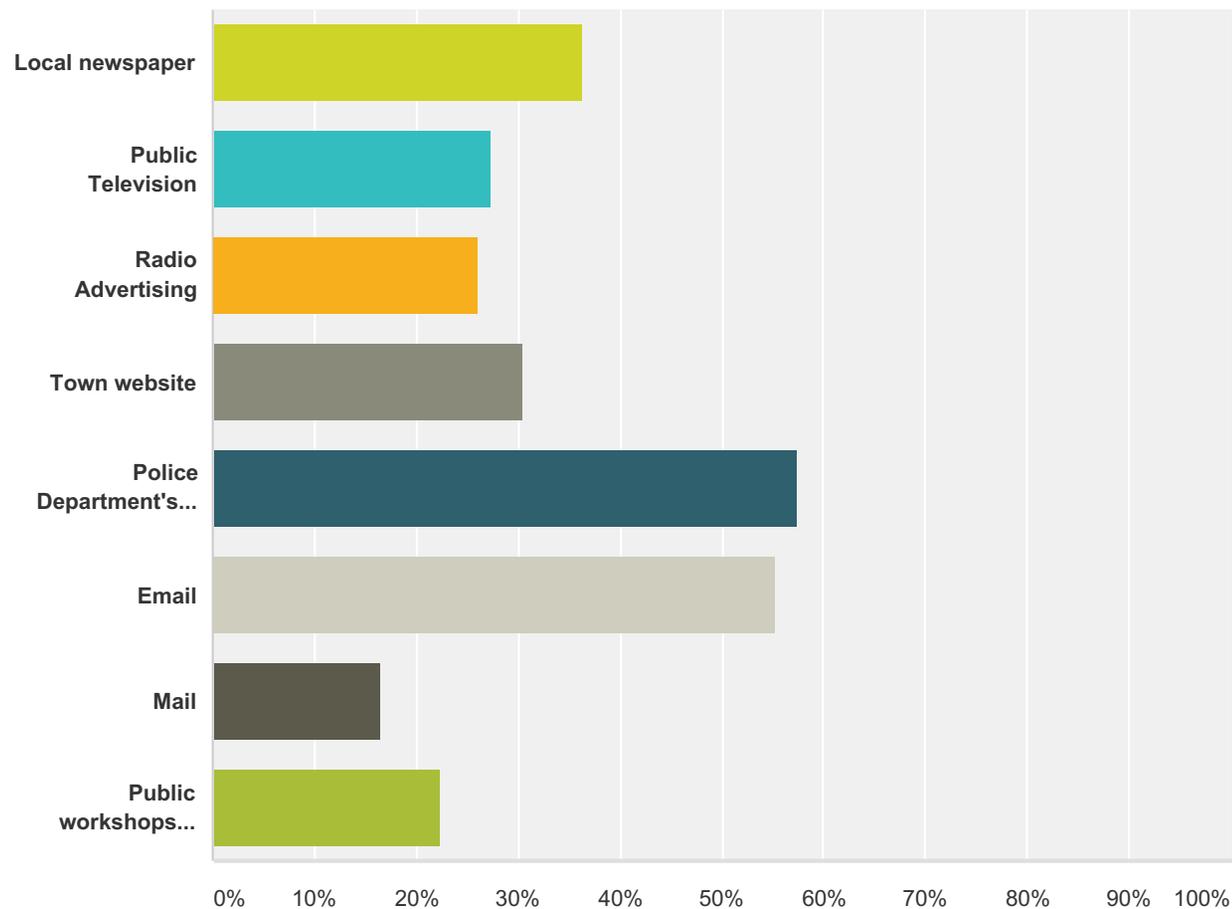
Answered: 156 Skipped: 18



Chapter 1: Public Survey Results

Q7 What is the most effective way to engage you in hazard planning and emergency preparedness activities? You can select more than 1 answer.

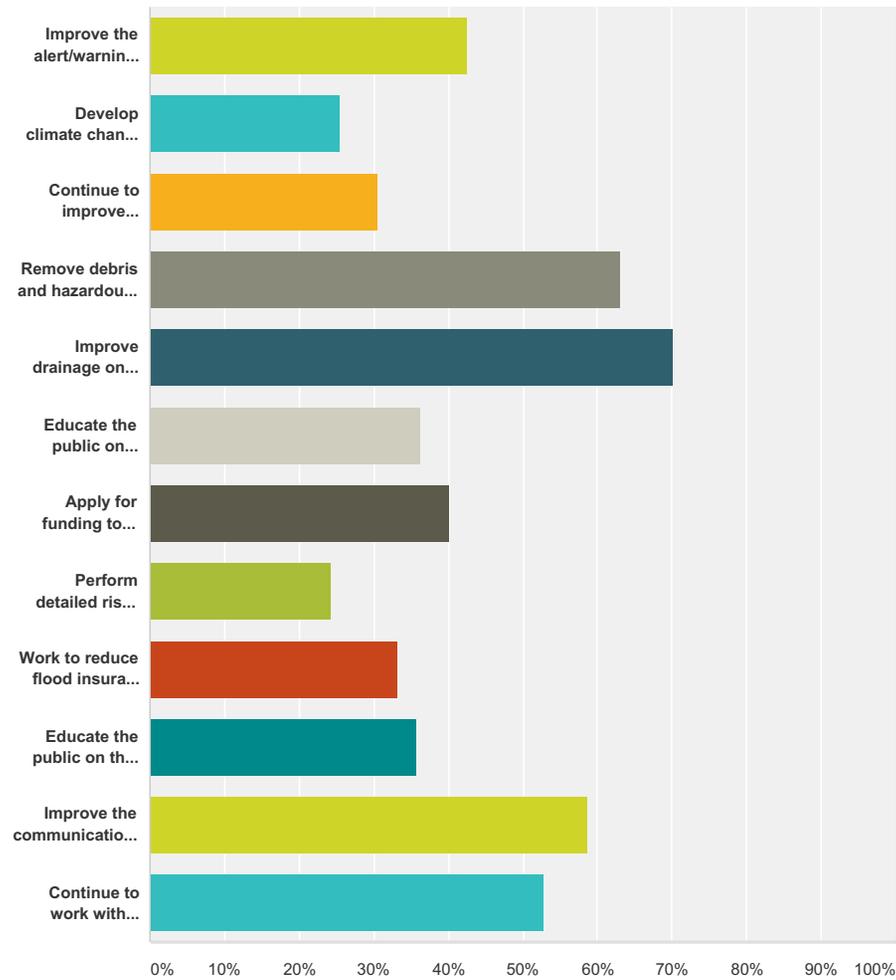
Answered: 157 Skipped: 17



Chapter 1: Public Survey Results

Q8 What steps can your local government take to reduce risk from natural hazards and protect the buildings and people of Yarmouth? Please select more than 1 answer.

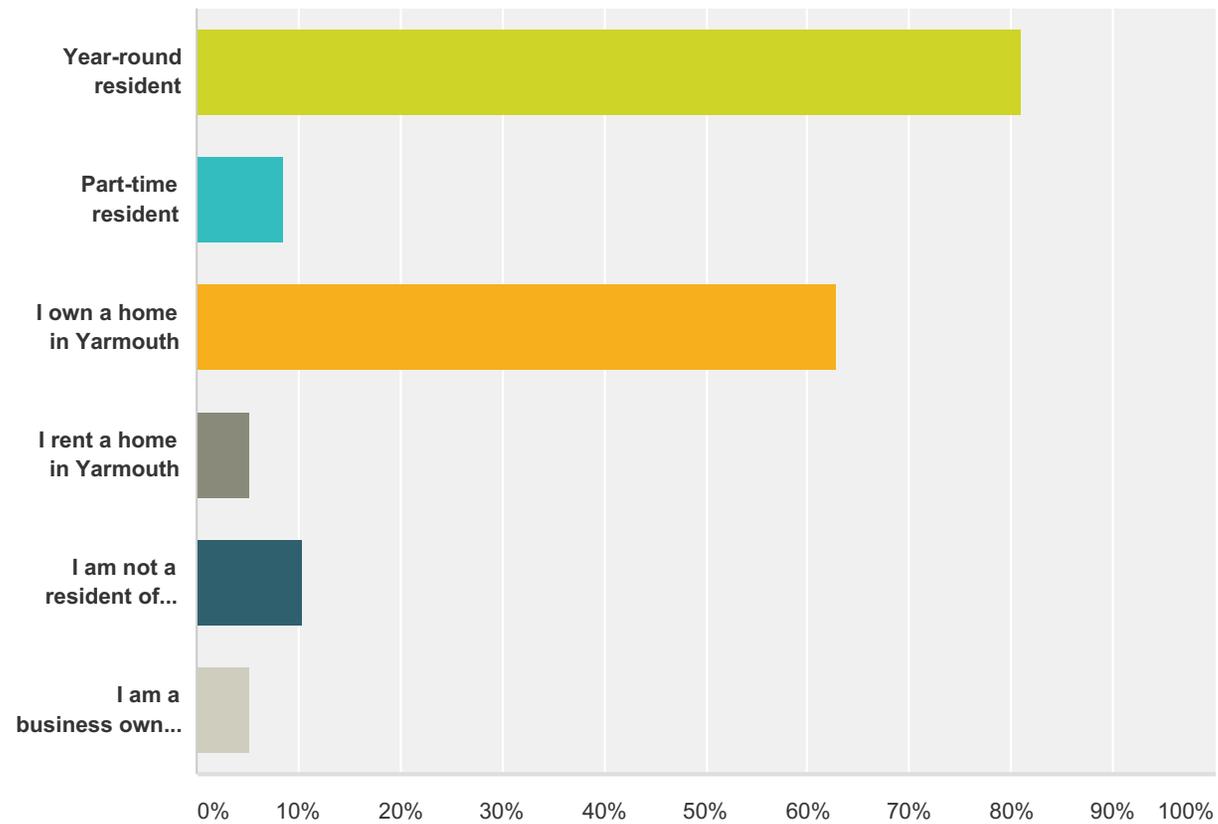
Answered: 157 Skipped: 17



Chapter 1: Public Survey Results

Q9 Please tell us about yourself. Select all that apply to you.

Answered: 153 Skipped: 21



Chapter 1: Public Survey Results

Q10 If you are interested in the hazard planning process, please provide your name, email and/or alternate contact information.

Answered: 38 Skipped: 136

Answer Choices	Responses
Name	94.74% 36
Email	97.37% 37
Alternate Contact Information	31.58% 12

Chapter 1: Public Survey Notices

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**Hazard Mitigation
Survey**

Take the Yarmouth Hazard Mitigation Survey
to help develop a Hazard Mitigation Plan for Yarmouth

<https://www.surveymonkey.com/r/YarmouthHazardPlan>
or visit the Town Website

Complete the Survey by October 21, 2016

<http://172.16.1.159/Carousel/TRMSImagePreviewer.aspx?Type=Page&ID=-1&FullSize=...> 10/13/2016

Williams, Kathleen**PLANNING BOARD**

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:25 PM
To: Brad Goodwin (BradGoodwin@HeartMedia.com); Chris Vincent (cmv@heartmedia.com); Joanne Crowley (joanne.crowley2@verizon.net); Kenneth Driscoll (kdriscollken@yahoo.com); Narm Wesire (n.wesire@comcast.net); Tom Baron (thomas.s.baron@verizon.net); Tom Roche (tassriverlodge@comcast.net)
Subject: FW: Yarmouth Hazard Mitigation Plan

Hi Guys,

Survey - Hazard Mitigation Plan. The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only **10 questions** and it will take just a few minutes to complete. **Please complete by October 21, 2016.** Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

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Chapter 1: Public Survey Notices

Williams, Kathleen

From: Grant, Kelly
Sent: Monday, October 03, 2016 4:18 PM
To: Williams, Kathleen
Subject: RE: Yarmouth Hazard Mitigation Plan

cone

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:21 PM
To: Grant, Kelly
Subject: Yarmouth Hazard Mitigation Plan

Hi Kelly,

Please forward the information below to the Conservation Commission

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

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Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:24 PM
To: Greene, Karen
Subject: Yarmouth Hazard Mitigation Plan

Hi Karen,

Please forward the information below to the Community Economic and Development Committee.

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

Kathy Williams, PE
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 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Public Survey Notices

Williams, Kathleen

From: Copeland, Jennifer
Sent: Tuesday, October 04 2016 9:11 AM
To: Gary Ellis; 'Tom Roche'; 'Mary Ann Walsh'; Dorcas McGurrin (marshside@gmail.com);
 Nate Small; heather@interstate.com; Beverlee Bachand; Tom Dixson
Cc: Williams, Kathleen
Subject: FW: Yarmouth Hazard Mitigation Plan Survey

Hi CPT,
 Below please find a link from Kathy for a Hazard Mitigation Plan Survey. Thank you in advance for participating!

Jen

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:22 PM
To: Copeland, Jennifer
Subject: Yarmouth Hazard Mitigation Plan

Hi Jen,

Please forward the information below to the Community Preservation Committee.

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Waygan, Mary
Sent: Tuesday, October 04 2016 8:59 AM
To: Williams, Kathleen
Subject: RE: Yarmouth Hazard Mitigation Plan

Will do!!

Mary Waygan, Affordable Housing/CDBG Program Administrator
 Town of Yarmouth Department of Community Development
 1146 Route 28, South Yarmouth, MA 02664
 508-398-2231 ext 1276 TDD 508-398-2231 Fax 508-398-2365
mwaygan@yarmouth.ma.us

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:23 PM
To: Waygan, Mary
Subject: Yarmouth Hazard Mitigation Plan

Hi Mary,

Please forward the information below to the Community Housing Committee and the Affordable Housing Trust.

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Public Survey Notices

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:51 PM
To: Mary Vilbon
Subject: Yarmouth Hazard Mitigation Plan - SURVEY

Hi Mary,

It would be much appreciated if you could forward the information below to the [Yarmouth Chamber of Commerce members](#).

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/s/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, October 03, 2016 4:08 PM
To: Ann Kaprelian; Bob Quinlioni; Chris Creeley (greeleyc@comcast.net); Joyce Cullen; Kathy Campbell; Patty Hughes; Susan Brita (sfbrita@gmail.com)
Subject: Yarmouth Hazard Mitigation Plan - SURVEY

Hi Guys,

Please forward the information below to the [Lewis Bay Group members](#).

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/s/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

Chapter 1: Public Survey Notices

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:50 PM
To: Gail Staff (richard.staff@verizon.net)
Subject: Yarmouth Hazard Mitigation Plan - SURVEY

Hi Gail,

It would be much appreciated if you could forward the information below to the [South Yarmouth Association](#).

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only **10 questions** and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Williams, Kathleen
Sent: Wednesday, October 12, 2016 4:09 PM
To: Brian Koelbel
Subject: Yarmouth Hazard Mitigation Plan

Hi Brian,

It was great meeting with you today. As we discussed I am forwarding to you information regarding an on-line Survey for a Hazard Mitigation Plan the Town is developing. It would be much appreciated if you could forward the information below to the [Gateway Isles Association](#) members.

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only **10 questions** and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Public Survey Notices

Williams, Kathleen

From: Linda Boliger <linda_boliger@verizon.net>
Sent: Monday, October 03, 2016 4:06 PM
To: Williams, Kathleen; Chris Greeley <greeleyc@comcast.net>
Subject: Re: Yarmouth Hazard Mitigation Plan - SURVEY

Sure. No problem, Kathy.

On 10/3/2016 3:49 PM, Williams, Kathleen wrote:

Ki Guys,

It would be much appreciated if you could forward the information below to the [Hyannis Park Civic Association](#).

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Tom Roche Sr. <bosriverdodge@comcast.net>
Sent: Monday, October 03, 2016 5:51 PM
To: Williams, Kathleen
Subject: Re: Yarmouth Hazard Mitigation Plan

Ok, will do.

Tom

On Oct 3, 2016, at 3:48 PM, Williams, Kathleen <kwilliams@yarmouth.ma.us> wrote:

Hi Tom,

It would be much appreciated if you could forward the information below to the [Bass River Civic Association](#).

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

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Chapter 1: Public Survey Notices

Williams, Kathleen

From: Xiarhos, Steve
Sent: Monday, October 03, 2016 2:19 PM
To: Williams, Kathleen
Subject: RE: Town News Item Posting

All set!

POSTED and I even took it myself!

NICE WORK KATHY!

☺

From: Williams, Kathleen
Sent: Monday, October 03, 2016 1:53 PM
To: Xiarhos, Steve
Subject: FW: Town News Item Posting

Hi Steve,

I am hoping you can post the information below to the Police Facebook Page. Please let me know if you can do this and when it is available on Facebook.

Thanks! Kathy

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Clark, Sandi
Sent: Monday, October 03, 2016 3:24 PM
To: Bob Palmieri; Chuck Hart; Dick Martin; Doug Campbell; Gerald Garrick; Jack McCormack; Richard Neitz; Sean Iggoe; Steven S. DeYoung (ssc@carterdeyoung.com); Tom Nickonello
Cc: Williams, Kathleen
Subject: FW: Yarmouth Hazard Mitigation Plan

Please see attached e-mail from Kathy Williams, Town Planner.

From: Williams, Kathleen
Sent: Monday, October 03, 2016 3:22 PM
To: Clark, Sandi
Subject: Yarmouth Hazard Mitigation Plan

Hi Sandi,

Please forward the information below to the Zoning Board of Appeals.

Survey - Hazard Mitigation Plan: The Town of Yarmouth, along with the Cape Cod Commission and other partners, are working to develop a Hazard Mitigation Plan for Yarmouth. The Plan will identify and assess our community's natural hazard risks and determine how to best minimize and manage those risks.

Please take the survey at the link below to share your opinions and participate in the hazard planning process. The survey is only 10 questions and it will take just a few minutes to complete. Please complete by October 21, 2016. Thank you so much for participating!

<https://www.surveymonkey.com/r/YarmouthHazardPlan>

Thanks,
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

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Chapter 1: Draft Plan Comment Website

[About CCC](#) |
 [Departments](#) |
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 [Quick Links](#) |
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 [Departments](#) »
 [Planning & Community Development \(Home\)](#) »
 [Regional Planning](#) »
 [Multi-Hazard Mitigation Planning](#) »
 [Yarmouth Hazard Mitigation Plan](#)



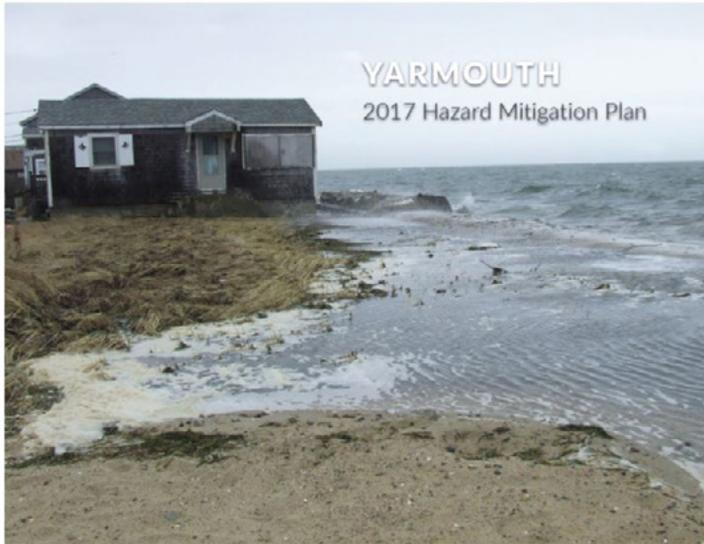
CAPE COD COMMISSION

[Mashpee Hazard Mitigation Plan](#)
[Yarmouth Hazard Mitigation Plan](#)

Yarmouth Hazard Mitigation Plan

>

[Text -](#) | [Text +](#)



YARMOUTH

2017 Hazard Mitigation Plan

DOWNLOAD PLAN

Higher Resolution Maps

List of Files

- Figure3.1 Yarmouth MHM Basemap.pdf 

SIZE: 670.91kb
 UPLOADED: Wed, May 31, 2017
- Figure2.8 Yarmouth MHM Storm Surge.pdf 

SIZE: 1.3mb
 UPLOADED: Wed, May 31, 2017
- Figure2.6 Yarmouth MHM FEMA FHA.pdf 

SIZE: 1.25mb
 UPLOADED: Tue, June 13, 2017
- Figure2.3 Yarmouth MHM FIRM.pdf 

The Town of Yarmouth and Cape Cod Commission have been working together to develop a Hazard Mitigation Plan for Yarmouth. The Hazard Mitigation Plan looks at the vulnerabilities in the Town and outlines actions the Town can take to help protect critical facilities and residents from natural hazards.

An approved hazard mitigation plan also makes the Town eligible for state and federal pre- and post-disaster funding. The Planning Team has completed a draft of the Hazard Mitigation Plan and now seeks public comment on it.

The public comment period for the plan will be open through Sunday, July 9.

Please email any comments you may have on the draft Yarmouth Hazard Mitigation Plan to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

The Planning Team will incorporate public comments into the plan and prepare it for presentation and approval for submittal to the Massachusetts Emergency Management

Chapter 1: Draft Plan Comment Notices

The screenshot shows the Yarmouth, Massachusetts website. The header includes the town name and navigation links: About Yarmouth, Government, Doing Business, Visiting, and I Want To. A search bar is located in the top right. A left sidebar contains a menu with the same navigation links and several utility icons: Notify Me, Request Tracker, Online Services, Minutes & Agendas, and Channel 18 Videos. The main content area features a news article titled "Draft Hazard Mitigation Plan" posted on June 19, 2017. The article text states that the town and Cape Cod Commission have developed a draft plan to identify critical infrastructure and vulnerabilities. It includes a call to action for public comment, with a deadline of Sunday July 9, 2017, and provides contact information for Chloe Schaefer. A search box and tools section (RSS) are on the right. Below the article are social media icons and a "Next" link pointing to "Cemetery Contact Lot Form". At the bottom, there is a section for "Other News in Home" with a link to "Cemetery Contact Lot Form" posted on October 26, 2016.

Chapter 1: Draft Plan Comment Notices



Yarmouth Police Dept.
@yarmouthpolice

- Home
- About
- Photos
- Reviews
- Events
- Likes
- Videos
- Posts
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Create a Page

Like
Share
...

Call Now

Message

Yarmouth Police Dept.

21 hrs · 🌐

DRAFT HAZARD MITIGATION PLAN

The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth.

Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. ... See More



2017 Hazard Mitigation Plan

www.capecodcommission.org

CAPECODCOMMISSION.ORG

Like
Comment
Share

Pat Hawley, Bob O'Reilly, Cynthia A. Olmstead and 2 others like this.

Yarmouth Police Dept.

21 hrs · 🌐

TOWN OF YARMOUTH FULL-TIME JOB WITH BENEFITS OPENING!

Heavy Truck Driver

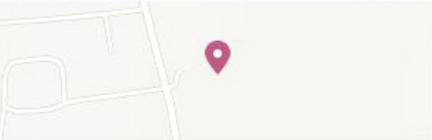
Police Station in West Yarmouth, Massachusetts

4.5 ★★★★★ · Always Open

Community

- 👤 Invite your friends to like this Page
- 👍 15,106 people like this
- 📡 14,901 people follow this
- 📍 844 people have visited

About See All



- 📍 340 Higgins Crowell Rd
West Yarmouth, Massachusetts, MA 02673
- ☎️ (508) 775-0445
- 🌐 yarmouthpolice.com
- 🏢 Police Station · Law Enforcement Agency · Government Organization
- 🕒 Hours
Always Open

People >

★★★★★

15,106 likes

844 visits

Chapter 1: Draft Plan Comment Notices

99.9 **CAPE** **Cape Classical** **OCEAN**
Country 104 **107.5** **107.5**
Something New *Easy*

CapeCod.com
 Where Cape Cod Finds Community

4th Of July Events | Weather Update Click to view | Traffic Update Click to view routes

NEWS | LIFESTYLE | ENTERTAINMENT | EVENTS | PHOTOS | CAPE WIDE NEWS | ABOUT THE CAPE

Search this website ... **Search**

You are here: [Home](#) / [Cape Wide News](#) / [Yarmouth Police encourage residents to review hazard mitigation plan](#)

Yarmouth Police encourage residents to review hazard mitigation plan

June 19, 2017

Share this: [Share 1](#) [Tweet](#) [G+1](#) [0](#) [Pin it](#) [More](#)

YARMOUTH – Yarmouth Police are encouraging residents to review a recently revised Draft Hazard Mitigation Plan for the town.

Yarmouth and the Cape Cod Commission have worked together to develop the document.

Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents.

Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplanthrough Sunday July 9, 2017.

Residents can provide input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org

CAPECOD.COM POLL

What is your favorite thing about the Cape during the summer? *

- Being Outside
- Nothing, I can't wait till fall
- The Beaches
- The Food
- Something else

Submit [View results](#)

MOST POPULAR ARTICLES

- [Photos From Father's Day Car Show Main Street Hyannis!](#)
- [Historic Restaurants of Cape Cod](#)
- [Father's Day Treat: Baseball & Pie!](#)
- [Heaven on Earth: The Best Cape Cod Beaches](#)

Chapter 1: Draft Plan Comment Notices

Chloe Schaefer

From: Chloe Schaefer
Sent: Friday, June 16, 2017 10:30 AM
Subject: Draft Yarmouth Hazard Mitigation Plan

Hello,

First of all, thank you for your input during the development of a Hazard Mitigation Plan for Yarmouth through the online survey. I am reaching out because you expressed an interest in staying informed about the Hazard Mitigation Plan for Yarmouth. The Planning Team has completed a draft of the Hazard Mitigation Plan and is seeking public comment. The public comment period for the plan will be open through Sunday, July 9.

Please go to www.capecodcommission.org/yarmouthhazardplan to review the plan. Send any comments to me, Chloe Schaefer, at chloe.schaefer@capecodcommission.org.

Following the public comment period, the Planning Team will incorporate comments into the plan and prepare it for presentation and approval for submittal to the Massachusetts Emergency Management Agency at an upcoming Board of Selectmen meeting. Thank you for your feedback!

Sincerely,

Chloe Schaefer
 Community Design Planner
 CAPE COD COMMISSION
chloe.schaefer@capecodcommission.org



Chapter 1: Draft Plan Comment Notices

Williams, Kathleen

From: Dennehy, Linda
Sent: Monday, June 19, 2017 12:18 PM
To: Barnes, Pam; Dennehy, Linda; Dweilley, Christopher; Erik Talley; Forest, Mark; Knapik, Daniel; Lawton, Bob; Forest, Mark; Stone, Mike; Holcomb, Norm; Post, Tracy
Cc: Williams, Kathleen
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Good Afternoon,

The below email is forwarded, fyi

Linda

From: Williams, Kathleen
Sent: Monday, June 19, 2017 10:57 AM
To: Dennehy, Linda
Cc: Knapik, Daniel
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Linda,

Please forward the information below to the [Board of Selectmen](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!

Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Clark, Sandi
Sent: Monday, June 19, 2017 11:16 AM
To: Williams, Kathleen
Subject: RE: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Kathy,

I have forwarded your e-mail to the ZBA.

-Sandi

From: Williams, Kathleen
Sent: Monday, June 19, 2017 10:56 AM
To: Clark, Sandi
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Sandi,

Please forward the information below to the [Zoning Board of Appeals](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!

Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Draft Plan Comment Notices

PLANNING BOARD

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, June 18, 2017 10:58 AM
To: Brad Goodwin (BradGoodwin@HeartMedia.com); Chris Vincent (christopher.vincent@comcast.net); Joanne Crowley (joanecrowley52@gmail.com); Kenneth Driscoll (driscollken@ymtown.com); Norm Weare (nweare@comcast.net); Tom Baron (thomas.s.baron@verizon.net); Tom Roche (basstriveridge@comcast.net)
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment - Planning Board

Hi Guys,

Draft Hazard Mitigation Plan The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouth/hazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

11

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, June 19, 2017 10:59 AM
To: Grant, Kelly
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Kelly,

Please forward the information below to the [Conservation Commission](http://www.capecodcommission.org).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouth/hazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

10

Chapter 1: Draft Plan Comment Notices

Williams, Kathleen

From: Greene, Karen
Sent: Monday, June 19, 2017 5:28 PM
To: Williams, Kathleen
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi!

Karen M. Greene, Director of Community Development
 Town of Yarmouth
kgreene@yarmouth.ma.us
 508-398-2231 x1278

From: Gréene, Káren
Sent: Monday, June 19, 2017 5:27 PM
To: Jack McCormack; John Barker (johnrbarker@verizon.net); Ken Driscoll; Kenneth Smith; Mary Wilton; Peter Q. Smith (psmith@mycapecodbank.com); Tom George (www.secretary@comcast.net)
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi! Please see below message from Kathy Williams regarding the Multi Hazard Mitigation Plan

Thank you,

Karen

Karen M. Greene, Director of Community Development
 Town of Yarmouth
kgreene@yarmouth.ma.us
 508-398-2231 x1278

From: Williams, Kathleen
Sent: Monday, June 19, 2017 11:00 AM
To: Greene, Karen
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Karen,

Please forward the information below to the [Community and Economic Development Committee](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

1

Williams, Kathleen

From: Waygan, Mary
Sent: Monday, June 19, 2017 2:18 PM
To: Joseph, Daniel; Tom Roche Sr.; Nathan Small; Norman Holcomb; Holcomb, Norm; Robotic Lawlorji; rroj5@gmail.com
Cc: Williams, Kathleen
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi!

Below is a link to the Town's Draft Mitigation Plan
 Please send any comments to chloe.schaefer@capecodcommission.org by July 9th.
 Mary

From: Williams, Kathleen
Sent: Monday, June 19, 2017 11:01 AM
To: Waygan, Mary
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Mary,

Please forward the information below to the [Community Housing Committee and the Affordable Housing Trust](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

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Thank you for your feedback!
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Draft Plan Comment Notices

Williams, Kathleen

From: Copeland, Jennifer
Sent: Wednesday, June 21, 2017 10:05 AM
To: Gary Ellis (jgarnett1@comcast.net), Tom Rodke, Mary Ann Walsh, Dorcas McGunn
 jmars'side@gmail.com, Nala Smith, Heather@internaric.com, Beverlee Bachand, Tom
 Durkin
Cc: Williams, Kathleen
Subject: FW: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi CPL,
 Please see the message below on the draft Hazard Mitigation Plan.

Thank you,
 Jen

From: Williams, Kathleen
Sent: Monday, June 19, 2017 11:01 AM
To: Copeland, Jennifer
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Jen,

Please forward the information below to the [Community Preservation Committee](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Williams, Kathleen

From: Tom Roche Sr. <bassriverlodge@comcast.net>
Sent: Monday, June 19, 2017 11:26 AM
To: Williams, Kathleen
Subject: Re: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Will do.

Tom

Sent from my iPhone: Bassriverlodge

On Jun 19, 2017, at 11:10 AM, Williams, Kathleen <kwilliams@yarmouth.ma.us> wrote:

Hi Tom,

We are seeking public input on the Draft Hazard Mitigation Plan and would appreciate it if you could forward the information below to the [Seas River Civic Association members](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

1

Chapter 1: Draft Plan Comment Notices

Williams, Kathleen

From: Williams, Kathleen
Sent: Monday, June 19, 2017 11:10 AM
To: Cris Lufiazzi (crissylu@msn.com)
Cc: Chris Greeley (greetyc@comcast.net); Bolliger, Linda (linda.bolliger@verizon.net)
Subject: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Hi Cris,

We are seeking public input on the Draft Hazard Mitigation Plan and would appreciate it if you could forward the information below to the [Hyannis Park Civic Association members](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

2

Williams, Kathleen

From: Susan Brita <sfbrita@gmail.com>
Sent: Tuesday, June 20, 2017 7:13 PM
To: Williams, Kathleen
Cc: Ann Kaprielian; Bob Quinlioni; Chris Greeley (greetyc@comcast.net); Joyce Cullen; Kathy Campbell; Patty Hugnes
Subject: Re: Draft Yarmouth Hazard Mitigation Plan for Public Comment

Thanks - will forward

Sent from my iPhone

On Jun 19, 2017, at 11:03 AM, Williams, Kathleen <kwilliams@yarmouth.ma.us> wrote:

Hi lo,

Please forward the information below to the [Lewis Bay Group members](#).

Draft Hazard Mitigation Plan: The Town of Yarmouth and the Cape Cod Commission have worked together to develop a Draft Hazard Mitigation Plan for Yarmouth. Hazard mitigation plans identify critical town infrastructure, vulnerabilities to natural hazards, and actions for the Town to take to protect facilities and residents. Approved plans also help maintain eligibility for state and federal pre- and post-disaster funding.

A draft of the Hazard Mitigation Plan is available for review and comment at www.capecodcommission.org/yarmouthhazardplan through **Sunday July 9, 2017**. Please provide your input by sending comments to Chloe Schaefer at chloe.schaefer@capecodcommission.org.

Thank you for your feedback!
 Kathy

 Kathy Williams, PE
 Yarmouth Town Planner
 1146 Route 28
 South Yarmouth, MA 02664-4492
 (508) 398-2231 Ext 1276
kwilliams@yarmouth.ma.us

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Chapter 1: BCREPC Meeting Notes (March 2, 2016)



**BARNSTABLE COUNTY
REGIONAL EMERGENCY PLANNING
COMMITTEE**
SUPERIOR COURT HOUSE
POST OFFICE BOX 427
BARNSTABLE, MA 02630

Phone: (508) 375-6618
FAX: (508) 362-2603
Email: bcrepc@barnstablecounty.org

MEETING NOTES

The Barnstable County Regional Emergency Planning Committee

Held a meeting on Wednesday, March 2, 2016 at 2:00 p.m. in the
Innovation Room in the OpenCape Building at the Barnstable County Complex
3195 Main Street, Barnstable, MA 02630

I. Welcome/Introductions

The meeting was called to order at 1405 by co-chair Chief Ron Fisette.
Introductions were made around the room:

Tim Lynch, Massachusetts Maritime Academy, Cally Harper, Cape Cod Commission, Lance Lambros, Office of Senator Vinny deMacedo, Hilary Greene, American Red Cross, Kent Farrenkopf, Eastham Fire Department, Jerry McDermott, Eversource, Philip Simonian, Yarmouth Fire Department, Kevin Morley, PIO BCREPC, Sean O'Brien, BCREPC, Debra Rogers, Falmouth Community Television, Dan Howard, ARES, Jeff Tavares, Falmouth Fire Department, Michael Walker, Incident Management Team, Diana Gaumont, Cape Cod Medical Reserve Corps, Roy Jones, Cape Cod Regional Transit Authority, Chrystal LaPine Health and Medical Coordinating Coalition, Bill Ciocca, National Grid, Dee Yeater, Visiting Nurse Association, Amy Henderson, AmeriCorps Cape Cod, Chloe Schaefer, Cape Cod Commission, Deirdre Arvidson, Barnstable County Department of Health and Environment, Amy Alati, Barnstable County Department of Health and Environment, Brian Dale, Cape Cod Regional Transit Authority, Ed Kulhawik, Eastham Police Department, Jeff Rossi, AmeriCorps Cape Cod, Paul Hoy, American Red Cross, Jake Garringer, AmeriCorps Cape Cod, Michael Clark, Barnstable Police Department, Brian Gallant, Sandwich Office of Emergency Management, Ron Fisette, Wellfleet Police Department, Chad Absten, Falmouth Fire Department, Laura Marin, Provincetown Health Department, Rachel Potts, Massachusetts Emergency Management Agency, Joseph Gordon, Barnstable County Sheriff's Office, Phil Burt, BCREPC, Eric Trudeau, National Park Service, Charles Noyes, Bourne Emergency Management Director.

II. Minutes: February 3, 2016

A motion was made by Brian Gallant to accept the minutes; the motion was seconded by Roy Jones and approved unanimously.

Chapter 1: BCREPC Meeting Notes (March 2, 2016)

III. Status Reports from REPC Subcommittees and Programs:

- **Executive Committee**

Sean O'Brien said there would be a meeting on March 14 to discuss expansion of the executive committee from 5 to 9 members

- **HAZMAT/Tier 2 Update**

Amy Alati reported it was the best year ever but most complicated. She praised the filers using the Tier 2 Manager software. 418 facilities reported in Barnstable County this year. BCREPC covers Nantucket County as well – 27 facilities reported on the island.

There were 67 office visits from public and private facility representatives in the month of February. Compliance protects the facilities by ensuring fire departments on Cape Cod and Nantucket receive the HAZMAT database and the facility emergency response plans.

Oyster Harbor Marine and Cape Cod Oil were exemplary said Amy. They were assiduous in their willingness to do the right thing.

- **Health Agents Coalition**

No report but Amy mentioned a program around opioid abuse. She has copies of the presentation

- **Incident Management Team**

Mike Walker reported on the MACC standup and the call-out for a search operation in Harwich. The team continues to seek more training opportunities.

- **Sheltering Task Group**

Phil Burt said there were no shelter operations this winter. The committee is looking for grant funding for equipment and supplies and scheduling walk-throughs during the summer months.

- **American Red Cross**

Paul Hoy introduced himself as the Disaster Program Manager on an interim basis. He reported the ARC is looking for a full-time replacement

Chapter 1: BCREPC Meeting Notes (March 2, 2016)

for Ellen Rossano who left the ARC due to health reasons. In terms of volunteers the ARC is trying to increase shelter manager capacity by 25%. The ARC is also adding supplies, in addition to shelter equipment and is also working on a mobile capacity, each of which would shelter 100 people. ARC is also increasing by 100 % the capacity of the Nantucket shelter with material for 100 people. Hilary Greene updated to committee on the Heroes Breakfast.

- **MEMA**

Rachel Potts reported there were no updates

- **OpenCape Liaison Task Group**

Sean O'Brien said the Task Group would be looking at dash/body cams and 700 MHz He would have a report at the next meeting.

- **Citizens Corps Council**

Amy Alati reported that the final edits were being made to the senior emergency reference magnetic card, which is to be printed by the Barnstable County Sheriff's Office. It will educate the senior population about planning for emergencies. Public seminars and education events will be held as well.

- **ARES**

Dan Howard reported that issues with antennas are being addressed at the Old Jail.

- **Barnstable County Sheriff's Office**

Joe Gordon reported that the S39 vehicle responded to Harwich for a search and rescue operation. He said that agencies shouldn't hesitate to ask for that vehicle as a command post. He reported that a new CERT class was starting at the Massachusetts Maritime Academy.

- **Public Information Officer**

Kevin Morley reported the shelter video project is making good progress. He reported that he is engaging Cape Cod Community Access TV stations in the production of Regional Shelter System videos

IV. **Introduction: Verizon Government Affairs**
Ellen Cummings, Regional Director

Chapter 1: BCREPC Meeting Notes (March 2, 2016)

Sean introduced Ellen. She has been working with Cape for six years wireline and wireless. She is very happy to make connection with public safety. She will stay around after meeting to meet with public municipal officials to hand out information sheet on reporting on problems.

Sean praised Ellen and Verizon for their responsiveness.

V. Presentation: Engaging Neighboring Communities in Hazard Planning
Cally Harper, PhD. Planner II
Cape Cod Commission

Cally Harper reported her primary role is helping towns update hazard mitigation plans. She reviewed elements of hazard mitigation plan. She presented a status update on hazard mitigation plans for Cape towns. She reported that the majority of towns do not have an active plan. She reviewed the process of developing a hazard profile. She also sought input from the BCREPC for Town Hazard Mitigation Plans. She sought discussion of the relevant hazards on Cape Cod. She asked the meeting members to fill out a survey on Survey Monkey.
www.surveymonkey.com/r/bcrepc

VI. News - Open Announcements - Information

Hillary Greene announced a fundraiser for Frank O'Laughlin on March 11.

VII. Public Comments

None

VIII. Adjourn

A motion for adjournment was made by Joe Gordon; seconded by Brian Gallant. The meeting was adjourned at 1445

Chapter 1: BCREPC Presentation (March 2, 2016)

Engaging Neighboring Communities
in Hazard Planning

Cally Harper, PhD
Cape Cod Commission
March 2, 2016

Today:

- Review elements of Hazard Mitigation Plans
- Status update on Hazard Mitigation Plans on Cape Cod
- Process for developing a Hazard Profile
- Ask you to comment on elements of the Hazard Profile

Three Fundamental Parts of a Town Hazard Plan



Data



Action +
Accountability



Public
Engagement

Data

- Identify relevant hazards
- Collect data on historical storm events
- Determine the impact and probability of storms
- Conduct a Vulnerability and Risk Assessment



Action +
Accountability

- Accountability for past Mitigation Actions
- Town Capability Assessment
- Develop new Mitigation Actions for the next 5 years



Public
Engagement

- Engagement occurs during the planning process and once a draft plan is developed
- Who is engaged? Public, Stakeholders, Neighboring Towns



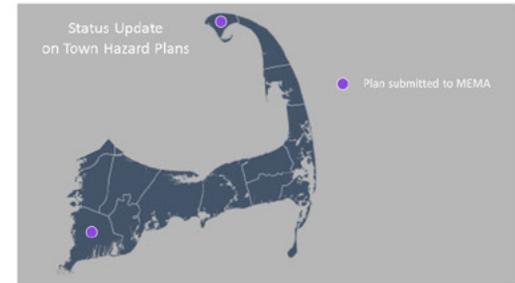
Chapter 1: BCREPC Presentation (March 2, 2016)

Why is hazard planning important?

1. Protects people and property
2. Eligibility for Hazard Mitigation Assistance
3. Community Rating System



©2014



Chapter 1: BCREPC Presentation (March 2, 2016)

FEMA Requirement 201.6(b)(2):

Give neighboring communities the opportunity to be involved in hazard mitigation activities



- A lot of towns are working on their plans!
- BCREPC meeting is a great opportunity to fulfill this requirement!
- Specifically, the towns would like to engage the BCREPC in the development of their hazard profiles

How is a Hazard Profile developed?

This process is performed by Hazard Planning Team with assistance from the Cape Cod Commission



Town reviews the natural hazards in the MA State Hazard Plan



- Erosion + Shoreline Change
- Dam/Culvert Failure
- Earthquake
- Fire: Wildland and Urban
- Flood
- Hurricanes + Tropical Storms
- Landslide
- Nor'easters
- High Winds
- Thunderstorms
- Extreme Temperatures
- Tornadoes
- Drought
- Severe Winter Weather
- Tsunami
- Sea Level Rise

Town reviews the natural hazards in the MA State Hazard Plan

Town looks at the data and determines which hazards are relevant to their town



Example from the 2016 Provincetown Hazard Mitigation Plan

Town engages the public and stakeholders to comment on relevant natural hazards



Seek the public input on:

- History and impact of storms in town
- Level of concern that a storm will occur again



Town engages the public and stakeholders to comment on relevant natural hazards



Public Input is used to determine which hazards undergo a Vulnerability and Risk Assessment

An example from the Provincetown Hazard Mitigation Plan

Chapter 1: BCREPC Presentation (March 2, 2016)

Seeking input from the BCREPC for Town Hazard Mitigation Plans

Nearly all towns will benefit from your input!



Activity #1: Discuss which hazards are relevant to Cape Cod

Activity #2: Fill out a survey on Survey Monkey

Activity #1: Discuss hazard relevance using local knowledge

- Erosion + Shoreline Change
- Dam/Culvert Failure
- Earthquake
- Fire: Wildland and Urban
- Flood
- Hurricane + Tropical Storms
- Landslide
- Nor'easters
- High Winds
- Thunderstorms
- Extreme Temperatures
- Tornadoes
- Drought
- Severe Winter Weather
- Tsunami
- Sea Level Rise

Are all of these hazards relevant to Cape Cod?

Are any missing?

Which ones affect only a few towns?

Activity #2: Survey on Impact + Probability of Natural Hazards



www.surveymonkey.com/r/BCREPC

You can fill it out now or it will be emailed to you this week.

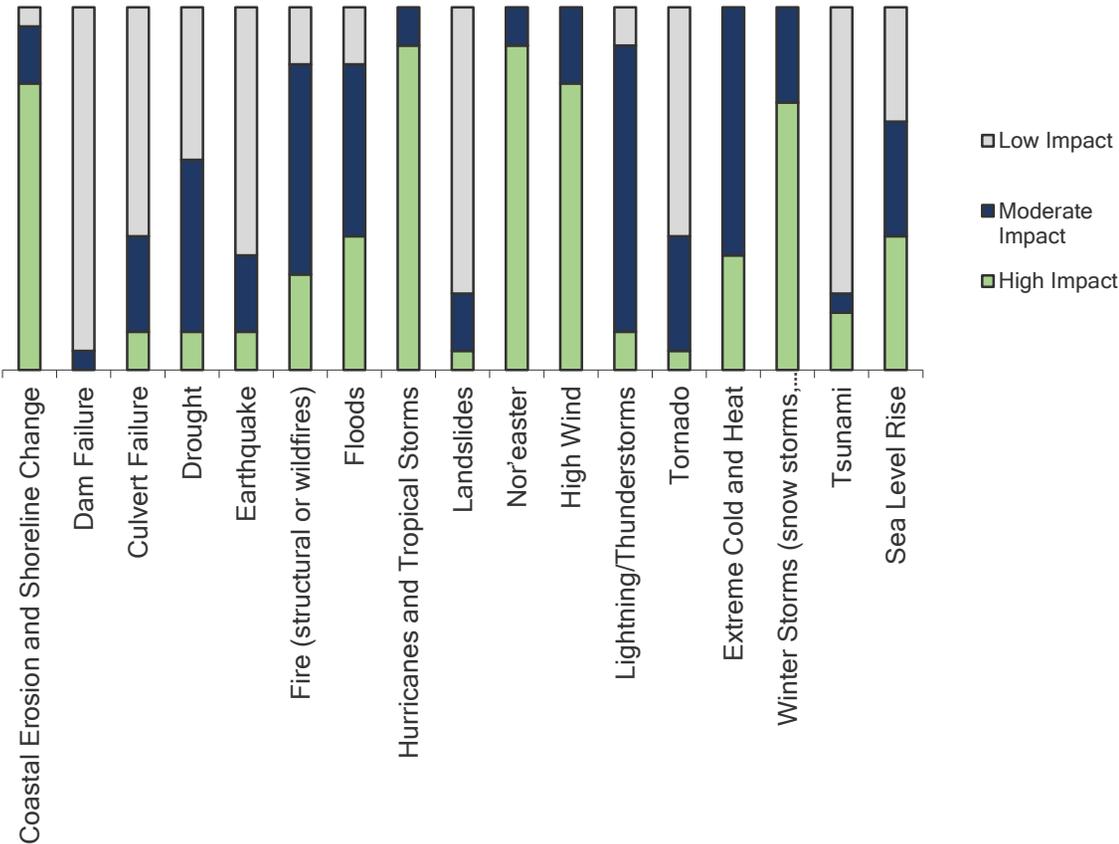
P.S. Its only 3 questions!



Cally Harper, PhD
 Community Design Department
 Cape Cod Commission
 (508) 744-1221
cally.harper@capecodcommission.org

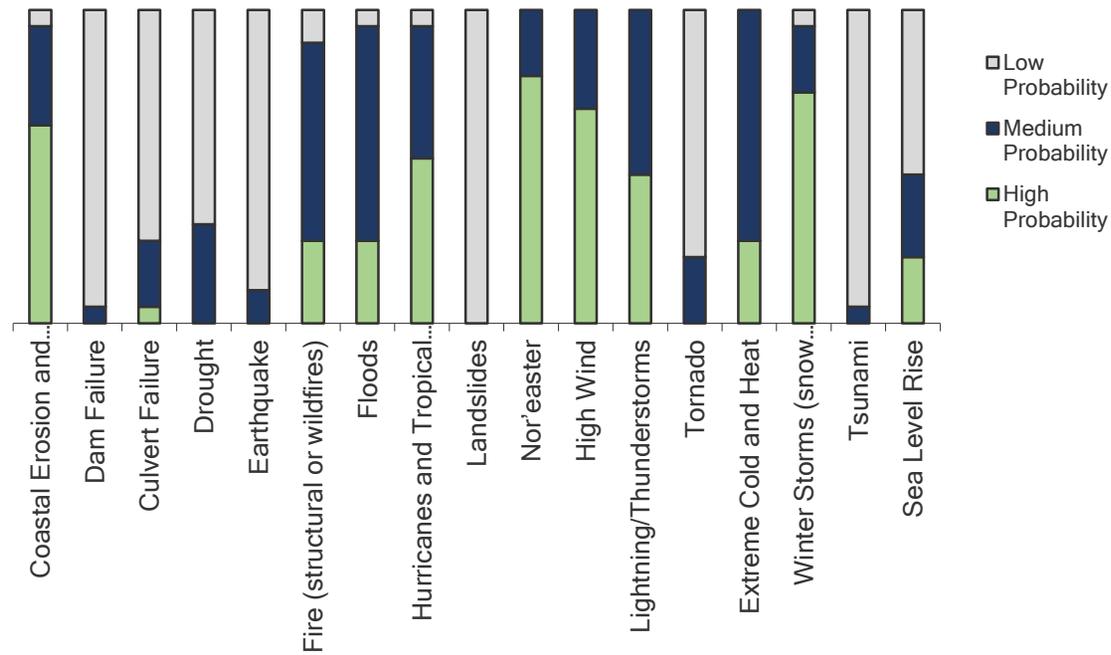
Chapter 1: BCREPC Survey Results

Question 1: For each hazard listed below, please identify if it will have a "low," "moderate" or "high" impact on Cape Cod. The towns would like you to use your local knowledge of Cape Cod. According to FEMA, impact is defined as the damage or consequence



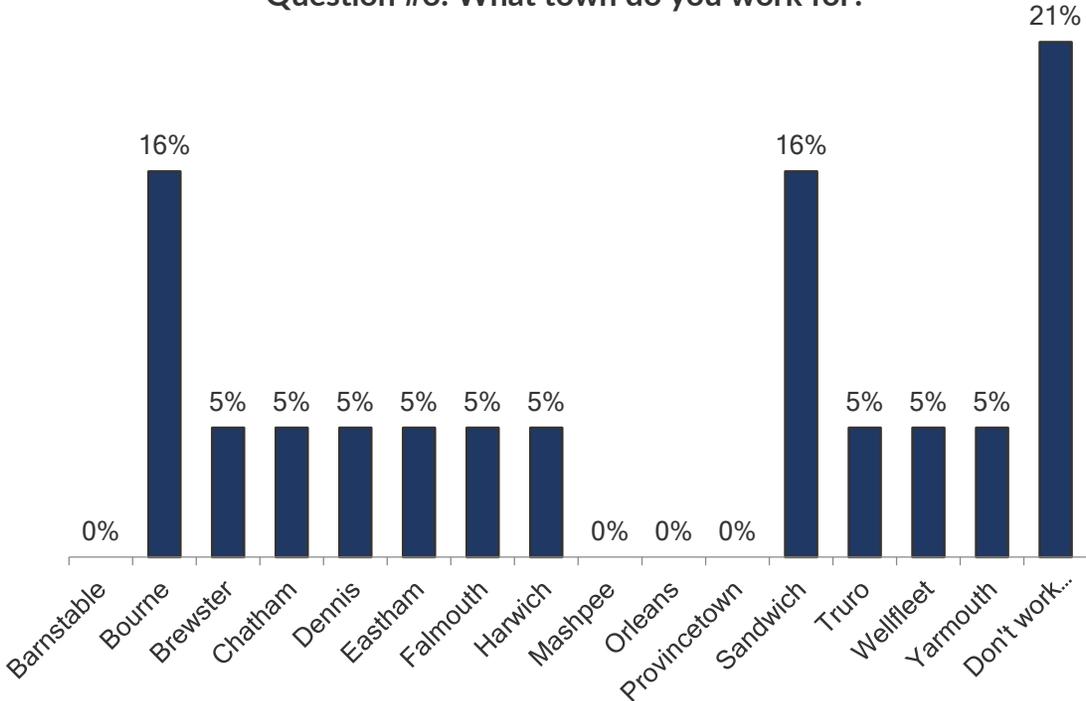
Chapter 1: BCREPC Survey Results

Question #2: For each hazard listed below, please assign a probability score of "low," "medium" or "high". According to FEMA, probability measures how often an event is likely to occur. Low probability means the event will occur at least once in the next

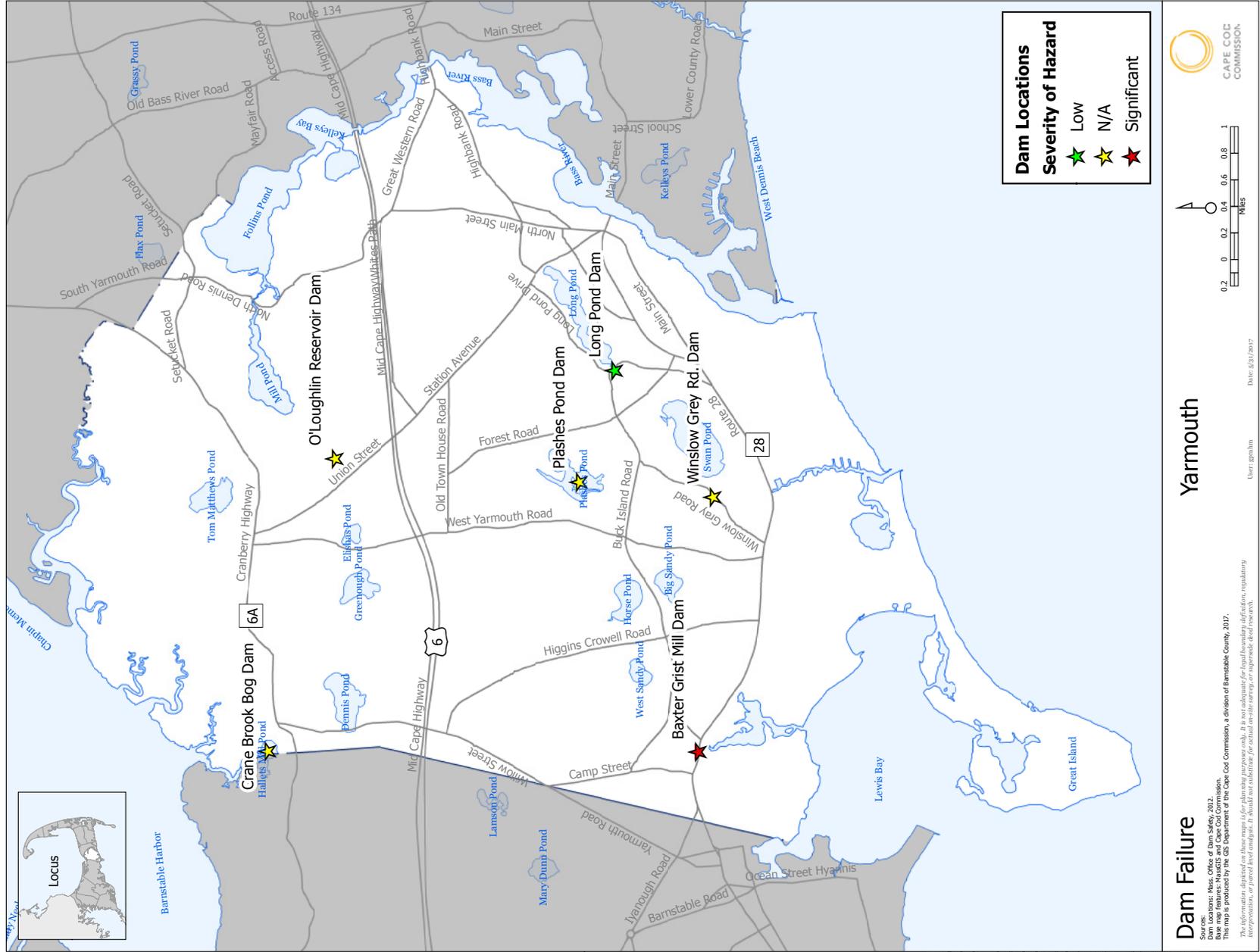


Chapter 1: BCREPC Survey Results

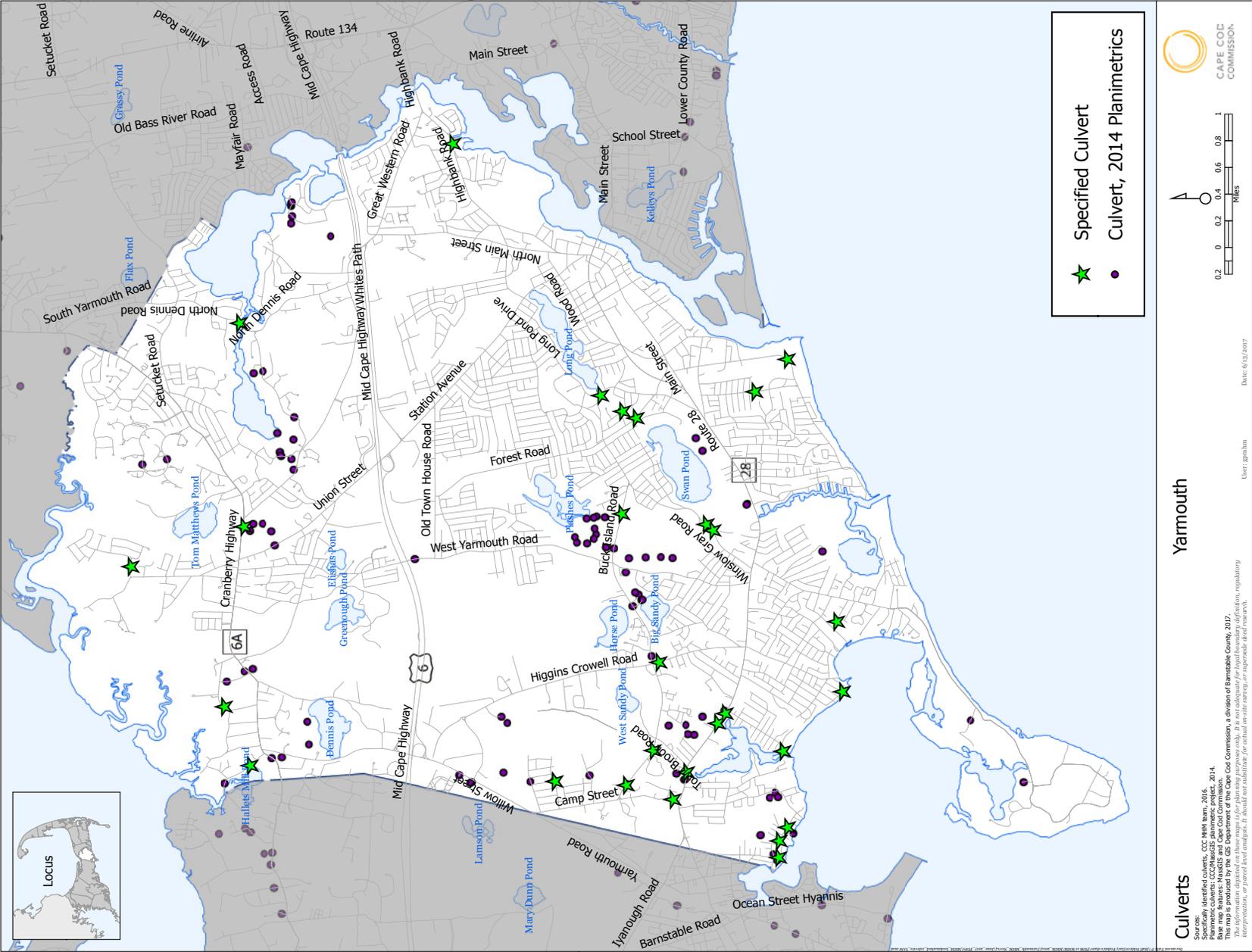
Question #3: What town do you work for?



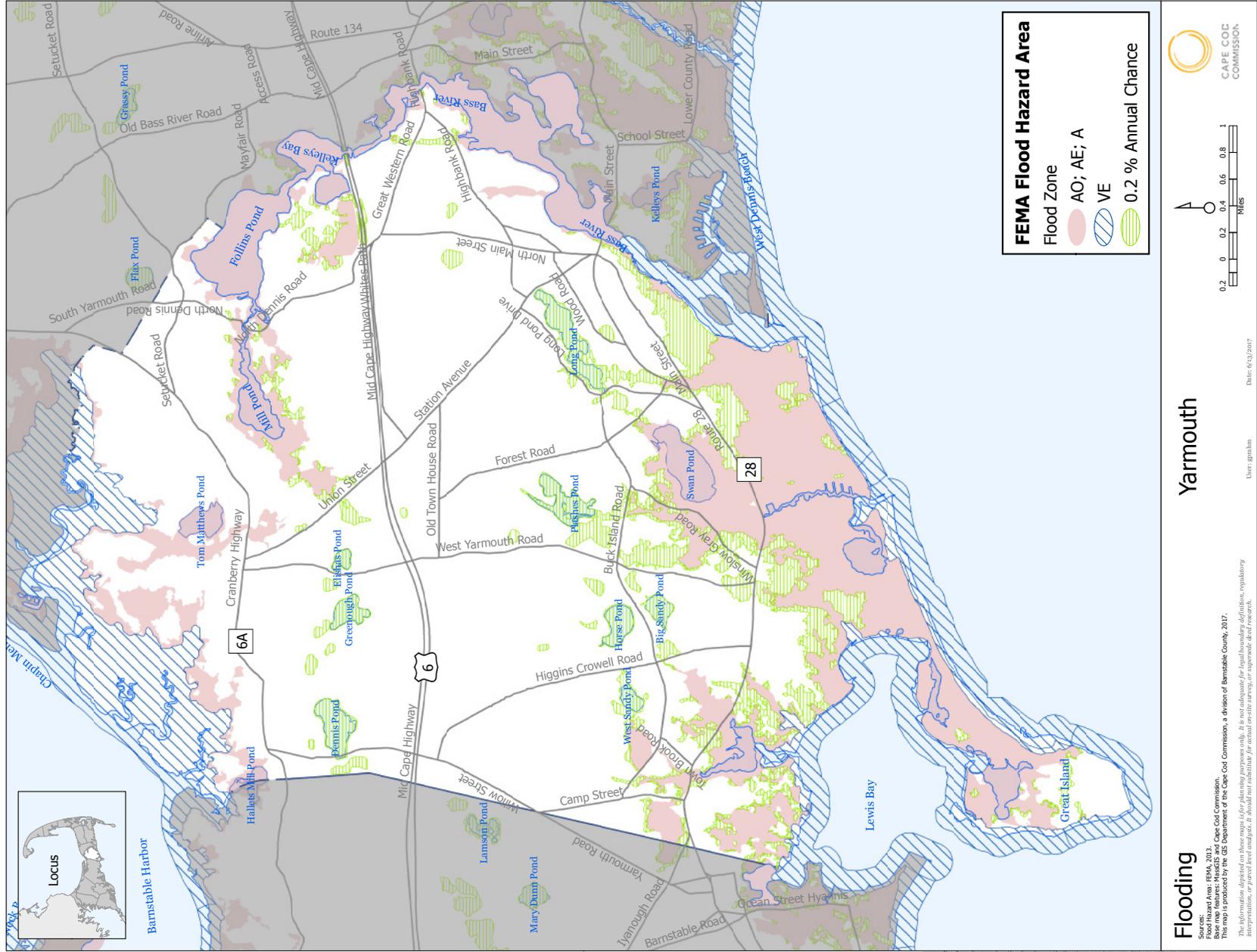
Larger Maps: Dams (Figure 2.2)



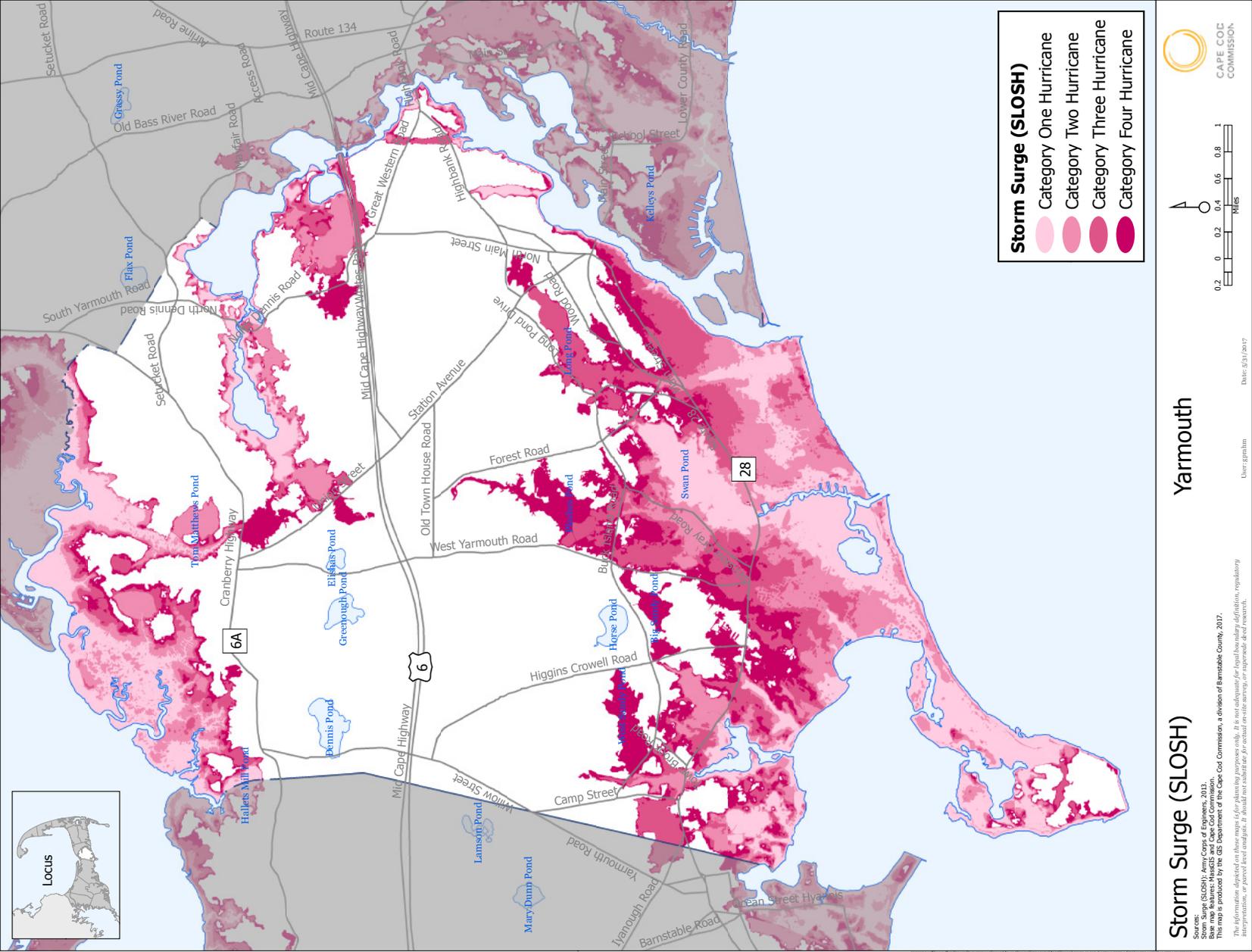
Larger Maps: Culverts (Figure 2.3)



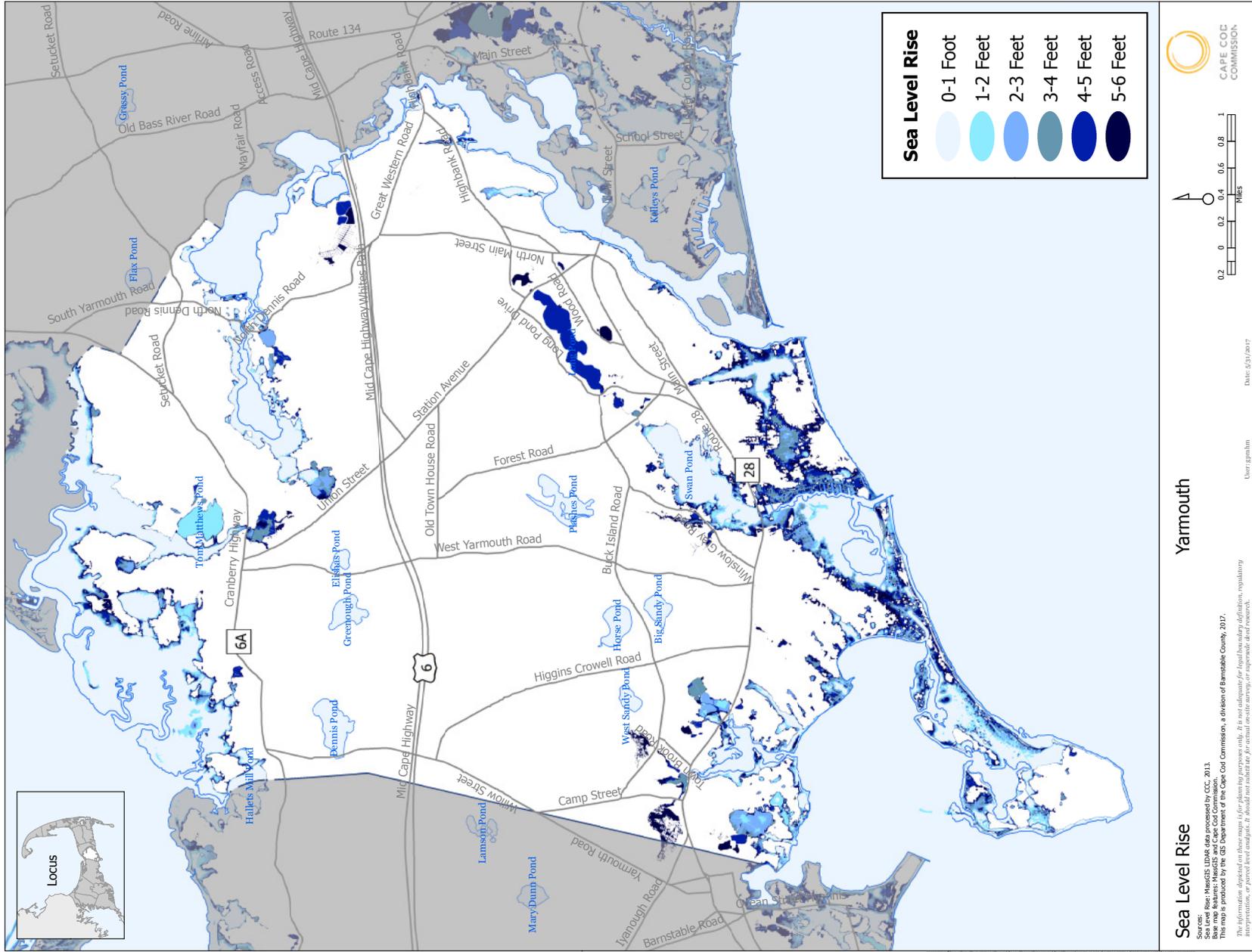
Larger Maps: FEMA Flood Hazard Area (Figure 2.6)



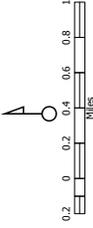
Larger Maps: Storm Surge (Figure 2.8)



Larger Maps: Sea Level Rise (Figure 2.19)



Larger Maps: Base Map (Figure 3.1)



Yarmouth

Multi-Hazard Mitigation Base Map

Sources: Features: NINECS and Cape Cod Commission.

This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2017.

The information depicted on these maps is for planning purposes only. It is not adequate for legal boundary definitions, regulatory interpretations, or parcel-level analysis. It should not substitute for actual on-site surveys, or separate deed research.

User: jgranth Date: 5/29/2017



Yarmouth Hazard Mitigation Plan, 2017



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 Sites: www.capecodcommission.org

