BOURNE

2017 Hazard Mitigation Plan

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Introduction

The purpose of hazard mitigation is to reduce loss from future natural disasters. Storms and other natural disasters can cause loss of life, damage to buildings and infrastructure and have devastating consequences to a community's economic, social and environmental well-being. One step 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 Federal Emergency Management Agency (FEMA). This plan only addresses natural hazards and does not consider impacts from man-made disasters.

The purpose of the Bourne Hazard Mitigation Plan is to reduce damages resulting from natural hazards by implementing sustained actions to reduce or eliminate long-term risk to human life and property from hazards. The Bourne 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 Bourne that can recover after a storm event occurs. Over the last 5 months, Town staff and the residents of Bourne have worked diligently to meet the FEMA requirements for updating a single jurisdiction hazard plan while maintaining the character and individuality of Bourne.

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It is important to note that if and when the 2017 Bourne Hazard Mitigation Plan Update is approved by FEMA and adopted by the Board of Selectmen, the town becomes eligible to receive funding from FEMA's Hazard Mitigation Assistance (HMA) program, which includes the following programs:

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

Review Tool Description:

FEMA developed a "Local Mitigation Review Guide" to help Federal and State officials assess Local Hazard Mitigation Plans in a fair and consistent manner and to ensure approved local plans meet the requirements of the Stafford Act and Title 44 Code of Federal Regulations (CFR) 201.6. The "Local Mitigation Review Guide" was used as guidance in updating the Bourne Hazard Mitigation Plan. When text in the Bourne 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 Bourne Hazard Mitigation Plan.**

Planning Team

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Members and Responsibilities

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The Planning Team is an interdisciplinary group of town staff members with expertise to develop the plan and authority to implement the action items it identifies. In July 2014, the Cape Cod Commission applied for funding on behalf of the Town of Bourne to help town staff update the 2004 Bourne Hazard Mitigation Plan. Using funds from this grant, several staff members from the Cape Cod Commission provided technical support to update the plan. ***Table 1.1*** lists the names, titles and affiliations of the Bourne Hazard Planning Team.

Name	Title	Affiliation
Terri Guarino	Health Agent	Health Department
Thomas Guerino	Town Administrator	Administration
Samuel Haines	Conservation Agent	Conservation Commission
Roger Laporte	Inspector of Buildings	Building Inspection Department
Coreen Moore	Town Planner	Planning Department
Timothy Mullen	Director	Department of Natural Resources
Charles Noyes	Director	Emergency Management Department
George Sala	Superintendent	Department of Public Works
Norman Sylvester	Chief	Fire Department
Dennis Woodside	Chief	Police Department
John Stowe Jr.	Detective Sergeant	Police Department
Erin Perry	Special Projects Manager	Cape Cod Commission
Gary Prahm	GIS Analyst	Cape Cod Commission

Table 1.1 | Bourne Hazard Planning Team

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

Meeting Schedule and Involvement

The Planning Team worked collaboratively throughout the planning process, meeting in February, March, April and May of 2017 to develop sections of the hazard plan.

Town Administrator	Assisted with the outreach strategy; reviewed drafts of the plan
Natural Resources Director	Reviewed/developed mitigation actions; reviewed drafts of the plan
DPW Director	Assisted with critical facilities list; reviewed drafts of the plan
Police Chief and Detective Sergeant	Assisted with public outreach strategy; provided data on hazard impacts
Fire Chief	Reviewed drafts of the plan
Health Agent	Assisted with critical facilities list; reviewed/developed mitigation actions
Emergency Management Director	Coordinated meeting locations and dates; assisted with outreach strategy; assisted with critical facilities list; reviewed/developed mitigation actions; reviewed drafts of the plan
Conservation Agent	Provided data on hazard impacts; reviewed/developed mitigation actions
Town Planner	Assisted with public outreach strategy
Building Inspector	Provided data on hazard impacts; reviewed/developed mitigation actions
Special Projects Manager, 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

The following is a list of dates and topics covered at each meeting:

February 15, 2017: kick-off meeting with the Bourne Emergency Management Director and Cape Cod Commission to discuss Planning Team membership and process to update the Bourne Hazard Mitigation Plan.

February 28, 2017: review process and timeline to update the Bourne plan, discuss planning team responsibilities and develop outreach strategy.

March 21, 2017: finalize outreach strategy and materials, agree upon critical facilities list, review hazard profile and identify town-specific impacts from natural hazards, and conduct probability assessment.

April 25, 2017: review public survey results, review and discuss vulnerability assessment, review 2004 mitigation goals and develop 2017 mitigation goals.

May 16, 2017: review the status of mitigation actions in the 2004 hazard plan, and develop new mitigation actions for the 2017 plan.

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

Outreach Strategy

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With the Public

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

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The Planning Team developed an online survey to gather data on the significance/relevance of the natural hazards identified in the Massachusetts State Hazard Mitigation Plan to Bourne, the impact of those significant natural hazards, and preparedness efforts in Bourne. The survey also gathered data on how residents would like to be engaged in the future. The survey was launched on March 22, 2017 and closed on April 12, 2017, giving the public three weeks to fill out the survey. A link to the survey was posted on the main page of the Town Website, and posted to the Police Department's Facebook page. The Planning team received 195 respondents 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 process for incorporating public input into the hazard plan was as follows:

1. The Planning Team reviewed survey responses during an in-person meeting held on April 25, 2017.
2. The Planning Team incorporated these responses in 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 Bourne. They were presented with the 11 hazards identified in the Massachusetts State Hazard Mitigation 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 2.9***).
   - 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 Bourne. They were presented with a list of 13 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, as feasible.

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Prior to Submission to MEMA/FEMA

A draft of the 2017 Bourne Hazard Mitigation Plan was released for public comment on July 31, 2017. The Planning Team posted a notice in the local newspaper, the Bourne Courier, directing the general public to the document.

The plan was discussed at the Bourne Board of Selectmen meeting on August 22, 2017. The public had the opportunity to submit written comments during the public comment period, or provide verbal comments during the meeting.

- **David Scarpato, Scarptec, Inc.:** Mr. Scarpato suggested clarifying that this plan does not address man-made hazards. Language was added to the introduction to provide clarification.

With Stakeholders

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

Stakeholders were actively engaged in updating the Bourne 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 provided input during the planning process and just prior to plan approval

Outreach Strategy

Identification of Stakeholders

Planning team members identified stakeholders from their various areas of expertise. Stakeholders included employees and volunteers from many different organizations and groups in Bourne including:

- Buzzards Bay Water District
- North Sagamore Water District
- Bourne Water District
- Massachusetts Maritime Academy
- Integrated Solid Waste Management
- Bourne Recreation Authority
- Bourne Housing Authority

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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***). Stakeholder input from the survey resulted in the following:

- Provided data on whether or not specific hazards were significant to the town (***See Table 2.1***)
- Identified 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 Bourne Hazard Mitigation Plan to the stakeholder group. Stakeholders were asked to provide comments on the Hazard Plan either in writing or verbally at the August 22, 2017 Board of Selectmen meeting. No comments were received.

With Neighboring Communities

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The neighboring communities of Falmouth and Sandwich and representatives from Joint Base Cape Cod were given the opportunity to participate in the planning process at a meeting of the Barnstable County Regional Emergency Planning Committee.

The neighboring communities of Plymouth and Wareham, which are outside of Barnstable County, were given an opportunity to comment on the Hazard Plan either in writing or verbally at the August 22, 2017 Board of Selectmen meeting.

Barnstable County Regional Emergency Planning Committee (BCREPC)

The Planning Team gathered input from the 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 Bourne, 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," "BCREPC Meeting Notes" and "BCREPC Survey Results" section in ***Appendix 1***.

Continuing Outreach Efforts During Plan Maintenance

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Once the 2017 Bourne Hazard Mitigation Plan is approved by MEMA and FEMA, it will be forwarded to the Bourne Board of Selectmen for adoption. Once adopted, the 2017 Bourne 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.

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

- **Development of Educational Materials** to prepare residents for nor'easters, hurricanes and severe winter weather, as well as other hazards, as needed..
- **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 Report

Technical Information Used in the Plan

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The 2017 Bourne 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 Bourne 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

Incorporation with Other Town Plans and Report

(FEMA 386-2, 2001) prepared by FEMA

- How-To Guide: Developing the Mitigation Plan (FEMA 386-3, 2003) prepared by FEMA
- How-To Guide: Bringing the Plan to Life – Implementing the Hazard Mitigation Plan (FEMA 386-1, 2002) prepared by FEMA
- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (2013) prepared by FEMA
- Hazard Mitigation Assistance Guidance (2015) prepared by FEMA
- National Flood Insurance Program Community Rating System Coordinator's Manual (FIA-15/2013 prepared by FEMA
- National Flood Insurance Program Floodplain Management Requirements: Study Guide and Desk Reference for Local Officials (FEMA 480, February 2005) prepared by FEMA
- Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA 543, January 2007) prepared by FEMA
- Mitigation Assessment Team Report Hurricane Ike in Texas and Louisiana: Building Performance Observations, Recommendations, and Technical Guidance (FEMA P-757, April 2009) prepared by FEMA
- Recommended Residential Construction for Coastal Areas: Building Strong and Safe Foundations (FEMA P-550, 2nd Edition, December 2009) prepared by FEMA
- Wind Retrofit Guide for Residential Buildings (FEMA P-804, December 2010) prepared by FEMA
- Home Builder's Guide to Coastal Construction Technical Fact Sheets Series (FEMA P-499, December 2010) prepared by FEMA
- Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas Volume I and II (4th edition, FEMA P-55, August 2011) prepared by FEMA
- Highways in the Coastal Environment: Assessing Extreme Events (2014) prepared by the U.S. Department of Transportation and the Federal Highway Administration
- National Climate Assessment (2014)

- **Technical Information from State Agencies:**
  - Massachusetts State Hazard Mitigation Plan (2013) prepared by Tetra Tech on behalf of the Massachusetts Emergency Management Agency and the Department of Conservation and Recreation
  - 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
- **Technical Information from Bourne:**
  - Bourne Local Comprehensive Plan (2004) prepared by the town of Bourne
  - Town of Bourne Zoning Bylaws (updated 2016) prepared by the Bourne Planning Board
  - Town of Bourne DRAFT Open Space and Recreation Plan (March 16, 2017) prepared by Horsley Witten Group

How Technical Information was incorporated

A4b

The technical information listed above was incorporated into the 2017 Bourne 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
  - provide current data on climate change and adaptation strategies

Incorporation with Other Town Plans and Report

- 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
- Bourne specific documents were used to:
  - ensure that mitigation actions in the 2016 were consistent with current activities and plans already in place in Bourne
  - provide technical data for the hazard profiles, risk assessment and mitigation actions

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Integrating the Hazard Plan into other Town Plans

The Mitigation Goals and Objectives identified in the 2017 Bourne Hazard Mitigation Plan will be incorporated into the objectives and policies of the Bourne Local Comprehensive Plan (LCP).

- **Bourne Local Comprehensive Plan:** voters approved the goals and policies of the LCP at the November 8, 2004 Town Meeting and the action items of the LCP at the May 15, 2006 Town Meeting. Revisions to the LCP were adopted at the May 12, 2008 Town Meeting. The Bourne 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 during future updates. Below are examples of Mitigation Goals that will be integrated in the update of the Bourne LCP:
  - Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards
  - Ensure mitigation measures are sensitive to natural features, historic resources, and community character

New FEMA guidance requires that the 2017 Bourne Hazard Mitigation Plan Update describe how the plan was integrated with other plans over the last five years. Because this is a new requirement, Bourne does not have a process in place to collect such information. Going forward, Bourne 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 Bourne Hazard Mitigation Plan.

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Contents of Chapter 1 Appendix

Contents in the Chapter 1 Appendix include:

- Team Meeting Attendance Sheets
- Public Survey on Hazard Mitigation
- Survey Documentation
- Results of Public Survey on Hazard Mitigation
- BCREPC Presentation
- BCREPC Meeting Notes
- BCREPC Survey Results

Natural Hazards

CHAPTER TWO

Bourne 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 Mitigation Plan. An evaluation of human-caused hazards (i.e. technological hazards, terrorism, etc.) is encouraged but not required for plan approval. Bourne has included an assessment of natural hazards only in the 2017 Bourne Hazard Mitigation Plan. **Chapter 2 provides a detailed description of the natural hazards that could impact Bourne in the future or have impacted Bourne in the past.**

Hazard Identification

State Hazards

The 2013 Massachusetts State Hazard Mitigation 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 Bourne

As suggested under FEMA planning guidance, the Planning Team reviewed the full range of natural hazards identified in the 2013 Massachusetts State Hazard Mitigation Plan and identified natural hazards that could impact Bourne in the future or that have impacted Bourne 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 Mitigation Plan and other resources. All resources are referenced in the text of each hazard profile.

Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Bourne?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Bourne?	Why was this determination made?
Coastal Erosion and Shoreline Change	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ 2015 Coastal Erosion Commission Report ▪ Massachusetts Coastal Zone Management Storm Coasts application ▪ Local knowledge from Town Staff	Yes	There is a history of erosion and shoreline change in Bourne

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Table 2.1 | List of relevant natural hazards for Bourne

Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Bourne?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Bourne?	Why was this determination made?
Dam (Culvert) Failure	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There are aging dams and culverts in Bourne therefore increasing the probability of failure
Earthquake	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a no history of earthquakes in Bourne but there is a history of earthquakes in Massachusetts
Fire (Urban and Wildland)	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff ▪ Barnstable County Wildfire Preparedness Plan	Yes	There is a history of wildfires in Bourne, especially stemming from Joint Base Cape Cod. Fire-adapted vegetation puts the town at risk for wildfire
Flood	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ FEMA 480 ▪ Local knowledge from Town Staff ▪ Newspaper articles	Yes	There is a history of flooding in Bourne
Hurricane and Tropical Storms	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ National Hurricane Center ▪ Local knowledge from Town Staff	Yes	There is a history of hurricanes and tropical storms in Bourne
Landslide	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	No	Loose soils and likelihood of flooding pose a risk for landslides
Nor'easters	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a strong history of nor'easters in Bourne

Hazard Identification

Table 2.1 | List of relevant natural hazards for Bourne (cont.)

Type of Natural Hazard	According to weather data, is there a history of this hazard happening in Bourne?	What resources were used to make that determination?	According to the Planning Team, could this hazard happen in Bourne?	Why was this determination made?
High Winds	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of high winds in Bourne
Thunderstorms	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of thunderstorms in Bourne
Extreme Temperatures	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of extreme cold and hot temperatures in Bourne
Tornadoes	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is no history of tornadoes in Bourne, but there have been tornado warnings in Barnstable County
Drought	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of drought in Barnstable County
Severe Winter Weather	Yes	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	Yes	There is a history of severe winter weather in Bourne
Tsunami	No	▪ 2013 Massachusetts Hazard Mitigation Plan ▪ Local knowledge from Town Staff	No	The probability of a damaging tsunami impacting Massachusetts is unknown, but there is no history to indicate it could happen.
Sea Level Rise	Yes	▪ 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 Bourne

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, transport and accretion shape the coastal shoreline. Shorelines change seasonally, tending to accrete gradually during the summer months when sediments are deposited by relatively low energy waves and erode dramatically during the winter when sediments are moved offshore by high energy storm waves, such as those generated by nor'easters.

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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 and identified discreet areas of coastline that are particularly susceptible. ***Figure 2.1*** is a series of two maps of the planning area showing how the shoreline has changed from the mid-1800s to 2009.

1 Coastal Erosion Commission Report, December 2015

Hazard Profiles

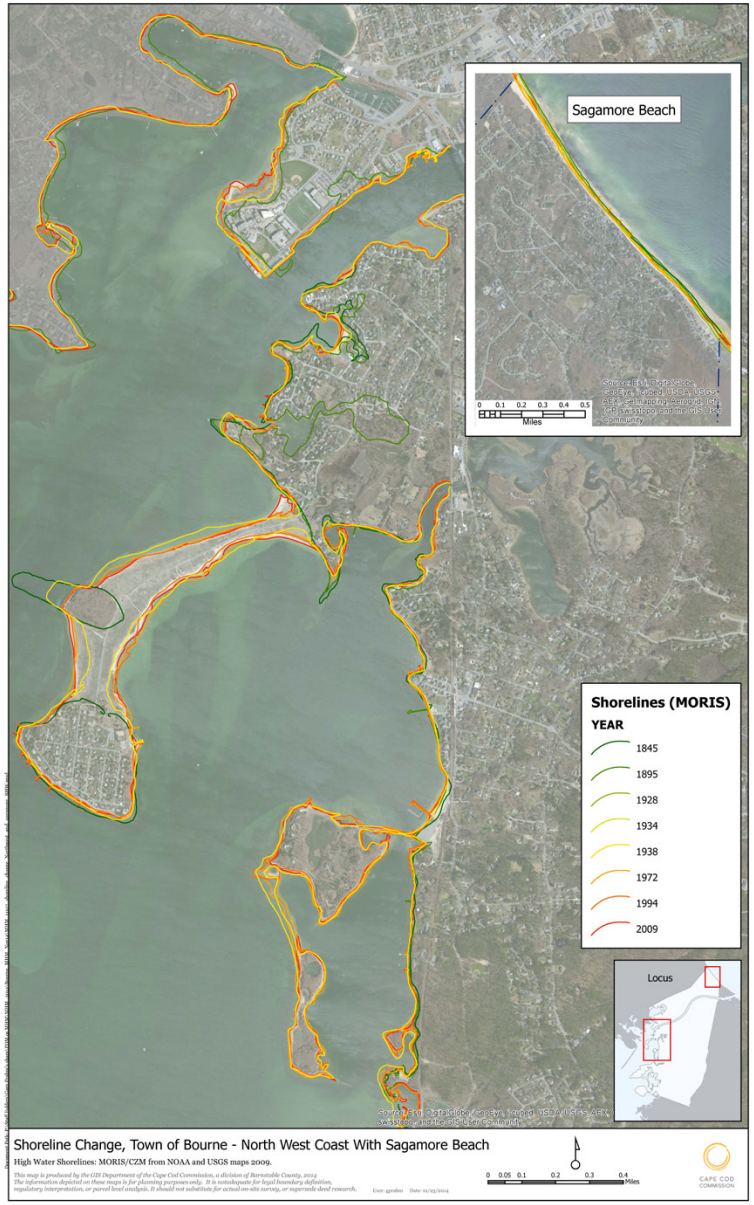

Figure 2.1a | Historic shoreline change along the coast of Bourne. Map was created using data from the Massachusetts Ocean Resource Information System

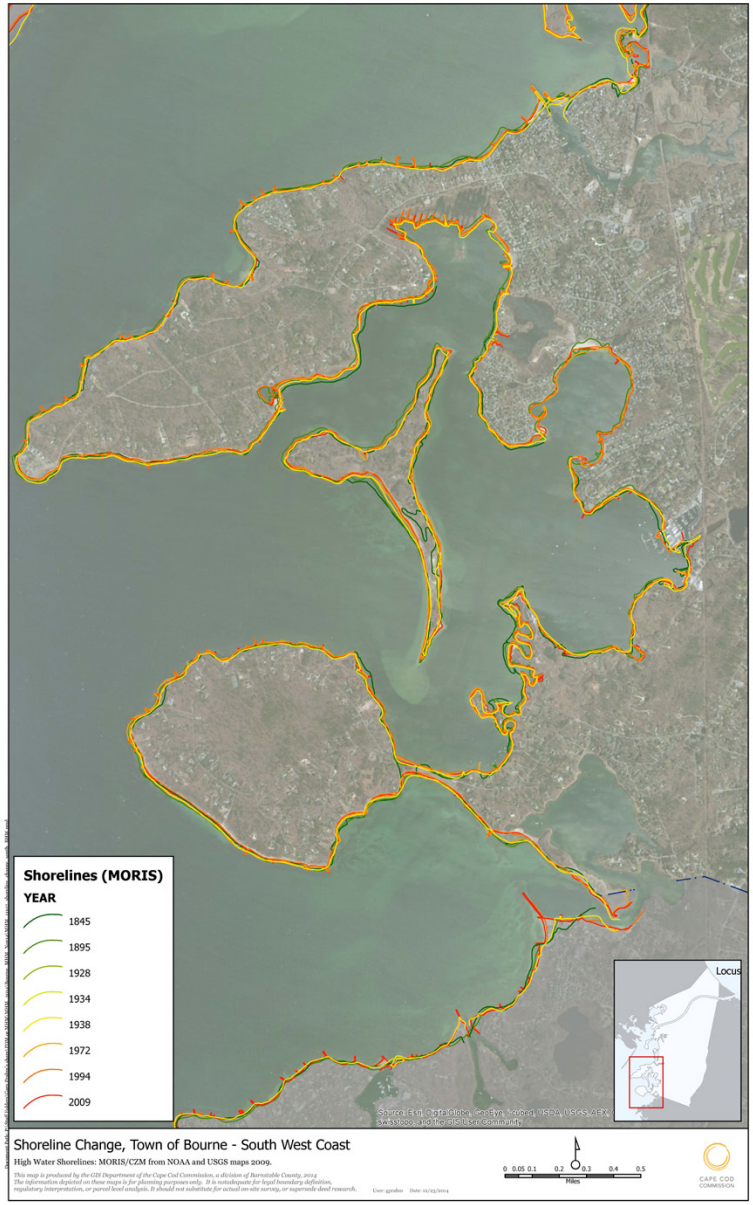

Figure 2.1b | Historic shoreline change along the coast of Bourne. Map was created using data from the Massachusetts Ocean Resource Information System

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 Coastal Erosion Commission's 2015 Report states the average shoreline change rates for Bourne, where positive values indicate accretion and negative values indicate erosion, is the following:

- **Entire Town:**
  - Short-Term Rate: -0.3 ± 1.1 ft/year
  - Long-Term Rate: -0.1 ± 0.7 ft/year
- **Cape Cod Bay Shoreline:**
  - Short-Term Rate: 2.3 ± 1.8 ft/year
  - Long-Term Rate: -0.5 ± 0.3 ft/year
- **Buzzards Bay Shoreline:**
  - Short-Term Rate: -0.4 ± 0.9 ft/year
  - Long-Term Rate: -0.1 ± 0.7 ft/year

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

Impact

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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 change[3]:

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- **People:** public safety is jeopardized when buildings collapse or water supplies are contaminated; erosion can cause roadways to collapse which would reduce the response time of emergency vehicles
- **Infrastructure:** erosion can expose septic systems and sewer pipes risking contamination of shellfish beds and other resources; accreting sand can block storm water pipes, causing urban drainage issues in town
- **Buildings:** erosion reduces the embedment of foundations in the soil, causing shallow foundations to collapse and making buildings on foundations

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

3 Coastal Erosion Commission Report, December 2015

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 loss
- **Natural Systems:** where engineered structures are used to stabilize shorelines, the natural process of erosion is altered, changing the amount of sediment available and erosion rates at adjacent areas; the town's natural ecosystem attractions—beaches, dunes, barrier beaches, salt marshes and estuaries—would also be threatened and could slowly disappear as sand sources that supply and sustain them are eliminated; under conditions of reduced sediment supply, the ability of coastal landforms to provide storm damage and flooding protection would be diminished, increasing the vulnerability of infrastructure and development.
- **Transportation:** roadways can become damaged due to shoreline recession

Probability

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The Planning Team determined that it is **HIGH LIKELY** that a shoreline change 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

Data from the Shoreline Change Project and local knowledge were used to make this probability determination.

(Dam) Culvert Failure

Overview

A dam is an artificial barrier that can impound water, wastewater or any liquid-borne material for storage or control of water. Dam failure is a catastrophic type of failure characterized by a sudden, rapid and uncontrolled release of impounded water. There are several reasons why dams might fail, including but not limited to[4]:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

The Massachusetts Department of Conservation and Recreation Office of Dam Safety classifies dams based on hazard potential. Classification is as follows:

- **High Hazard Potential:** dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
- **Significant Hazard Potential:** dams located where failure may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
- **Low Hazard Potential:** dams located where failure may cause minimal property damage to others. Loss of life is not expected.

A culvert is a structural opening under a roadway that allows water to pass from one side of a roadway to the other.[5]

Water flowing under the road typically comes from two sources – streams and road runoff – and these water resources require different types of culverts[6]:

- Stream crossing culvert is located where the roadway crosses over a stream channel and the culvert allows water to pass downstream
- Runoff management culvert is a strategically placed culvert to manage roadway runoff

4 Massachusetts State Hazard Mitigation Plan, Dam Failure, 2013

5 http://water.epa.gov/polwaste/nps/urban/upload/2003_07_24_NPS_unpavedroads_ch3.pdf and Massachusetts Highway Department: Project Development and Design Guide 2006

6 Ibid.

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).[7] 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 to:

- Buildup of flood waters on the upstream side of the culvert that exceed the capacity of the culvert. (video of a culvert failure in Maine, see: https://www.youtube.com/watch?v=NTbhyHNA1Vc)
- The pipe inside the culvert becomes occluded because of debris or improper maintenance
- The pipe inside the culvert loses its structural integrity and begins to cave in
- 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.

Hazard Location

B1c

There are seven dams located in Bourne (locations shown in ***Figure 2.2***).

- Two dams are in Bournedale: Mill Pond Dam and Foundry Pond Dam
- Two dams are in Monument Beach: Brookside Pond #1 Dam and Brookside Pond #2 Dam
- Two dams are in Pocasset: Mill Pond Dam and Shop Pond Dam
- One dam is in Cataumet: Red Brook Pond Dam

There are 126 culverts located in Bourne (locations shown in ***Figure 2.3***).

7 Ibid.

Hazard Profiles

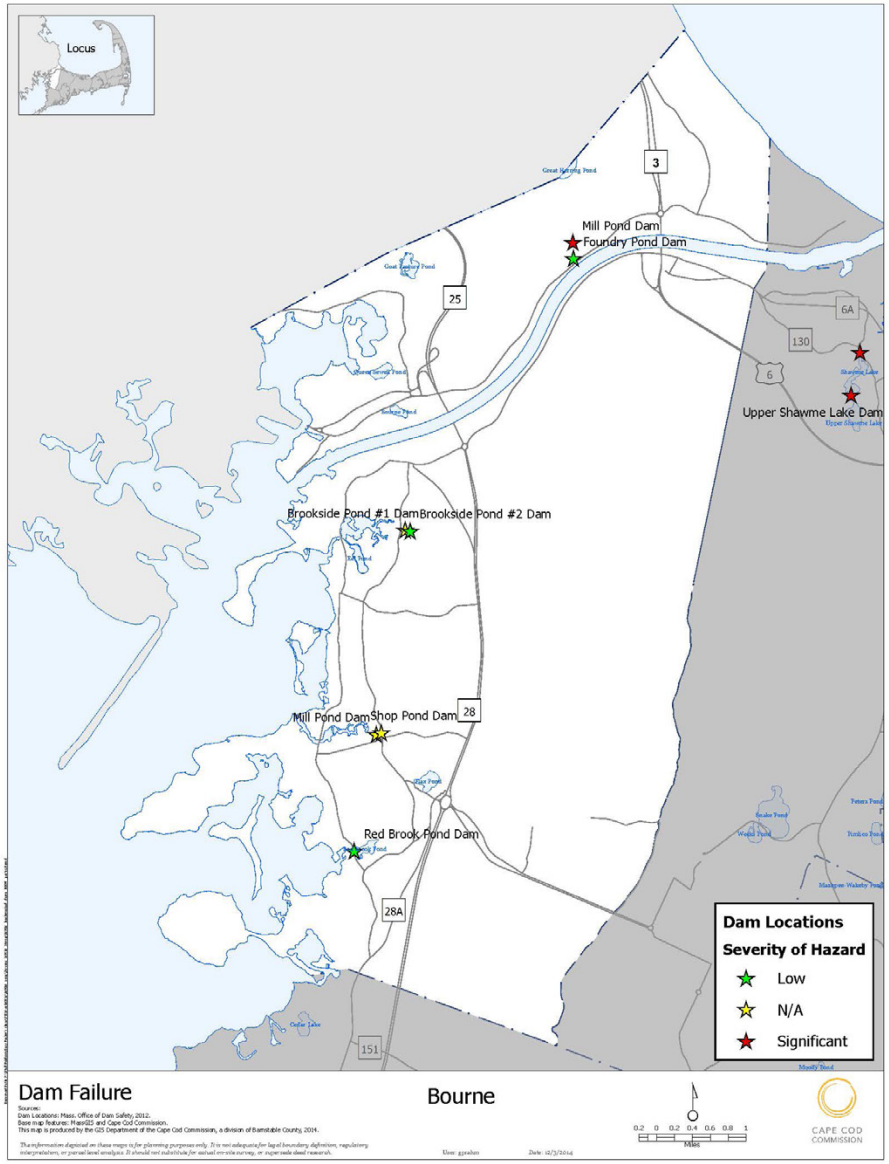

Figure 2.2 | Map of the location and hazard potential of dams in Bourne

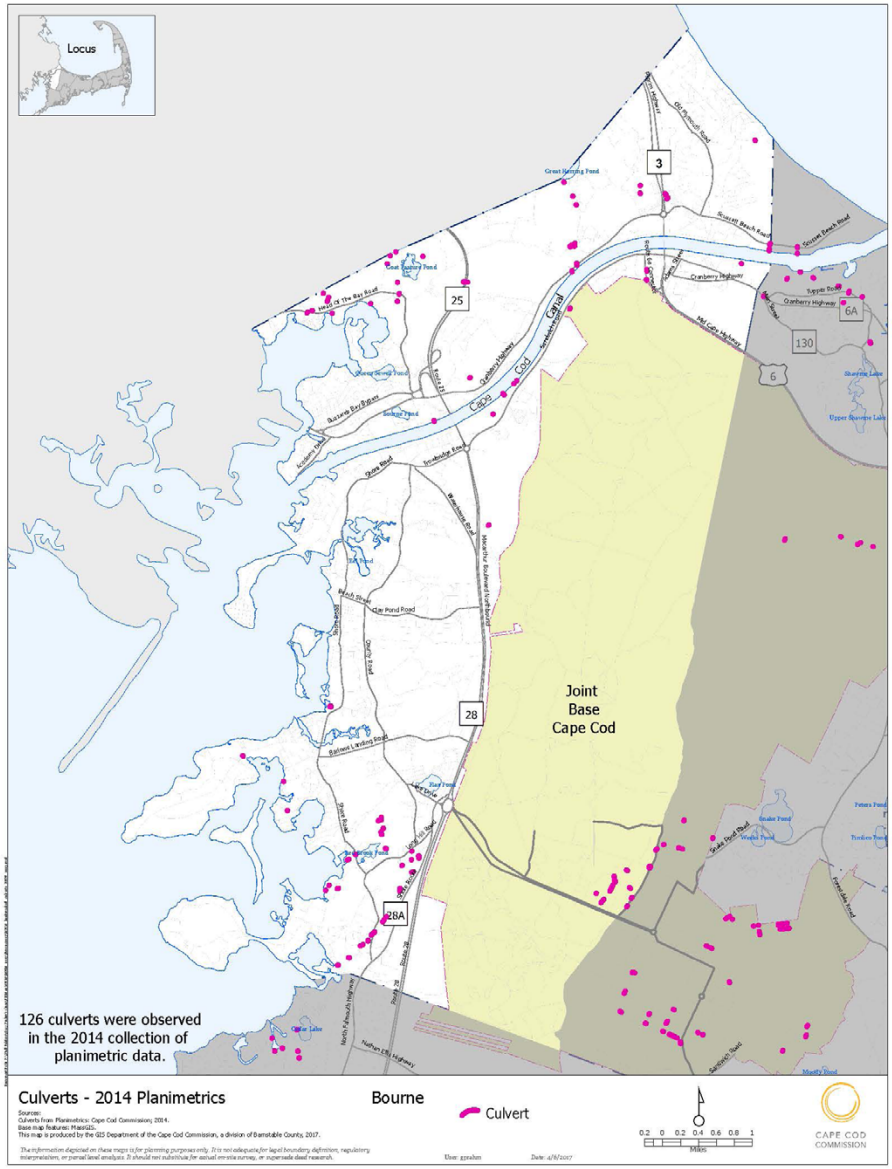

Figure 2.3 | Map of the location of culverts in Bourne

B1c, B2a,c

Previous Occurrences and Extent

There is no record of dam or culvert failure in Bourne.

According to the Office of Dam Safety, none of the seven dams in Bourne are classified as high hazard potential. A single dam, the Mill Pond Dam located in Bournedale, is classified as having significant hazard potential. Three dams are classified as low hazard potential, including Foundry Pond Dam in Bournedale, Brookside Pond #2 Dam in Monument Beach, and Red Brook Pond Dam in Cataumet. The remaining three dams (Brookside Pond #1 Dam, Mill Pond Dam, and Shop Pond Dam) have not been assessed. ***Figure 2.2*** includes the hazard classification for each dam location.

Since Bourne 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.[8] In August of 2011, Tropical Storm Irene brought heavy precipitation to 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. In Rochester, NH water was redirected onto cemetery grounds – unearthing caskets and scattering human remains throughout the downtown area.

Impact

B3a

If Foundry Pond Dam and/or Mill Pond Dam in Bournedale failed both residences and transportation infrastructure could be impacted by downstream flooding. Both dams are located along Scenic Highway, which is the primary connection between Routes 3 and 25. Those dams are located up gradient of private residences and water flows through a culvert located under Scenic Highway. There is concern that this culvert may not be capable of handling an increase in flow that could result from the failure of these dams and the potential exists for Scenic Highway, as well as an adjacent roadway (Bournedale Road), to be washed out.

8 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

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

- Landslides around the reservoir perimeter
- Bank erosion on rivers
- Destruction of downstream habitat

Below is a list of possible impacts from culvert failure:

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

Probability

B2b

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

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

The probability of any type of dam failure is low in today's regulatory and dam safety oversight environment. Dam failures usually coincide with an event that causes them; therefore, they are thought of as a residual risk, or a risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the dam was designed to handle.[9]

9 Massachusetts State Hazard Mitigation Plan, Dam Failure, 2013

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.

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. 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. See ***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:

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

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

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.

B1c

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 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

BBetween 1627 and 2008, there were 366 earthquakes recorded in Massachusetts.[10] 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 New England.

Below is a list of earthquakes that affected eastern Massachusetts[11]:

- 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

10 Massachusetts State Hazard Mitigation Plan, Earthquake, 2013

11 Ibid.

- January 28, 1940: no data available on extent of hazard
- October 16, 1963: Intensity VI, caused plaster to fall in a house, a wall cracked, stones fell from a building foundation, dishes were broken, windows cracked
- October 30, 1963: no data available on extent of hazard
- October 24, 1965: slight damage to homes on Nantucket, house timbers creaked, doors, windows and dishes rattled
- December 30, 2012: Magnitude 1.2 earthquake about 7 miles south of Gardner, MA. No extent data available.
- April 2012: a swarm of 12 or more earthquakes occurred off of the New England coast about 250 miles east of Boston. The largest of these earthquakes measured a magnitude of 4.4 on the Richter Scale. This swarm of earthquakes was of particular concern because of the major earthquake 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 Bourne.

Impact

B3a

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

Earthquakes can also cause large and sometimes disastrous landslides. Sand dunes 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.[12]

Probability

B2b

Earthquakes cannot be predicted and may occur at any time of the day and any time of the year.[13] The Planning Team determined that it is **POSSIBLE** that an earthquake will impact Bourne. 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

12 Ibid.
13 Ibid.

Hazard Profiles

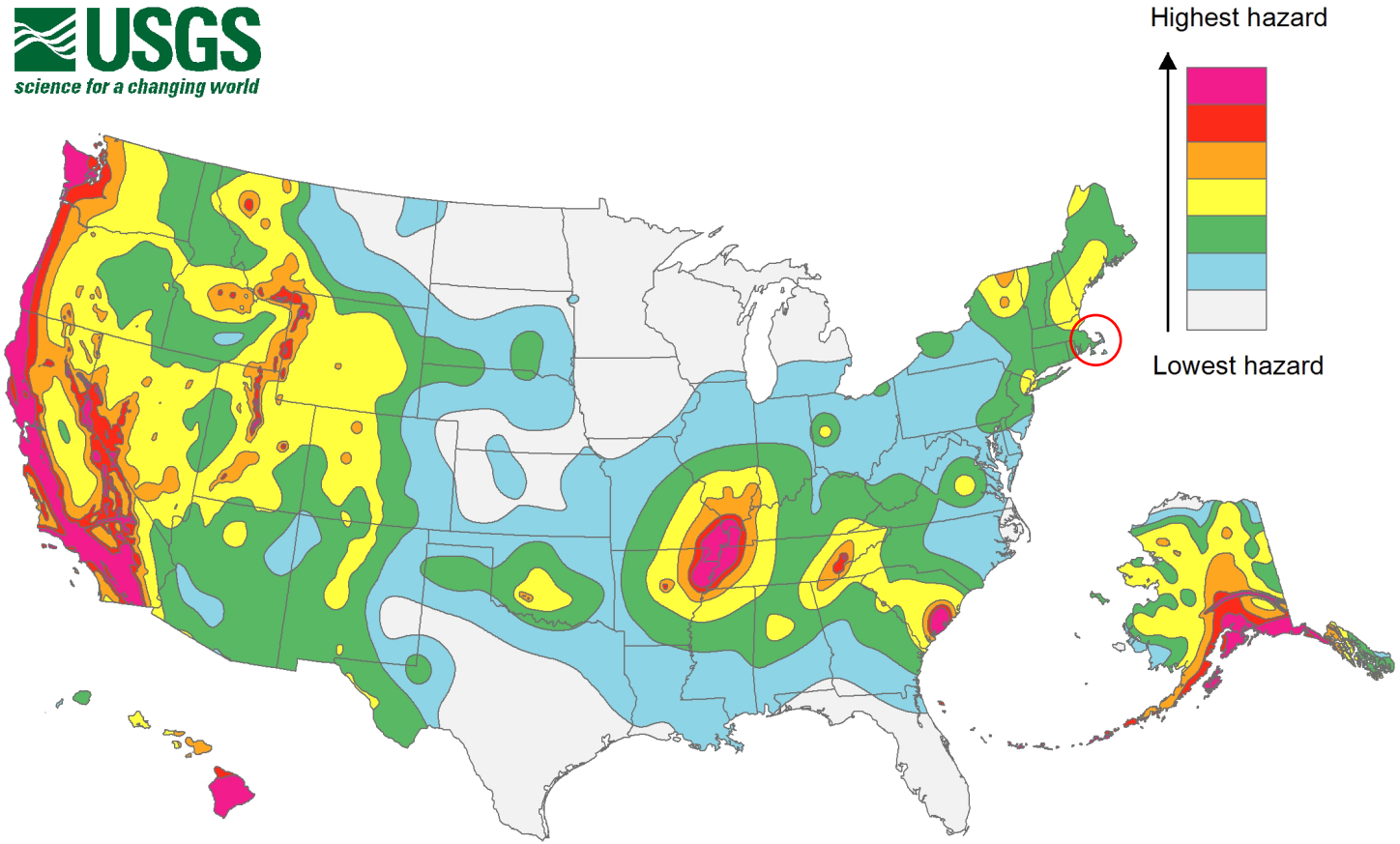

Figure 2.4 | 2014 Simplified earthquake hazard risk map for the United States. A circle was used to identify the planning area on the map.

least one chance in the next 100 years

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

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

Fire: Urban and Wildland

Overview

This portion of the Bourne 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.[14] 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).

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. 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.

14 Massachusetts State Hazard Mitigation Plan, Fire, 2013

Hazard Profiles

B1c

Hazard Location

Properties in areas of compact development are more vulnerable to urban fires. In Bourne, there are no specific areas that appear to be more vulnerable to urban fires than others, given the information in the Previous Occurrences section below.

Bourne has several large tracts of forested land that cause concern for wildfire. A team of fire professionals developed the Barnstable County Wildfire Preparedness Plan and conducted a town-wide risk assessment for wildfire in Bourne (***Figure 2.5***). The eight numbered areas are areas of suggested mitigation focus based on this risk assessment.

Bourne Town Forest, Four Ponds Conservation Area and Water District Lands are identified in the Barnstable County Wildfire Preparedness Plan and each has an existing Community Wildfire Protection Plan. In addition, the Camp Edwards Fire Management Plan addresses wildfire on Joint Base Cape Cod.

B1c, B2a,c

Previous Occurrences and Extent

Britton Crosby, a retired Lieutenant and Paramedic with COMM FD on Cape Cod, wrote a book documenting the history of firefighting on Cape Cod. This book, entitled "Cape Cod Firefighting" was published and released in May 2003; this information was later transferred to a website, www.capecodfd.com.

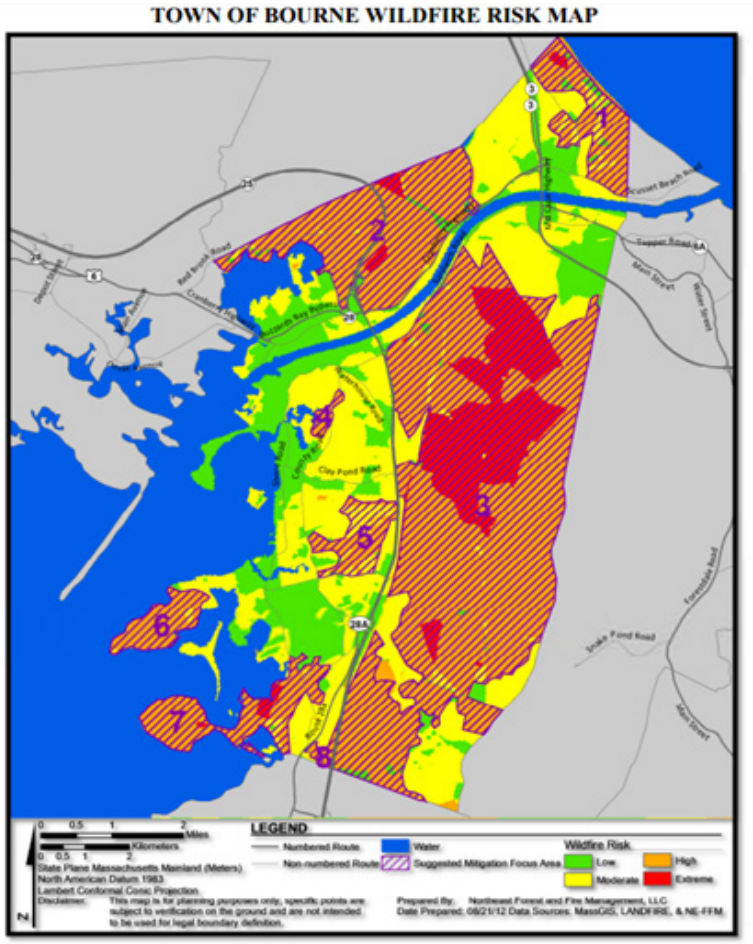

Figure 2.5 | Town of Bourne wildfire risk map from the Barnstable County Wildfire Preparedness Plan

The following is a list of major urban fires listed on that website for Bourne:

- **December 22, 1981:** A multiple alarm fire aboard the 532 foot Massachusetts Maritime Academy ship "Bay State" killed one cadet and injured others. Mutual aid operated for several hours to contain the below decks fire.
- **September 1988:** Fires resulted from an accident involving an 18 wheeler and several vehicles at the north approach to the Bourne Bridge. Two people were killed and several were injured.
- **April 1, 1991:** A four alarm fire destroyed the China Bay Chinese restaurant in Buzzards Bay. The fire at the east end of the Buzzards Bay rotary was extensive and required significant mutual aid.
- **August 25, 1993:** A three alarm fire destroyed the former Sagamore Lumber yard on Freighthouse Road in South Sagamore. Six towns assisted Bourne as they protected one 30,000 gallon and two 18,000 gallon propane tanks exposed to the fire.
- **November 27, 1994:** A fire destroyed a 100 year old mansion at the end of Monument Neck Road in Monument Beach. Efforts were hampered by water supply problems, access, and the size of the waterfront house.

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:** 5,000-acre wildfire kills 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 blaze out of control and consume 50,000 acres.
- **(http:**//www.mashpeema.gov/sites/mashpeema/files/uploads/mashpeewildlife.pdf)
- **June 1949:** 75 acres or more of brush and

woodland burned after a fire started at the Truro Town Dump. Firefighters from Truro, Provincetown, Wellfleet, Brewster and Orleans helped bring it under control. (Provincetown Banner, June 16, 1949)

- **May 1982:** A marsh fire burned over 500 acres at Scusset Beach in Bourne. Several cottages were lost. (www.capecodfd.com)
- **April 22, 1988:** A wildfire burned approximately 1,600 acres at Otis Air Force Base. Fifty people were evacuated as the fire grew rapidly and moved toward Route 130. The fire was contained before it crossed the road and impacted structures. (www.capecodfd.com)
- **July 23-24, 2016:** A brush fire burned more than 100 acres on Joint Base Cape Cod amid drought conditions. The fire struck an area where old explosives are stored, hampering efforts to control the blaze. A dozen fire vehicles responded, fighting the fire from land and sky. (Cape Cod Times, June 24, 2016)

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; this will weaken soils and cause failure on slopes, wildfires can affect the land for many years, including causing changes to the soil and therefore increasing the risk of future flooding, contamination of reservoirs, change the permeability of the ground. When fires burn hot and for long periods of time, the soil will bake and become impermeable. When this happens, runoff and the risk of flooding increases
- **Transportation:** transportation may be temporarily disrupted

B2b

Probability

The Planning Team determined that it is **LIKELY** that both urban fire and wildfire will impact Bourne. Probabilities were defined based on the frequency of occurrence:

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

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

Flood

Overview

There are several types of flood hazards that impact Bourne:

- 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.[15]
- 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

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

than if the same surge occurred at low tide.[16]

- Urban drainage occurs in flat areas where runoff or rain collects and cannot drain out. Drainage systems are made up of ditches, storm sewers, retention ponds and other infrastructure that store runoff and carries it into a receiving stream, lake, or ocean. When most of these systems were built, they were designed to handle the amount of water expected during a 10-year storm event. Larger storms overload the system and result in back-ups. When this system is blocked, water forms temporary ponds. This water will remain in an area until it infiltrates into the soil, evaporates, the blockage is cleared or the water is actively pumped out.[17]

B1c

Hazard Location

Flooding in Bourne is often 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 Bourne. This map depicts areas of Bourne in V and A zones and the 2% annual flood areas.

16 Ibid.

17 Ibid.

Previous Occurrences and Extent

Below is a list of rain, flooding and coastal flooding events experienced in Bourne and in Barnstable County from 1950 - 2015. Data was collected from NOAA's National Climatic Data Center.

- **February 24, 1998:** The second powerful nor'easter to affect the region in less than a week brought a deluge of rain to southeastern Massachusetts, gale force winds along the coast, and coastal flooding to Chatham on Cape Cod and to Martha's Vineyard and Nantucket. Coastal flooding occurred on Martha's Vineyard where Beach Road was closed from Edgartown to Oak Bluffs. Waves were reported splashing over the top of houses in the Eastville section of Oak Bluffs. Beach erosion occurred on Nantucket, where there was a loss of about 20 feet of dunes on the east side of the Island. Up to 12 to 15 feet was lost along Sconset Bluff. There were a few reports of coastal flooding at Chatham on Cape Cod. Dozens of basements were flooded and coastal roads had to be closed as the aftermath of the heavy rain.
- **March 5, 2001:** A major winter storm impacted the Bay State with near blizzard conditions, high winds, and coastal flooding. The slow-moving storm, which tracked south of New England, dumped over two feet of snow across the interior, knocked out power to about 80,000 customers, and shut down businesses and schools for several days. There

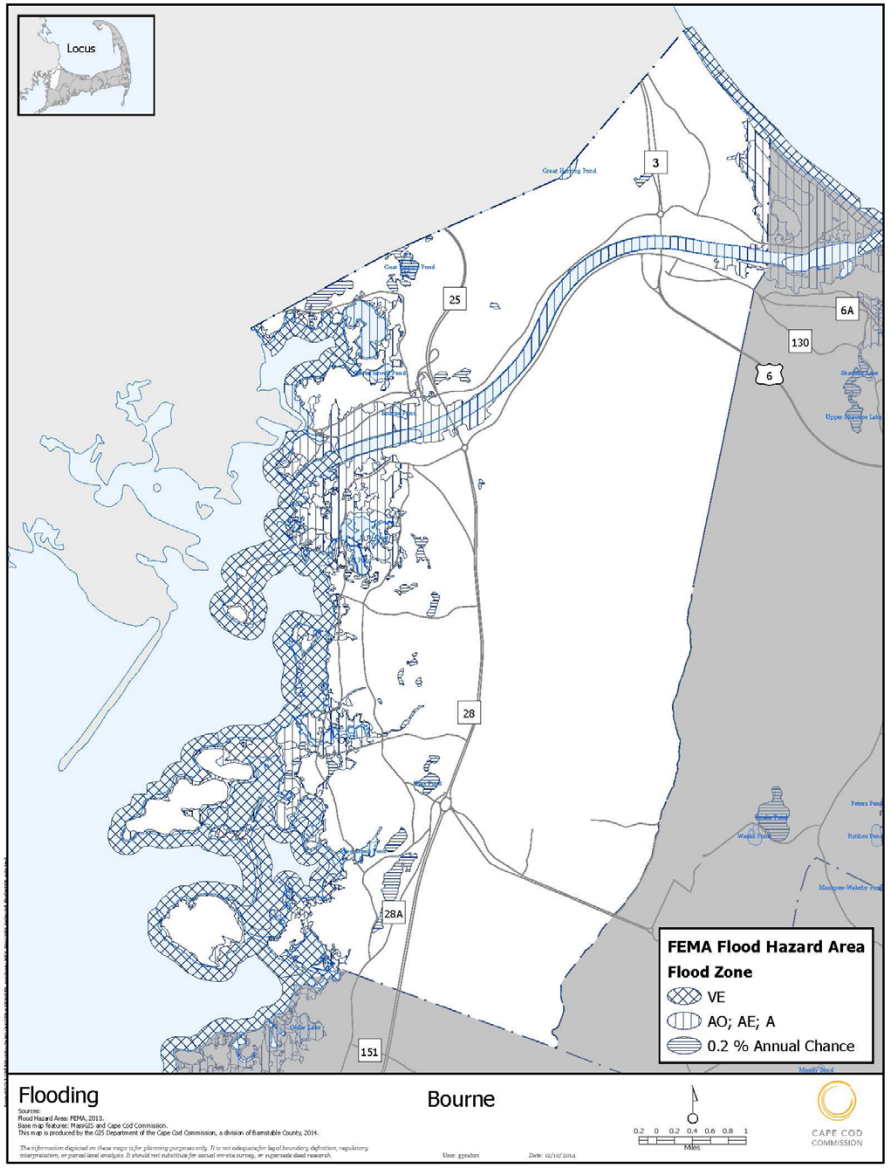

Figure 2.6 | FEMA flood hazard area map

were also many reports of downed trees and wires during the height of the storm, along with reports of lightning and thunder. High tides during the storm ran 2 to 3 feet above normal, resulting in widespread coastal flooding along the entire east facing coastline, including Cape Cod and the islands. The strong surf slammed sea walls and flooded beachfront homes and roadways.

- **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 lines and trees down all over roads and travel was extremely dangerous. Coastal flooding caused major damages to homes along the vulnerable areas.
- **April 16, 2007:** An unusually strong and slow moving coastal storm for mid-April tracked to western Long Island Sound on April 16th before weakening slowly and drifting offshore. This storm brought a variety of impacts in southern New England, including heavy snow to the higher elevations of western Massachusetts, damaging winds in excess of 60 mph, widespread river and stream flooding, and significant coastal flooding through several high tide cycles. Minor to moderate coastal flooding occurred along the coastline of Massachusetts through several high tide cycles, due to the combination of strong onshore winds, high seas, and astronomically high tides. A small stream in Harwich came out of its banks and closed a nearby roadway.
- **September 3, 2010:** Tropical Storm Earl made its closest pass to Southern New England the morning of September 4th, passing 98 miles to the southeast of Nantucket Island. The Automated Surface Observing System at Nantucket Memorial Airport (ACK) recorded the only tropical storm force wind in Southern New England, measured shortly after midnight on the 4th at 36 knots (41 mph). High surf induced by Earl resulted in minor coastal flooding in Newport, RI and Nantucket, MA. Meanwhile, a couple of locations on Cape Cod experienced minor freshwater flooding due to three to five inches of heavy rainfall. Also on Cape Cod, several trees were downed by the persistent sustained winds. A foot of water flooded Orleans Road in Chatham and the intersection of Route 137 and Pleasant Bay Road in Harwich.
- **October 30, 2011:** A rare and historic October Nor'easter brought very heavy snow to portions of southern New England on Saturday October 29. A state of emergency was declared by Governor Patrick on October 29th and he declared an end to the state of emergency on November 6th. This storm also brought damaging winds to Cape Cod and the islands with wind gusts up to 70 mph occurring early Sunday morning October 30 as well as minor to moderate coastal flooding to east coastal Massachusetts during the high tide

early Sunday morning. Moderate coastal flooding occurred with splashover a small seawall that resulted in the flooding of Old Main Street in Sandwich with 18 to 24 inches of water. This made the road impassable. Astronomically high tides contributed to the coastal flooding.

- **July 18, 2012:** Lightning struck a home on Coast Guard Road in Truro, which started a fire. Some minor flash flooding.
- **September 13, 2013:** A cold front moved through an unstable atmosphere across southern New England, triggering showers and thunderstorms across much of Massachusetts and Rhode Island. There was enough shear and instability for some of these storms to become severe, producing damaging winds. In addition, because of the very moist atmosphere and heavy rain over the previous two days, flash flooding also occurred in several locations. A basement was flooded on Chris Drive. Five to six inches of water flooded the police station parking lot.
- **January 27, 2015:** Blizzard conditions for more than 12 hours recorded Cape wide. Snow totals reaching 30+ in. Coastal flooding and high winds caused widespread moderate damages. Ballston Beach was inundated with ocean water which affected South Pamet Road.
- **July 1, 2015:** A strong upper level disturbance and cold air aloft moved into southern New England resulting in showers and thunderstorms. Plenty of moisture throughout the atmosphere led to heavy rain and some minor street flooding. Main Street was flooded and closed for 20 minutes.
- **August 11, 2015:** A warm front moving north through southern New England brought showers and thunderstorms to much of the area. Because of a copious amount of moisture in the atmosphere, some of these showers and storms produced heavy rain which in turn produced street flooding, most of it minor. In Chatham, several roads experienced street flooding, closing the roads. These included: Orleans Road at Frost Fish Road, Stepping Stones at Heritage Lane, Commerce Park South, Main Street near the Chatham Motel, and Route 28 near Stoney Hill Road.
- **January 10, 2016:** A strong low pressure system moved through the Great Lakes bringing heavy rain, thunderstorms, and gusty winds to southern New England. A strong low level jet combined with the heavy rain to result in intermittently strong winds mixing to the surface. These winds resulted in scattered tree and power line damage across southern New England. A portion of Route 130 flooded in the Forestdale section of Sandwich and minor street flooding occurred at the intersection of Route 6A and Quaker Meeting House Road, also in Sandwich.

B3a

Impact

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

- **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
- **Emergency Response:** the Bourne Police Station, Buzzards Bay Fire Station, and Pocasset Fire Station are currently located in the floodplain
- **Infrastructure:** flooding can leave large amount of debris and sediment on and around town infrastructure; floods can damage gas lines, utility poles, water infrastructure, wastewater treatment plants, cause sewage spills
- **Buildings:** moving water can damage the walls of buildings; building foundations on the beach can be undermined by the velocity of floodwaters; floodwaters pick up anything that floats, including logs, lumber, propane tanks and vehicles – when this happens, these objects can act as battering rams and damage buildings; buildings can float off of their foundations if not anchored properly
- **Economy:** as communication and infrastructure systems are damaged and disrupted, economic activities come to a standstill, often resulting in dislocation and dysfunction of normal business activities; roadways disruptions affect the customer base and slow recovery times for small businesses; the high cost of relief and recovery may adversely affect investment in infrastructure or other development activities; there can be losses associated with decreased land value in floodplains
- **Natural Systems:** During flood events, storm water systems cannot handle the high water volume and oftentimes, untreated sewage can enter into the environment, floods can transfer sediment and debris into parks, beaches, estuaries, rivers, etc.
- **Transportation:** floods can wash out bridges and culverts, debris in floodwaters can occlude culverts so much that the culvert acts like a dam; roadways can be washed away in a flood event; there can be major disruptions to transit, train or ferry services

B2b

Probability

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 and urban drainage concerns in Bourne 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.[18] In the Atlantic Basin, the hurricane season "officially" runs from June 1 to November 30; peak activity is in early to mid-September.[19]

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

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.[20] This scale estimates potential property damage (***Table 2.3***). Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.
2. **Amount and location of storm surge.** Storm surge is simply water that is pushed toward the shore by the force of the winds swirling around the storm.[21] This advancing surge combines with the normal tides to

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

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

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

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

Hazard Profiles

B1c, B2a,c

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

Table 2.3 | Saffir-Simpson Hurricane Wind Scale (National Hurricane Center)

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

maps.[22] 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. In Massachusetts, hurricane category is the predominant factor in "worst case" hurricane surges. The resulting inundation areas are grouped into Category 1 and 2, Category 3, and

22 Massachusetts State Hazard Mitigation Plan, Hurricanes and Tropical Storms, 2013

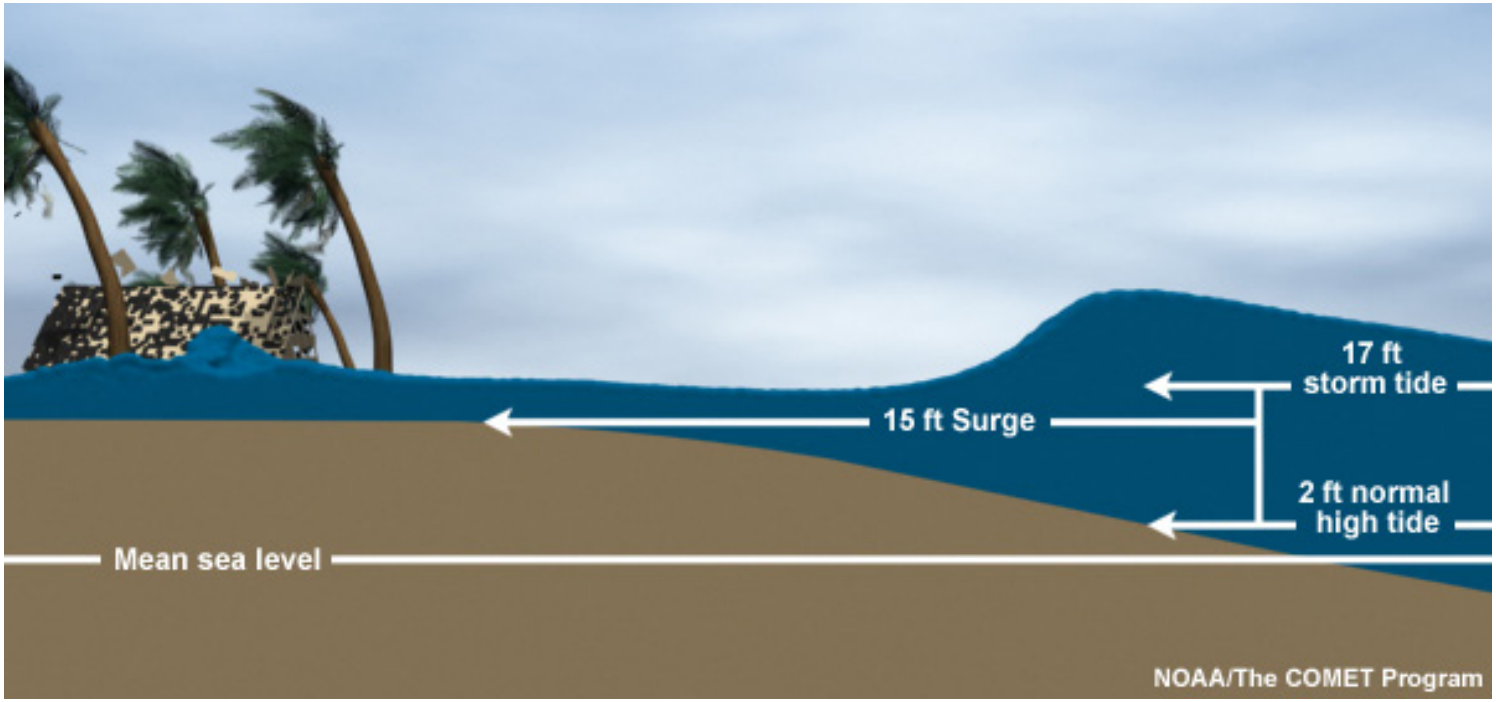

Figure 2.7 | Schematic of the generic differences between mean sea level, normal high tide, storm surge and storm tide. This graphic is for educational purposes only. The numbers shown (2, 15, 17 feet) are not specific to Bourne.

Category 4. The hurricane category refers to the Saffir-Simpson Hurricane Intensity Scale. The 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.

B1c

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

B1c, B2a,c

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*** and ***Figure 2.10***).

These maps indicate that there is a strong history of hurricanes affecting the Atlantic Coast of the United States, including Barnstable County. Data collected from the FEMA disaster declaration website, the 2013 MA State Hazard Plan, and local experts (including the Planning Team and the Barnstable County Emergency Planning Committee) was also used to document the previous occurrences of tropical cyclones that affected Cape Cod. ***Table 2.4*** describes the major disaster declarations and most memorable cyclones to affect Barnstable County and thus, the planning area.

B3a

Impact

The National Hurricane Center describes the types of damages that a community could experience during a Category 1-5 storm.[23]

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.

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

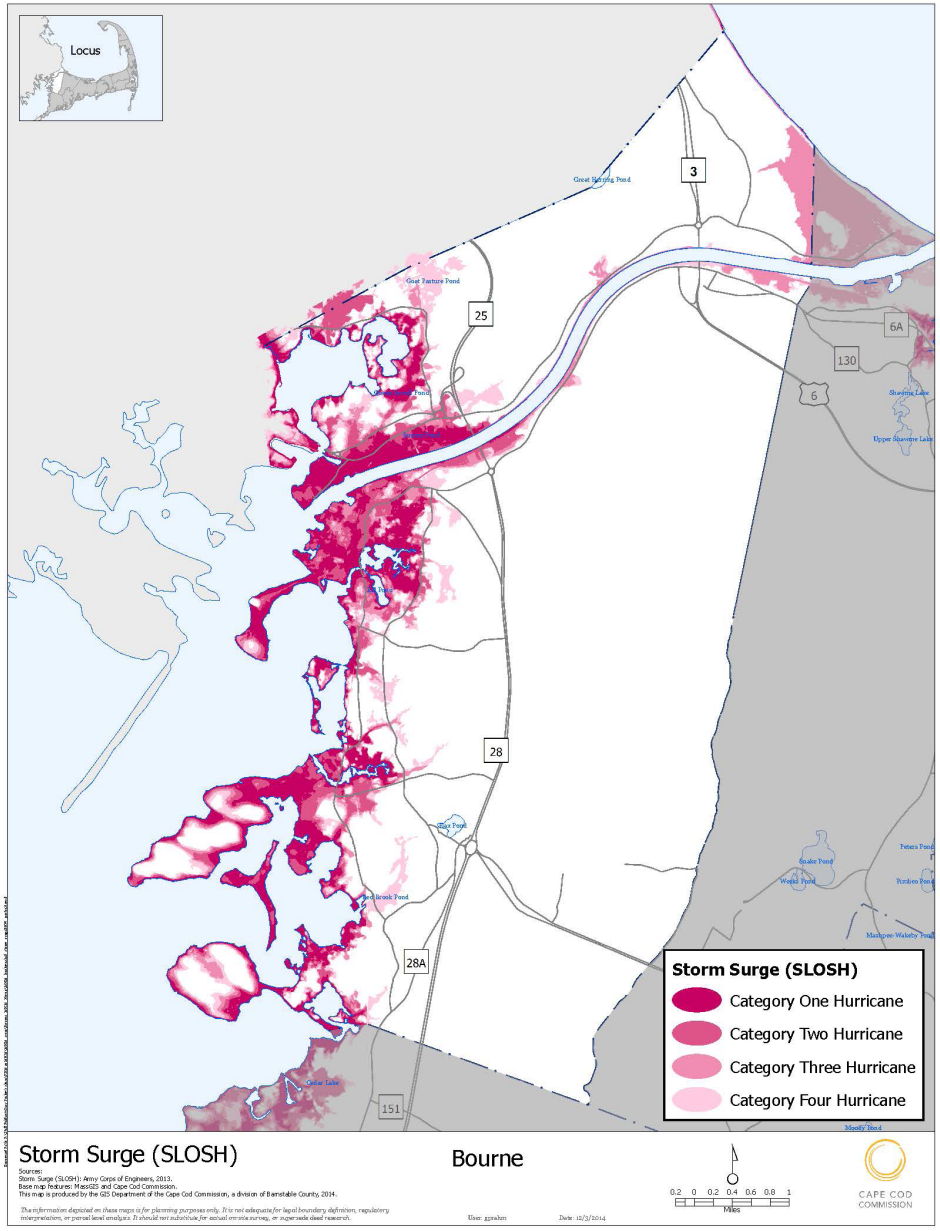

Figure 2.8 | SLOSH map for Bourne

- 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.

- **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

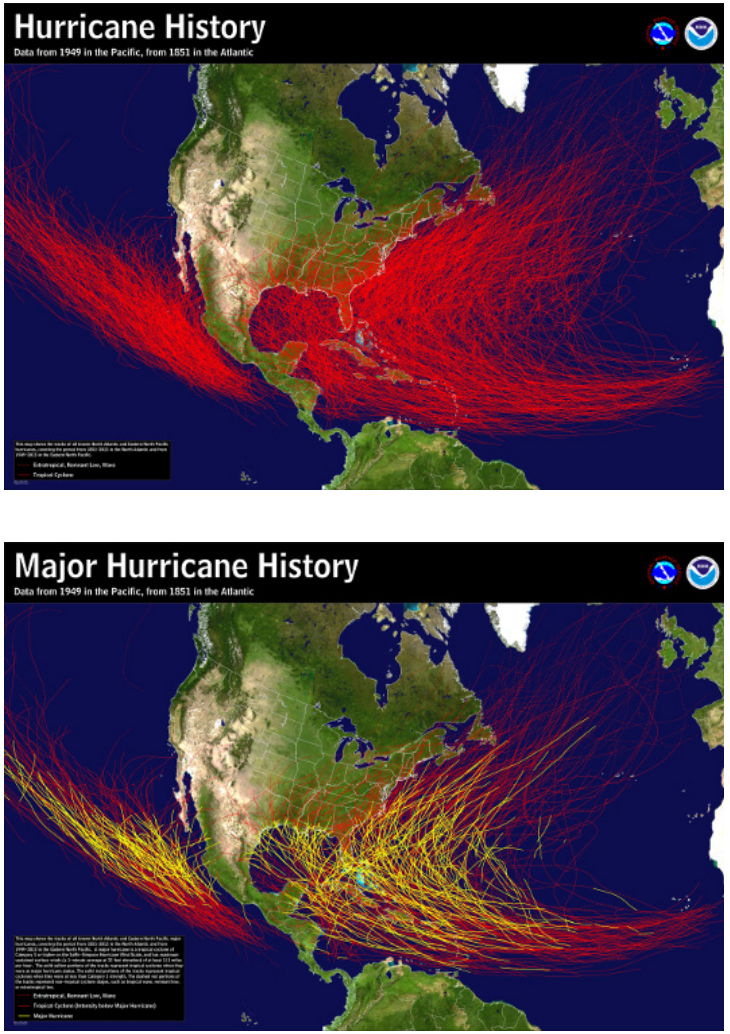

Figure 2.9 | Hurricanes and major hurricanes in the Atlantic Basin (above) and in Barnstable County from 1851-2013, National Hurricane Center (right).

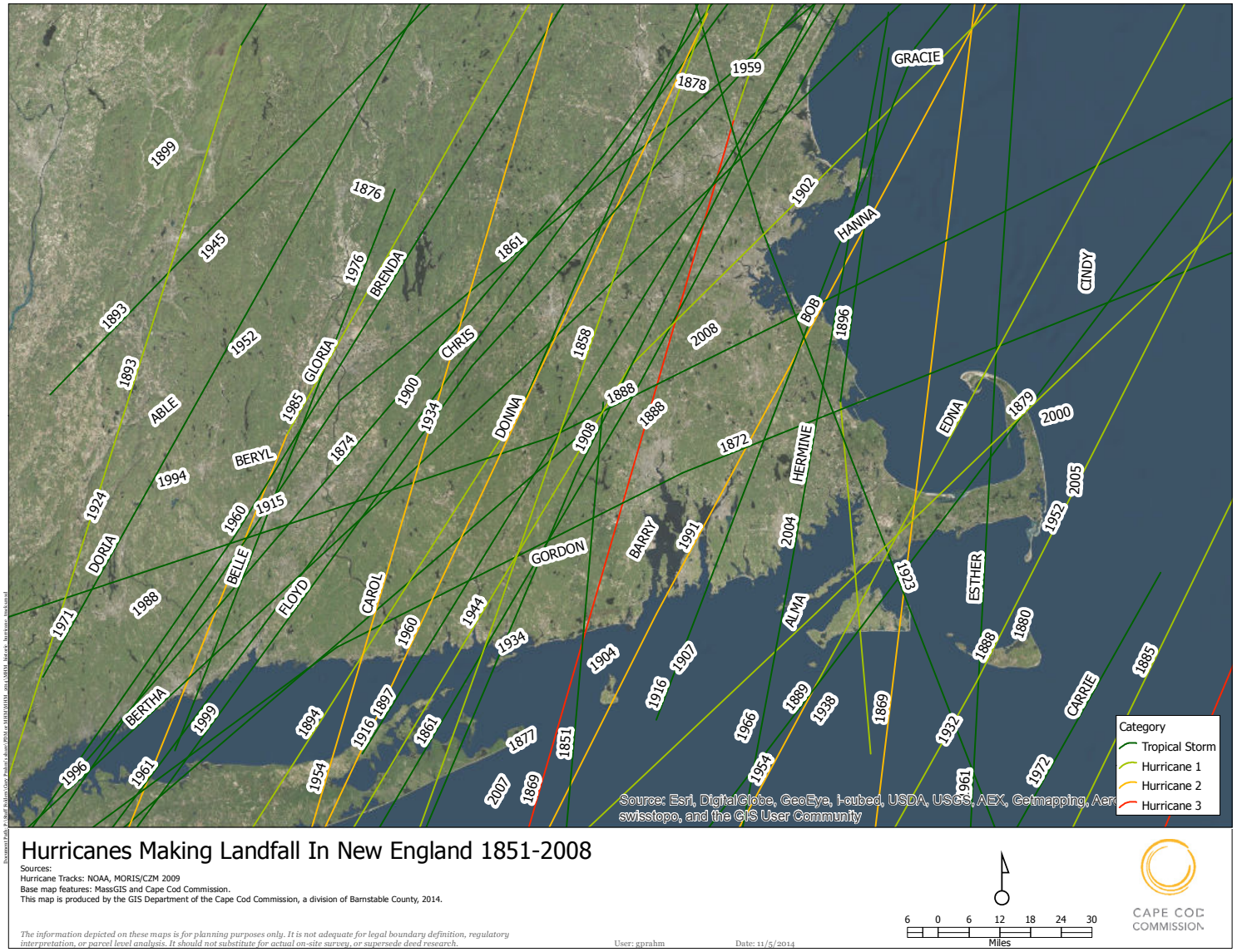

Figure 2.10 | Hurricanes Making Landfall in New England, 1851-2008

Hazard Profiles

B2c

Major Disaster Declarations and Most Memorable Tropical Cyclones for Barnstable County from 1954 - 2012

Number	Storm Name	Safrir-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

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

Hazard Profiles

- **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.
  - 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:**
  - 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.

The impacts listed above were generated by technical experts at the National Hurricane Center.

B2b

Probability

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.

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.[24]

Below is a list of the most common causes of landslides in Massachusetts[13]:

- **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.[13]
- **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

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

which can sometimes lead to landslide.[25]

B1c

Hazard Location

Landslides occur in every state in the U.S., but the majority of Massachusetts, including Bourne, has a low incidence of landslides.

B1c, B2a,c

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 Bourne.

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 Bourne, therefore there is no data on the worst conditions experienced in Bourne from a landslide.

B3a

Impact

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

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

B2b

Probability

The Planning Team determined that it is **UNLIKELY** 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 landslides to make this probability determination.

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

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.[26] 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.[27]

The east coast of North America provides an ideal breeding ground for nor'easters. 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.[28] Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and producing extended periods of heavy precipitation. The level of damage in a strong hurricane is often more severe than a nor'easter, but historically Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (one or two per year).

Traditionally, nor'easters are not given names like hurricanes and tropical storms. This changed 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.

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

27 Ibid.

28 Ibid.

B1c

Hazard Location

Coastal areas of Bourne 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.

B1c, B2a,c

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

The following is a list of some of the nor'easters that affected Barnstable County, but it is not a complete list because of the reasons mentioned above[29]:

- **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.[30] 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-

29 Massachusetts State Hazard Mitigation Plan, Nor'Easters, 2013

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

facing shoreline communities from Chatham to Provincetown 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 three and six inches of snow fell before it changed to rain. Wind gusts of up to 40 and 60 mph resulted from this event and created snow drifts of up to three feet. Buildings were damaged, businesses and schools were closed, and road travel was disrupted.
- **January 22-23, 2005:** A major winter storm brought heavy snow, high winds, and coastal flooding to southern New England. In Massachusetts, blizzard conditions were reported on Nantucket. Near-blizzard conditions were reported in areas and brought between one and three feet of snow and produced wind gusts of up to 65 mph. The highest snowfall totals were reported in eastern Massachusetts (between two and three feet). Minor to moderate coastal flooding was observed around high tide in eastern Massachusetts coast. Roads were inundated and evacuations occurred.
- **April 2007:** an intense coastal storm brought rain and coastal/inland flooding to eastern Massachusetts. The storm was primarily a rain event due to warmer temperatures. For this Patriot's Day Storm, the surge peaked on a high tide on April 16, 2007 and the time period of one foot surge lasted more than four high tides (~47 hours). Major coastal flooding and storm damage resulted not only from the severity of the storm but also due to the timing of the Perigean spring tides. The 2007 nor'easter hit during highest predicted tide of the month which was also the top 0.2% of the year. This 2007 storm breached the barrier beaches at both Pleasant Bay on the Lower Cape and Katama Bay on Martha's Vineyard (***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.[31] 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.[32] Governor Baker declared a state of Emergency and issued travel bans in preparation for this storm; all shelters in Barnstable County were opened; transit and ferry services were cancelled; winds gusted to 75 mph; rain/snow mix transitioning to 15-18 inches of snow; 5,700 out

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

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

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).

Impact

Below is a list of possible impacts that could occur in Bourne 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; 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

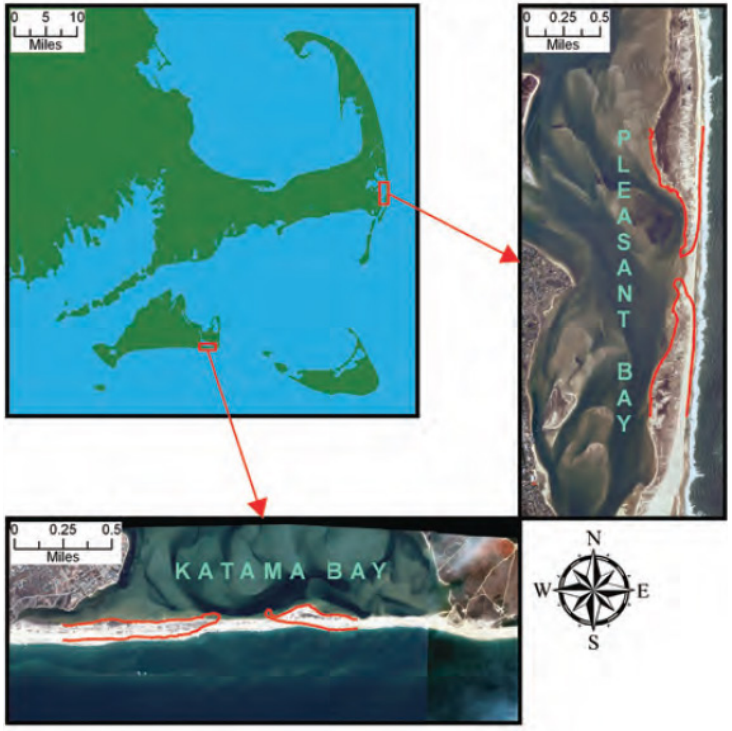

Figure 2.11 | Locations of barrier island breaches that occurred during the April 2007 storm. The Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) collected the aerial photograph shortly before the storm and the red lines were extracted from JALBTCX LIDAR flown shortly after the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

- **Transportation:** roadways can become impassable from storm surge and debris; culverts damaged from storm surge

B2b

Probability

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 Bourne to make this probability designation.

High Winds

Overview

Wind is air in motion relative to the ground surface.[33] High winds can occur as an isolated event or it can accompany other weather events such as:

- before and after frontal systems
- hurricanes and tropical storms
- severe thunder and lightning storms
- tornadoes
- nor'easters

The National Weather Service issues warnings and advisories for high wind events as follows[34]:

- **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,

33 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013
34 Ibid.

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.

B1c

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 Bourne 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 entire planning area is vulnerable to high winds, especially the coastline of Bourne.

Previous Occurrences and Extent

B1c, B2a,c

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**

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

Impact

B3a

Below is a list of possible impacts that could occur in Bourne during a high wind event:

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

Hazard Profiles

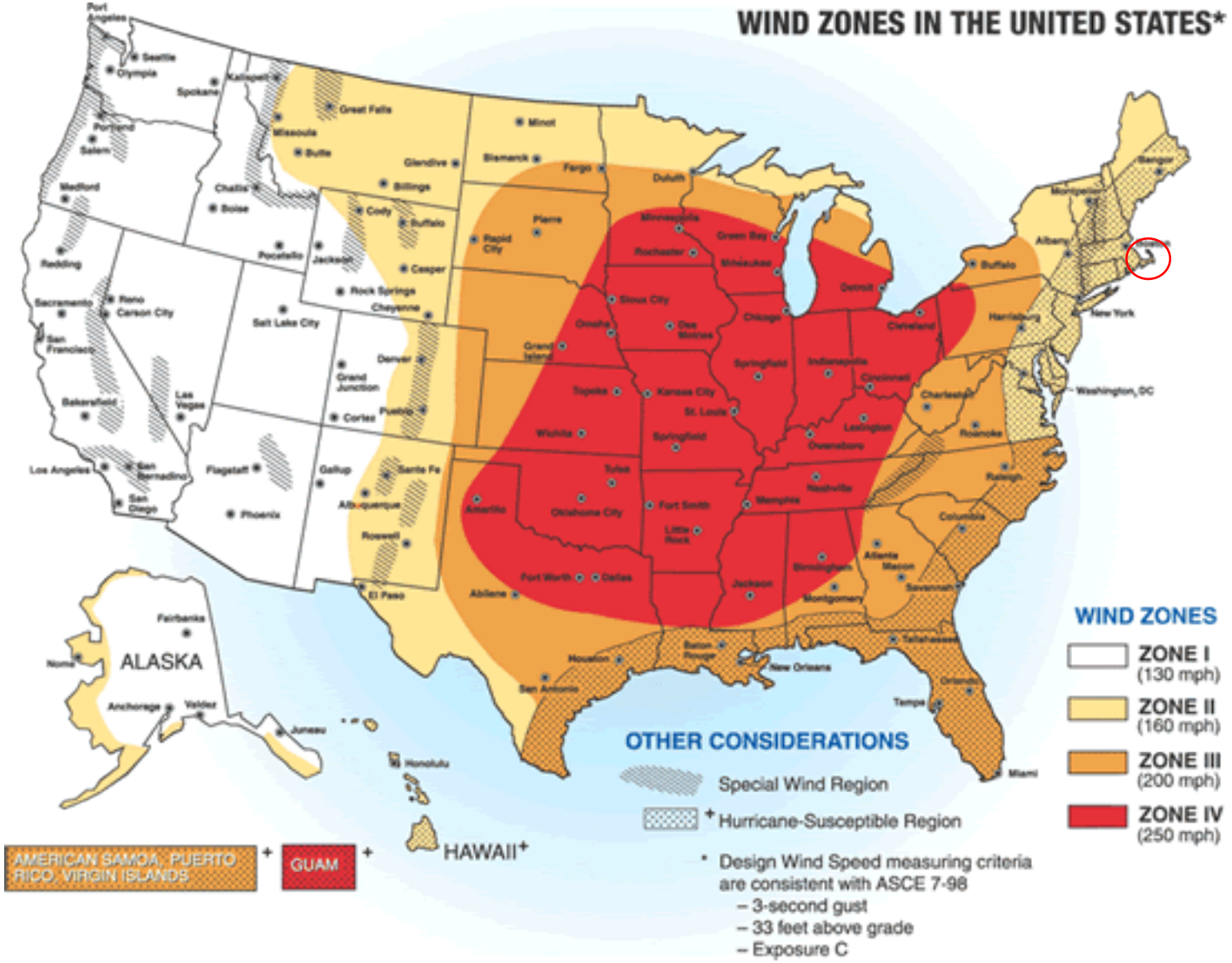

Figure 2.12 | Map of frequency and strength of windstorms in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Mitigation Plan.

B2b

Probability

The Planning Team determined that it is **HIGHLY LIKELY** that a high wind events 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 Bourne'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.[35] The National Weather Service considers a thunderstorm to be severe if it produces any of the following: hail at least one inch in diameter, winds of 58+ mph or a tornado.

Three basic "ingredients" are required for the formation of a thunderstorm:

- moisture that forms clouds and rain
- unstable air that rises rapidly
- lift caused by cold or warm fronts, sea breezes or heat from the sun

The following is a description of the formation of thunderstorms.[36] 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

35 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013

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

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***).

We see this discharge as a bright, visible flash of lightning. The channel of air through which lightening passes can be heated to 50,000°F. The rapid heating and cooling of the air near this lightning channel causes a shock wave that results in the sound of thunder. Compared to hurricanes and winter storms, thunderstorms affect a relatively small area. The typical thunderstorm is 15 miles in diameter and lasts on average for 30 minutes.[37]

37 Ibid.

Hazard Location

B1c

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

Previous Occurrences and Extent

B1c, B2a,c

Using local knowledge, the Planning Team concluded that thunderstorms occur every year in Bourne. However, data on these storm events are not consistently recorded at the local level. The NOAA National Climatic Data Center (NCDC) lists the following thunderstorm wind and lightening events in Bourne from 2000-2016:

- **May 8, 2000:** An isolated severe thunderstorm produced nickel size hail in Pocasset. A golfer in

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

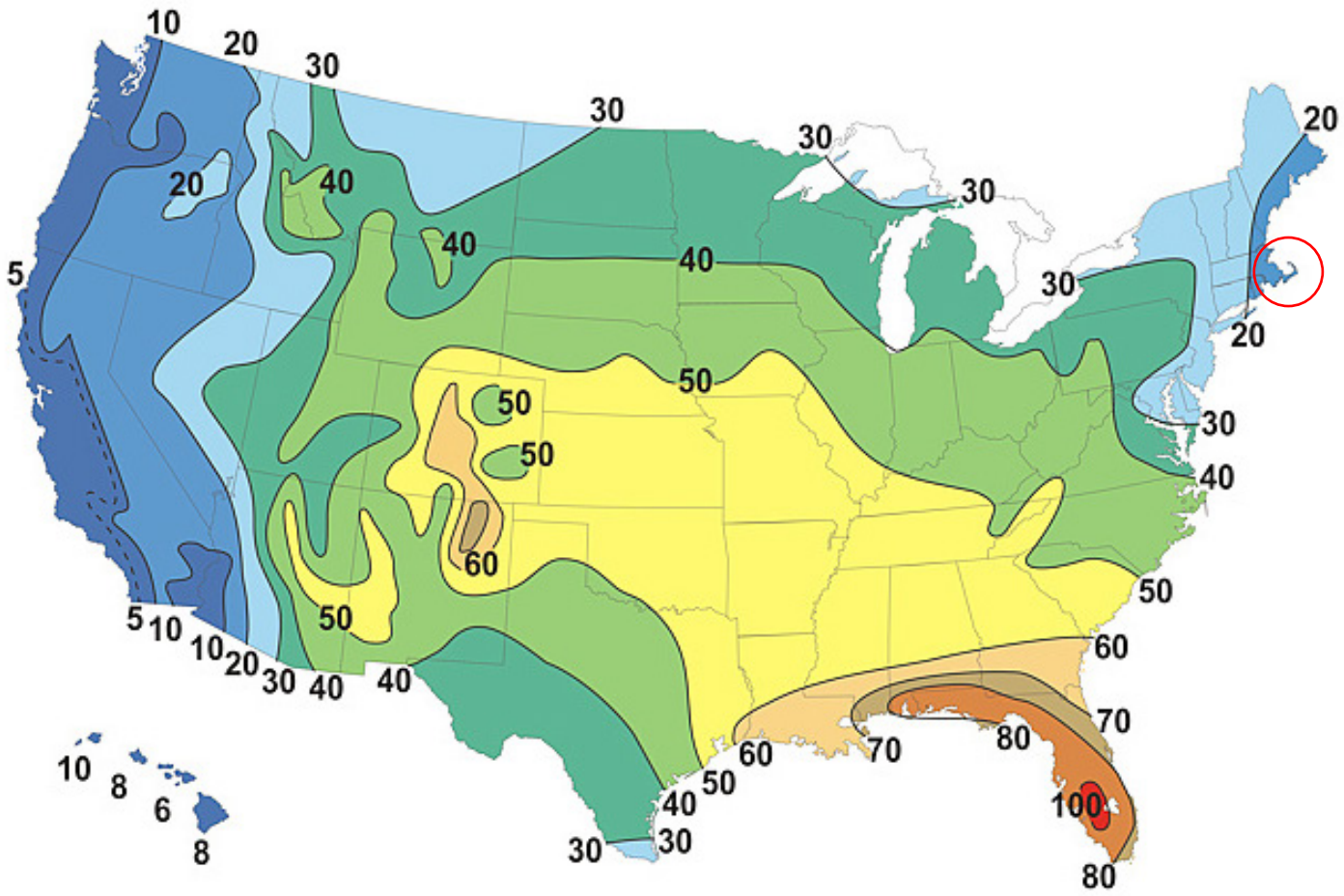

Figure 2.14 | Map of the average number of thunderstorms per year in the United States. Planning area is highlighted with a red circle. Map is from the 2013 Massachusetts State Hazard Mitigation Plan

Bourne was seriously injured when he was struck by lightning.

- **August 8, 2002:** Thunderstorm winds uprooted a tent secured with 18 inch steel stakes at the Pan-Mass Challenge. One of these stakes struck a person, causing minor injuries.
- **July 18, 2006:** Severe thunderstorms moved through southeastern Massachusetts at night, ahead of a cold front dropping through southern New England. Lightning struck a house on Scraggy Neck Road in Bourne, causing minor damage.
- **July 3, 2014:** An approaching cold front, combined with tropical moisture in advance of Hurricane Arthur, produced two rounds of showers and thunderstorms during the afternoon and evening. The storms produced wind damage across much of the Bay State, primarily along and north of the Mass Pike.
- **July 1, 2016:** Wires on Canal Road in Bourne were downed by thunderstorm winds.
- **August 4, 2016:** Thirty to forty trees were downed in a square mile area in the vicinity of Shore Road and Beach Street.

Impact

B3a

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

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

B2b

Probability

The Planning Team determined that it is **LIKELY** that thunderstorms 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 Bourne'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.[38] 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

B1c

The entire planning area is vulnerable to extreme temperatures.

Previous Occurrences and Extent

B1c, B2a,c

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

38 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013

Hazard Profiles

According to the Planning Team the last time a warming or cooling center was opened in the Town of Bourne was during February 2013 in response to extreme cold temperatures, heavy snow and power outages resulting from a blizzard.

B3a

Impact

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

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

B2b

Probability

The Planning Team determined that it is **POSSIBLE** 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 Bourne's history of extreme temperatures and the number of times the town opened up their warming or cooling facilities in town to make this probability determination.

39 Ibid.

Tornadoes

Overview

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

Tornadoes can form from a variety of sources:

- 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

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

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[41] (***Figure 2.15***).

Previous Occurrences and Extent

B1c, B2a,c

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 thunderstorms across Cape Cod.
- **August 20, 1997:** Showers developed during the

41 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013

Hazard Profiles

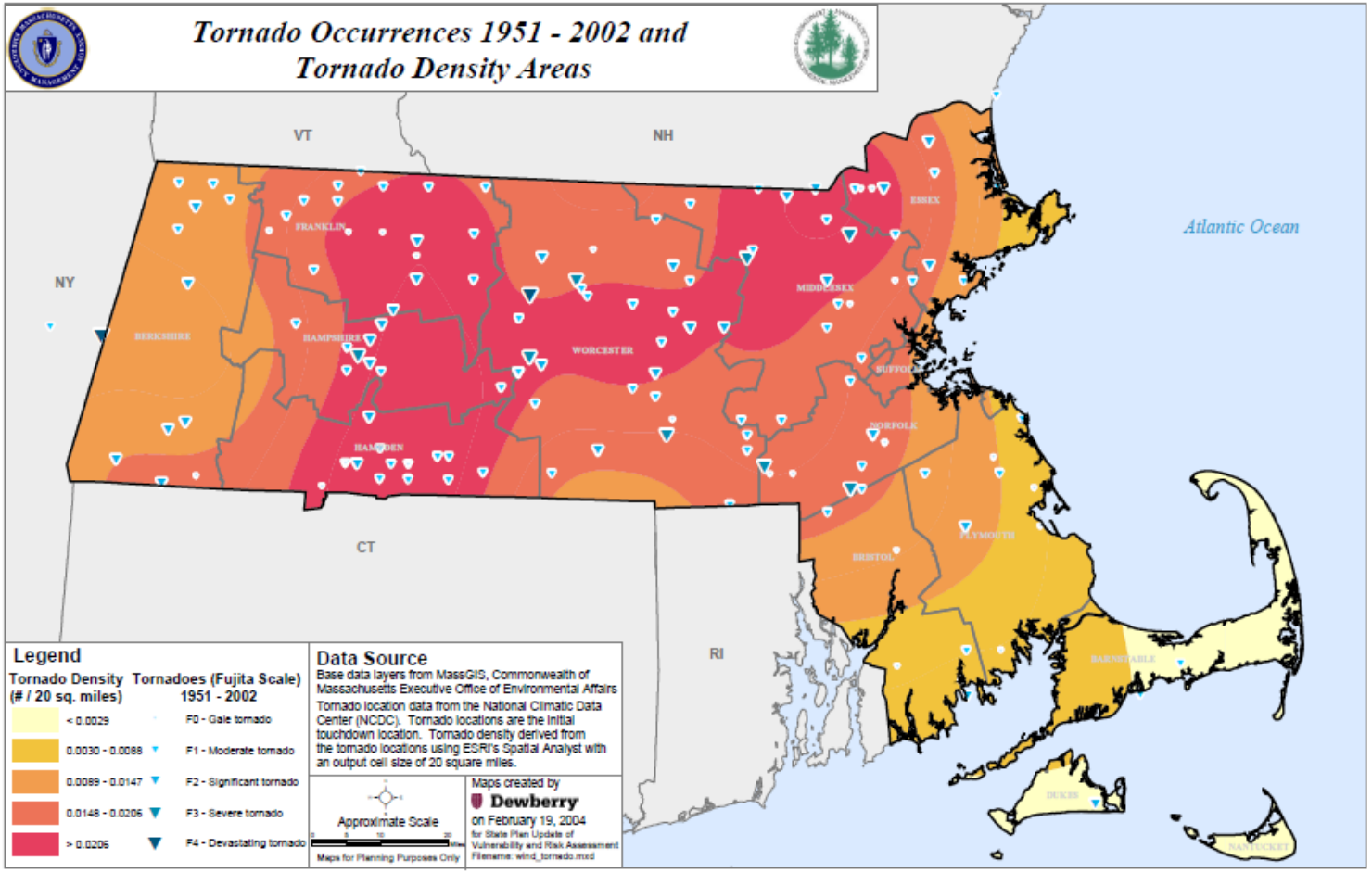

Figure 2.15 | Tornado occurrence and density for Massachusetts. Map is from the 2013 Massachusetts State Hazard Mitigation Plan

afternoon in southeastern Massachusetts and these went on to produce three waterspouts, at least one confirmed weak tornado (F0) and numerous funnel clouds. The first waterspout occurred just east of the Sagamore Bridge, over Cape Cod Bay, at 1:30 p.m. Another waterspout was reported just west of Bourne, over Buzzards Bay, at 3:20 p.m. Throughout the afternoon, there were numerous reports of funnel clouds, some of which appeared in newspaper photos and documented via amateur radio operators' videos. Many of the funnels came as far a half-way down before retreating up into the cloud. There were no reports of damage or injury as a result of these events.

B3a

Impact

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

- **Scale F0, <73 mph winds, light damage:** some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
- **Scale F1, 73- 112 mph winds, moderate damage:** 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

B2b

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

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

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

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

The Planning Team used 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.[43] Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region.

B1c

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.

Previous Occurrences and Extent

B1c, B2a,c

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

- **Standardized Precipitation Index (SPI)** reflects soil moisture and precipitation conditions; 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; available from the National Climate Data Center.
- **Keetch-Byram Drought Index (KBDI)** is designed specifically for fire potential assessment. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity.
- **Precipitation Index** is a comparison of measured precipitation amounts (in inches) to historic normal precipitation. Cumulative amounts for 3-, 6-, and 12-month periods are factored into the drought determination.
- **Groundwater Level Index** is based on the number of consecutive months groundwater levels are 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.

43 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013

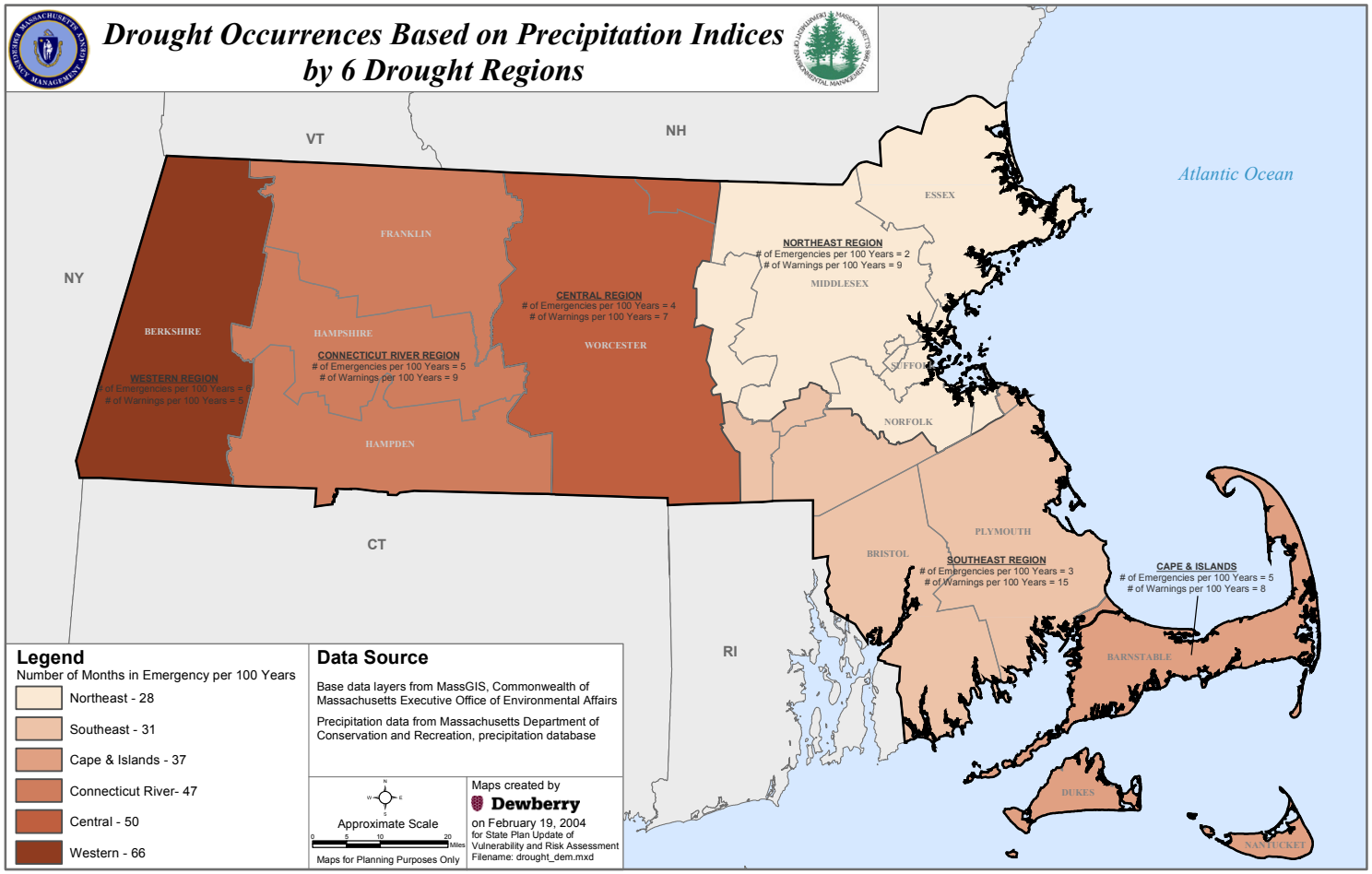

Figure 2.16 | Number of drought emergencies per 100 years for Massachusetts. Map is from the 2013 Massachusetts State Hazard Mitigation Plan

Hazard Profiles

- **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/descriptions for Barnstable County was compiled from data in 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 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

Drought Level	Standardized Precipitation Index	Crop Moisture Index*	Keetch-Byram Drought Index*	Precipitation	Groundwater	Streamflow	Reservoir***
Normal	3-month > -1.5 **or** 6-month > -1.0 **or** 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 **or** 6-month = -1.0 to -1.5 **or** 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 **or** 6-month = -1.5 to -3.0 **or** 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% **or** 6 month cum. < 70% **or** 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 **or** 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%, **or** 6 month cum. <65% and 12 month cum. <65%, **or** 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

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 in January

There is no data on the extent of drought for Bourne specifically; all drought levels are reported at the County level. Voluntary water use restrictions were in place in Buzzards Bay during the 2016 drought.

B3a

Impact

The following is a list of impacts that are possible with drought[44]:

- **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

B2b

Probability

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

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

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

44 Massachusetts State Hazard Mitigation Plan, Severe Weather, 2013

Severe Winter Weather: Snow, Blizzards and Ice Storms

Overview

A winter storm occurs when there is significant precipitation during periods of low temperatures.[45] Winter storms typically occur from early autumn to late spring and can include any of the following events[46]:

- **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[13]
- **Blowing snow:** wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground that is picked up by the wind
- **Snow squalls:** brief, intense snow showers accompanied by strong gusty winds. Snow accumulation may be significant
- **Snow showers:** snow falling at varying intensities for brief periods of time, some accumulation is possible
- **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***).

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

46 Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008 and Massachusetts State Hazard Mitigation Plan, Severe Winter Weather, 2013

Hazard Profiles

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.

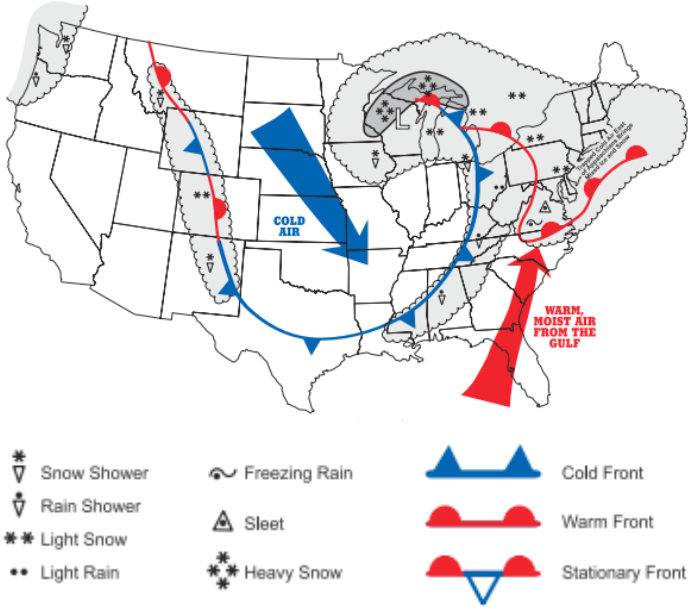

Figure 2.17 | How winter storms form

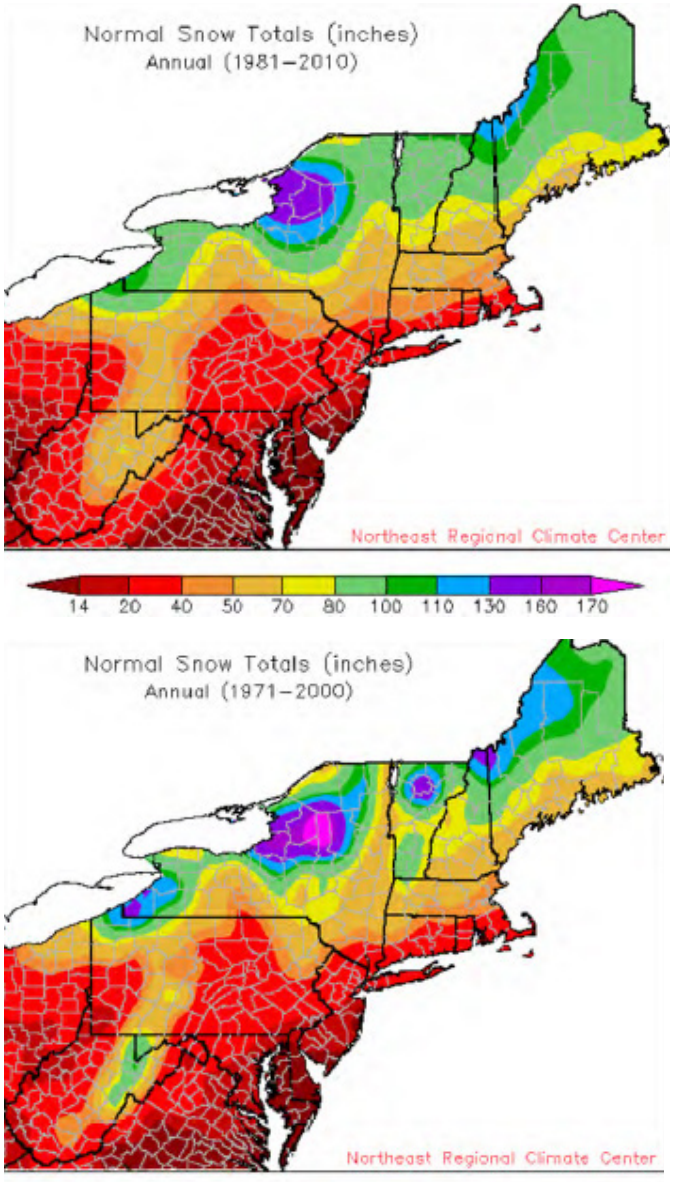

Figure 2.18 | Annual Snow Totals in inches from 1971-2000 (top) and 1981-2010 (bottom). Maps are from the 2013 Massachusetts State Hazard Mitigation Plan

B1c

Hazard Location

The entire planning area is at risk for snow, blizzards and ice storms. During these events, there are specific areas of Bourne that experience higher snow accumulations and higher winds than other areas of town. Areas along the coast are particularly vulnerable as additional ocean moisture often causes higher snow amounts and winds.

Previous Occurrences and Extent

B1c, B2a,c

Snow and other forms of winter precipitation occur frequently in Bourne. 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 Bourne to be within 14-40 inches per year from 1971-2000 and from 1981-2010.[28]

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

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 Mitigation Plan

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:

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

B3a

Impact

Below is a list of impacts likely to occur during a winter storm event[47]:

- **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

47 Winter Storms, The Deceptive Killers, A Preparedness Guide, U.S. Department of Commerce, NOAA, National Weather Service, American Red Cross, June 2008 and Massachusetts State Hazard Mitigation Plan, Severe Winter Weather, 2013

It is important to note that not all winter storms affecting Bourne were declared federal disasters. Therefore, Bourne likely experienced more severe winter weather than documented above.

B2b

Probability

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 Bourne's history of snow storms and blizzards to make this probability designation.

Tsunami

Overview

A tsunami is a series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean flood, seismic or volcanic activity or underwater landslides. Tsunamis generate a devastating onshore surge of water.[48] 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

B1c

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.[49]

Previous Occurrences and Extent

B1c, B2a,c

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

The US Atlantic coast and Gulf Coast states have experienced six tsunamis in the last 200 years – only a total of six tsunamis have been reported[50]:

48 Massachusetts State Hazard Mitigation Plan, Tsunami, 2013
49 Ibid.
50 Ibid.

Hazard Profiles

- 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 Bourne.

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, especially for the fishing industry, disruption of coastal systems will have far-reaching economic effects
- **Natural Systems:** It uproots trees and plants and destroys animal habitats such as nesting sites for birds. 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

B2b

Probability

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

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

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

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

Sea Level Rise

Overview

Sea level rise refers to the increase in mean sea level over time.[51] Relative sea level rise is a combination of eustatic and isostatic contributions:

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

Sea level has been rising around the globe for thousands of years since the end of the last Ice Age. For a little over a century, tidal gauges and satellites have been measuring changes in sea level. Tide gauge stations measure the height of water referenced to a horizontal control point, or benchmark, and gauges are used to track and predict tide levels and longer term sea level.

Long-term data sets from tide stations have been used to understand local and global sea level trends. The National Oceanic and Atmospheric Administration's (NOAA) Center for Operational Oceanographic Products and Services maintains several tide gauge stations across coastal Massachusetts, including long-term stations at Boston, Woods Hole and Nantucket. The sea level data recorded by NOAA and other tide gauges produce trends in relation to fixed reference levels on land, and therefore the data from these stations includes variation in local land elevations.

There is high confidence that the warming atmosphere associated with global climate change is expected to accelerate both the thermal expansion of seawater and the melting of glaciers and ice sheets and will lead to increasing rates of sea level rise.[52]

Hazard Location

B1c

The entire coast of Bourne 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 http://www.capecodcommission.org/sealevelrise/). The Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and

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

52 United States Environmental Protection Agency, 2006

Hazard Profiles

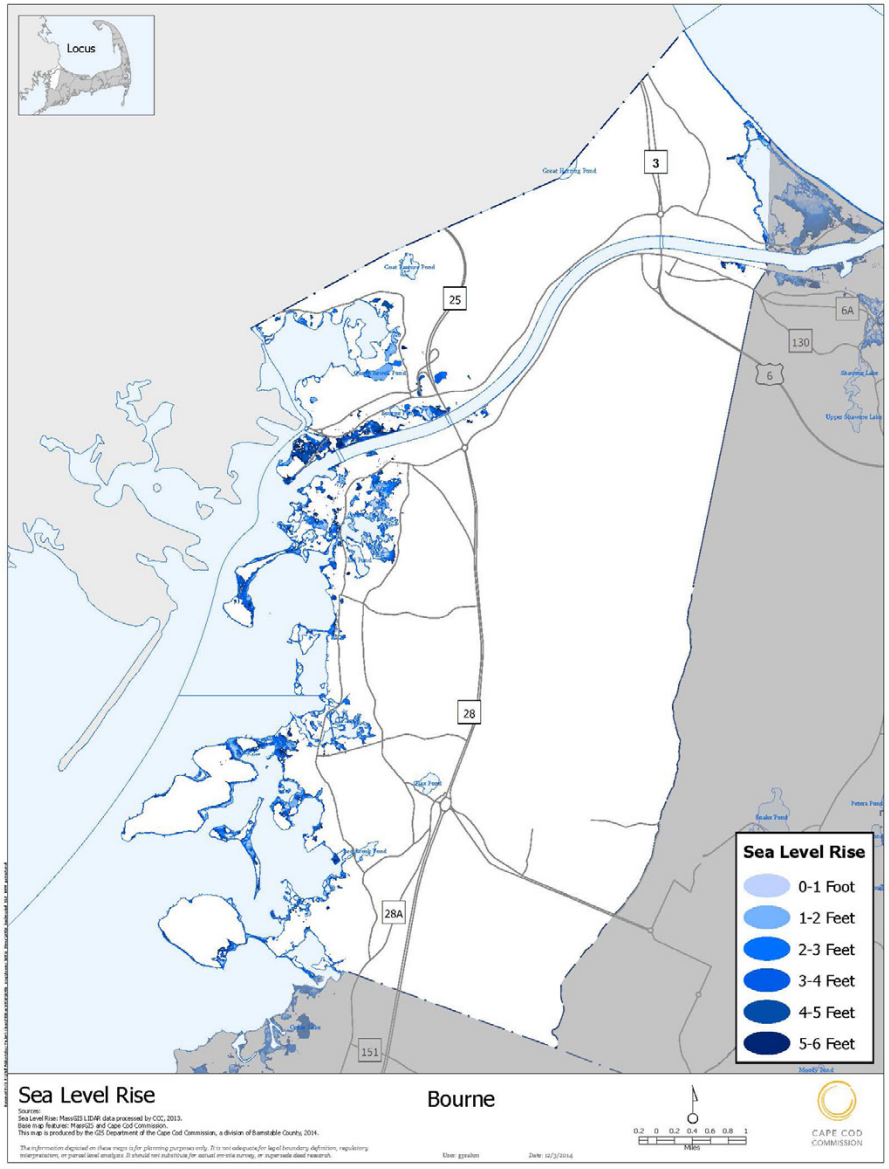

Figure 2.19 | Sea level rise projections for Bourne

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 below[53]:

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

B3a

Impact

As relative sea level rises, high water elevations will move landward, areas of coastal shorelines will retreat, and low-lying areas will be increasingly exposed to erosion, tidal inundation, and coastal storm flooding. Developed parts of the coast are especially vulnerable because of the presence of infrastructure, homes and businesses that can be damaged or destroyed by coastal storms. In addition, development often impedes the ability of natural coastal systems to buffer inland areas from storm damage, further exacerbating the problem. Many coastal habitats are also vulnerable to rising sea levels, including salt marshes, beaches and dune systems, and floodplains, because they are generally at or within a few feet of existing sea elevations. These areas provide significant environmental benefits, including habitat value, filtering of pollutants for improved water quality, protection of inland areas from flooding and storm surge, and extensive recreational opportunities.[54]

53 Ibid.

54 Ibid.

B2b

Probability

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

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

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

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 Mitigation 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 Bourne (see Column 2 of ***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
- 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
- Flood
- Hurricanes and Tropical Storms
- Nor'easters
- High Winds
- Severe Winter Weather
- Sea Level Rise

Hazards Selected for Risk Assessment

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

Table 2.7 | List of Hazards selected for a risk assessment

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.[55]

The following changes in hazard frequency and intensity are expected to occur with changes in climate[56]:

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.

Earthquakes: The impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes.

Fire: Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Flooding: While it is not known if the number of storms will increase in the future as the result of climate changes, it is anticipated that the intensity of tropical and extra-tropical storms may increase as the storm intensity is a function of sea surface temperature, which continue to rise. Thus, we may experience more intense storms with greater rainfall in the future.

55 United States Environmental Protection Agency, 2006

56 Massachusetts State Hazard Mitigation Plan, Climate Change Impacts, 2013

Tropical Cyclones: Although there is still some level of uncertainty, research indicates the warming climate may double the frequency of Category 4 and 5 hurricanes by the end of the century, and decrease the frequency of less severe hurricane events.

Nor'easters and Winter Storms: Weather extremes are likely to become more frequent and cause more damage under a changing climate. Although no specific storm is directly linked to climate change, an increasing number of events could become more common. New England is expected to experience changes in the amount, frequency, and timing of precipitation. Along with rising temperatures, it is expected that annual precipitation will increase by 14%, with a slight decrease in summer totals and a 30% increase in winter totals. Winter precipitation is predicted to be in the form of rain rather than snow. This change in precipitation will have significant effects on the amount of snow cover, winter recreation, spring snowmelt and peak stream flows, water supply, aquifer recharge, and water quality. Snow is also predicted to fall later in the winter and cease falling earlier in the spring.

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

Asset Inventory

CHAPTER THREE

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

People

Population: Year-round and Seasonal

There are 19,729 year-round residents in Bourne.[1] The median household income for this population is $69,157.[2] According to the Bourne Local Comprehensive Plan, the seasonal population is approximately double that of the year-round population.

Base Map of Bourne

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

Natural Environment

Bourne is defined by its natural resources, most notably it's quiet harbors and inlets for boating and swimming. Bordered on the west by Buzzards Bay, on the northeast by Cape Cod Bay and split by the Cape Cod Canal, access to the water contributes considerably to Town character. The Cape Cod Canal winds through town in a westerly direction and connects Buzzards Bay with Cape Cod Bay. The coastline to the northeast is regular and unprotected. The coastline to the west is very irregular with peninsulas, islands, inlets and small bays. Bourne has 15 beaches and landings and is home to diverse fishing and shellfishing.[3]

Sixty-five percent of Bourne is mapped as priority habitat.[4] There are three Areas of Critical Environmental Concern (ACECs), including

- Herring River Watershed in Bournedale, which extends beyond the town line into Plymouth, and includes 11 ponds, and more than 250 acres of protected and important anadromous fish runs,
- Back River, which includes unaltered marshes, flats and wetlands and is designated an Estuary of National Significance by the U.S. Environmental Protection Agency, and
- Pocasset River, which includes marsh, floodplain, flats and wetlands that provide flood control, water quality benefits, and storm damage prevention, among other benefits.

In addition to water resources, Bourne is home to several large tracts of forested land, including:

1 U.S. Census, 2015 American Community Survey
2 Ibid.
3 Massachusetts Division of Marine Fisheries and http://buzzardsbay.org/shellfish.htm
4 Massachusetts Natural Heritage and Endangered Species Program, Natural Heritage Atlas 13th edition, 2008

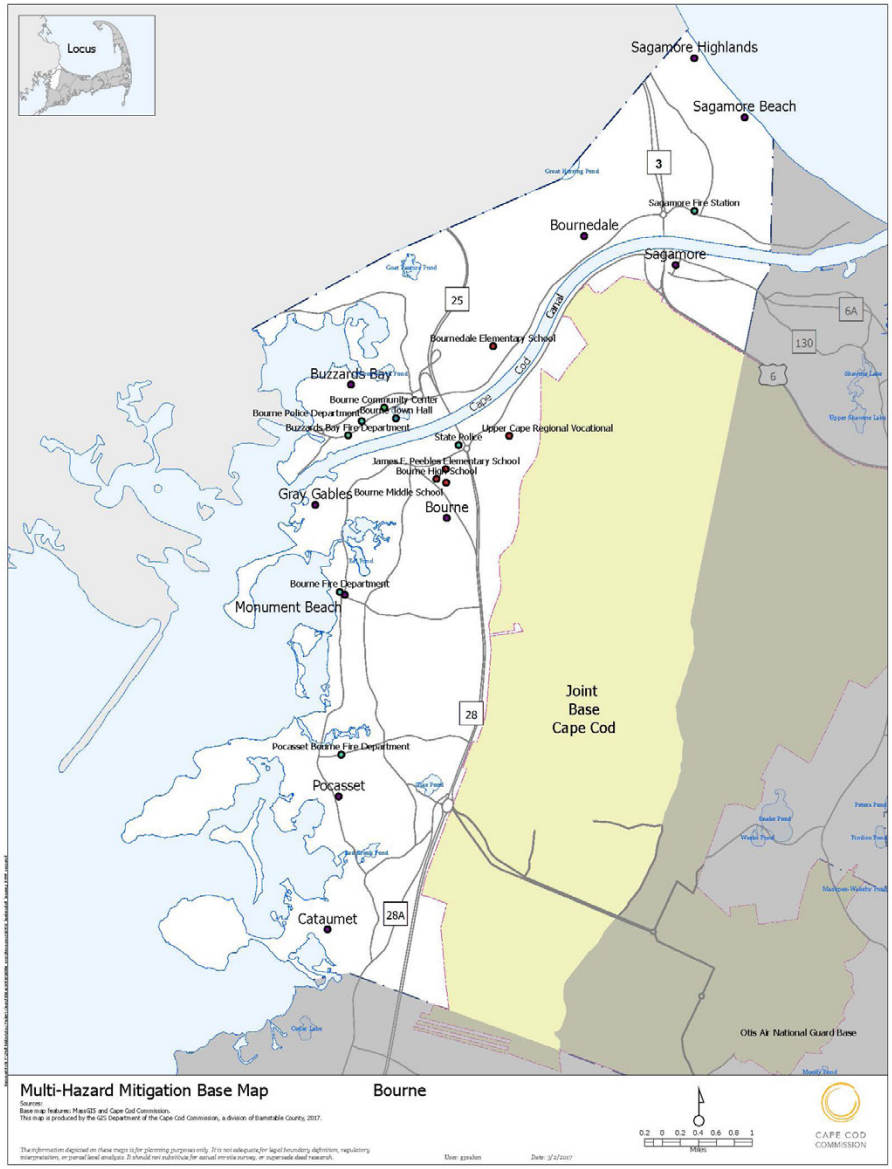

Figure 3.1 | Base map of Bourne

- Bourne Town Forest and adjacent Four Ponds Conservation Area and aquifer protection lands in Pocasset,
- North Sagamore Woodlands, Carter Beale Conservation Area, Old Field Pond Preserve, Bournedale Forest, and Buzzards Bay Water District land, all north of the Canal,
- Monks Park and Briarwood and Little Bay Conservation Area in Monument Beach, and
- Red Brook forest, in Cataumet.

Built Environment

Housing

Bourne has 11,469 total housing units.[5] ***Table 3.1*** is a list of the type and number of housing units in Bourne.

Businesses

Bourne's business landscape of 465 establishments is dominated by Retail (86), Accomodations/Food Service (71), Professional, Scientific and Technical Services (64), and Health Care and Social Assistance (51) with a combined estimated value of $874 million in 2012 (***Table 3.2***). ***Table 3.3*** includes the number employed in each sector.

5 U.S. Census, 2015 American Community Survey

Critical Facilities

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

Regionally Important Infrastructure

Cape Cod Canal

The Towns of Sandwich and Bourne border the Cape Cod Canal. Since 1928 The U.S. Army Corps of Engineers, New England District has been responsible for the operations and maintenance of the Cape Cod Canal. In 1933, the canal was widened and deepened to facilitate the passage of large ships between major ports in Boston, New Bedford, Providence and New York. With annual visitation exceeding three million, the Cape Cod Canal is one of the Corps busiest projects

UNITS IN STRUCTURE	Estimate
1-Unit, detached	9,256
1-Unit, attached	514
2 Units	332
3 or 4 Units	570
5-9 Units	388
10-19 Units	67
20+ Units	250
Mobile Homes	92
Built Prior to 1940	2,310

Table 3.1 | Number and type of housing units in Bourne, U.S. Census American Community Survey (estimate), 2015

Type	Number	Value
Utilities	1	Q
Wholesale trade	17	119,376
Retail trade	86	349,385
Transportation and warehousing (104)	22	25,815
Information	14	N
Finance and insurance	17	N
Real estate and rental and leasing	26	9,885
Professional, scientific, and technical services	64	185,506
Administrative and support and waste management and remediation services	27	29,342
Educational services	10	4,755
Health care and social assistance	51	73,622
Arts, entertainment, and recreation	14	D
Accommodation and food services	71	52,881
Other services (except public administration)	45	23,405

D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals

N = Not available or not comparable

Table 3.2 | Estimated number and value of Bourne businesses. Source: U.S. Census Bureau, 2012 Economic Census, 2012 Economic Census of Island Areas, and 2012 Nonemployer Statistics, data files released on a flow basis from March 2014 through June 2016.

Type	Number Employed
Utilities	a
Wholesale trade	118
Retail trade	737
Transportation and warehousing (104)	224
Information	159
Finance and insurance	c
Real estate and rental and leasing	105
Professional, scientific, and technical services	487
Administrative and support and waste management and remediation services	280
Educational services	84
Health care and social assistance	629
Arts, entertainment, and recreation	c
Accommodation and food services	816
Other services (except public administration)	239

a = 0 to 19 employees

c = 100 to 249 employees

Table 3.3 | Estimated number of employees by industry in Bourne. Source: U.S. Census Bureau, 2012 Economic Census, 2012 Economic Census of Island Areas, and 2012 Nonemployer Statistics, data files released on a flow basis from March 2014 through June 2016.

Built Environment

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	Bourne Police Department	Community Building	Bourne High School
		Buzzards Bay Fire Station	Jonathan Bourne Public Library	Bourne Middle School
		Monument Beach Fire Station	Bourne Housing Authority	Bournedale Elementary School
		Pocasset Fire Station	Gallo Ice Arena	Upper Cape Regional Technical School
		Sagamore Fire Station	Department of Public Works	Cape Cod and Islands Community Mental Health Center
		Bourne Town Hall	James F. Peebles Elementary School	Bourne School Administration Office
		Bourne Integrated Solid Waste Management Facility		
Transportation Systems	Critical assets in all 5 modes of transportation (air, road, transit, rail, sea). Source: FEMA How-to Guide 2/ FEMA 386-2	Bourne Bridge	Shore Road Railroad Overpass	Back River Railroad Bridge
		Sagamore Bridge	Scraggy Neck Road Railroad Overpass	Emmons Road Railroad Bridge
		Memorial Circle	Old Monument Neck Road Railroad Overpass	Mashnee Road
		Belmont Rotary	Monument Beach Marina	Circuit Ave, Pocasset
		Bourne Rotary	Barlow's Landing	Scraggy Neck Road, Cataumet
		Taylor Point Marina	Cape Cod Canal Railroad Bridge	Bypass Rd, Buzzards Bay
		Valley Bars Cir Railroad Bridge	Cohasset Narrows Bridge	Saltmarsh Lane, Pocasset
		Pocasset River Railroad Bridge		
Lifeline Utilities	Includes wastewater, water, oil, natural gas, electric power, and communication systems	North Sagamore Water District	Buzzards Bay Water Tank 1	South Sagamore Water Tank
		North Sagamore Water Tank	Buzzards Bay Water Tank 2	Bourne Water District
		Scenic Highway Water Tank	Buzzards Bay Water Pump Station 1	Bourne Water Pump Station 1
		North Sagamore Water Tank	Buzzards Bay Water Pump Station 2E	Bourne Water Pump Station 2
		North SagamoreWater Pump Station 1	Buzzards Bay Water Pump Station 3W	Bourne Water Pump Station 3
		North Sagamore Water Pump Station 2	Buzzards Bay Water Pump Station 4	Bourne Water Pump Station 4
		North Sagamore Water Pump Station 3	Bourne Water Tank	Bourne Water Pump Station 5
		Buzzards Bay Water District	Monument Beach Water Tank	

Table 3.4 | List of Critical Facilities in Bourne

and serves as the gateway to historic Cape Cod. The Corps primary mission is to provide safe navigation to the 14,000 commercial and recreational vessels that transit the 17.5 mile waterway each year. However the 1,000 acres of land that surrounds the canal provides diverse recreational opportunities such as hiking, fishing, biking, picnicking and ship watching.

Joint Base Cape Cod

This facility is a 22,000-acre property shared by the Towns of Bourne, Sandwich, Mashpee and Falmouth. The industrial area in the southern part of the reservation is where the US Coast Guard, Army National Guard, and Otis Air National Guard Base (ANGB) facilities are located. Aircraft runways, maintenance areas, access roads, housing, and support facilities are found in this 5,500-acre area. The northern 14,700-acre area, also known as Camp Edwards, is used primarily by the Army National Guard. This area contains the 2,200-acre Impact Area, associated military training ranges, and the U.S. Coast Guard Air Station Cape Cod. The 750-acre Veterans Administration Cemetery is located in the southwestern corner of the reservation.

Cultural and Historic Properties

The Massachusetts Cultural Resources Information System lists areas, buildings, burial grounds, objects and structures of historical and cultural significance. This list includes 458 properties in Bourne and is available at http://mhc-macris.net/.

The National Register of Historic Places includes the following three properties in Bourne:

- George I. Briggs House, Sandwich Road
- Cleveland Ledge Light Station, Cape Cod Canal
- Wing's Neck Light, Wings Neck Road

The Bourne Historical Society, whose mission includes preserving, protecting, presenting and promoting the history of Bourne, has identified many significant properties, particularly in the Bourne Village area. A full list of properties is available at http://www.bournehistoricalsociety.org. Examples of notable properties they've identified include:

- Gray Gables Railroad Station
- Coady School
- Bourne United Methodist Church
- Jonathan Bourne Historical Center

Repetitive Loss Properties

B4a

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

The Town of Bourne has 15 Repetitive Loss Properties, all residential.

D1a

New Developments in Bourne

Below is a list of new developments in Bourne:

- **Keystone Place at Buzzards Bay:** an assisted living facility that opened in 2015
- **Red Brook Harbor Club:** townhome development with 15 units that became available in 2016
- **Coady School Residences:** a 55+, affordable 58-unit development that will open in 2017
- **Hampton Inn:** a 100 room hotel in Buzzards Bay that has received permits from the Planning Board and Conservation Commission and is moving to construction
- **Police Station:** an approximately 26,000 square foot building along the bypass road in Buzzards Bay, near Queen Sewell Park, to be open by 2020

The Planning Team determined if each of the new developments were in the floodplain using FIRMs, vulnerable to storm surge using SLOSH model or vulnerable to sea level rise using the Cape Cod Commission's Sea Level Rise Model.

This exposure assessment indicates the following new developments are vulnerable: Keystone Place at Buzzards Bay, Hampton Inn, and the Police Station (*Table 3.5*). The Town of Bourne and/or the developer is addressing risks in the following ways:

Keystone Place at Buzzards Bay: it is elevated on fill, the bottom floor is parking and an evacuation plan is in place

Hampton Inn: when constructed, it will be elevated on fill and the center line of the road will be above base flood elevation

Police Station: the location of the new police station is substantially less vulnerable than the existing location along Main Street.

Name of New Development	Special Flood Hazard Area (yes/no)	SLOSH zone (yes/no)	Sea Level Rise (yes/no)
Keystone Place at Buzzards Bay	Yes	Yes	Yes
Red Brook Harbor Club	No	No	No
Coady School Residences	No	No	No
Hampton Inn	Yes	Yes	Yes
Police Station	No	Yes	No

Table 3.5 | Exposure Assessment of New Developments in Bourne

Built Environment

Vulnerability Assessment

CHAPTER FOUR

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

Methodology: Vulnerability Assessments

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

- **Vulnerability Assessment of Parcels and Buildings:** this assessment was completed by the Town of Bourne 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: Vulnerability Assessment of Parcels and Buildings

To estimate the total number of parcels and value of buildings located in Bourne, 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
- **Multi-Family Dwelling:** includes condos, 2-3 family homes, multiple houses on a single property, 4-8 unit homes and 8+ units
- **Non-Profit/Municipal:** government or town owned

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

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

Next, the Planning Team used GIS to overlay maps of hazard areas onto parcel and value data. Only a subset of natural hazards was identified for further vulnerability assessment (see ***Table 2.7*** 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 Bourne 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 2.7*** in Chapter 2 shows a SLOSH map for the Town of Bourne.
- **Sea Level Rise:** Bathtub model developed by the Cape Cod Commission was used to model the impacts of sea level rise on B. ***Figure 2.18*** in Chapter 2 shows a Sea Level Rise map for the Town of Bourne.
- **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 was 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.
- **Severe Winter Weather:** Data is not available. A detailed vulnerability assessment could not be completed at this time.

It is important to note that SLOSH and Sea Level Rise models are coarse models to illustrate vulnerability to

Methodology: Vulnerability Assessments

storm surge and sea level rise using the best available data. Both of these 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. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features. However, the SLOSH model does not explicitly model the impacts of waves on top of the surge nor does it account for normal river flow or rain flooding. Future advancements in the SLOSH model will allow for the resolution of some of these limitations.[2]
- Cape Cod Commission's Sea Level Rise model: Sea Level Rise data was derived from classified Digital Elevation Model (DEM) data collected through Light Detection and Ranging (LiDAR) in 2011 by the United States Geological Society (USGS). The elevation data is accurate to 18 cm at a 95% confidence level with a 1 meter resolution. This elevation data was adjusted to Mean Higher High Water (MHHW) using the NOAA VDatum Software. The Sea Level Rise is shown as a simple representation of a change in elevation, commonly referred to as a "Bathtub" model. No account has been made for the effects of velocity and resulting erosion caused by wave action.

Methods: Exposure Assessment of Critical Facilities

For this exposure assessment, the Team reviewed and edited the critical facilities list from the 2004 Hazard Mitigation Plan. This updated list of critical facilities was mapped in GIS. Sea level rise, flooding, and storm surge maps were overlaid on the map of critical facilities. If a critical facility was 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, and severe winter weather are not available and therefore their impact on critical facilities was not determined.

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

Results: Vulnerability Assessment

Parcels and Buildings Vulnerable to Flooding

Flooding (V Zone)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	2	3%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	10	8%	$25,514,700	$91,800	0%
Emergency Response	6	0	0%	$2,475,700	$0	0%
Entertainment and Recreation	37	7	19%	$6,480,600	$1,735,900	27%
General Services	139	2	1%	$32,074,700	$66,000	0%
Heavy Industrial	22	1	5%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	0	0%	$6,048,700	$0	0%
Medical Office/Clinic	22	0	0%	$23,226,800	$0	0%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	75	18%	$317,311,600	$64,201,900	20%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	0	0%	$3,189,300	$0	0%
Professional/Tech. Services	41	3	7%	$4,405,500	$211,600	5%
Retail Trade	112	0	0%	$46,487,700	$0	0%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	815	10%	$1,287,911,200	$186,318,900	14%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	222	14%	$4,244,000	$1,369,300	32%
Wholesale Trade	91	0	0%	$24,229,800	$0	0%
COLUMN TOTALS:	10,486	1,141		$1,932,607,100	$314,232,700	

Table 4.1 | The proportion of buildings and value of buildings located in a V zone. Table generated using 2015 Bourne Assessing Data

Results: Vulnerability Assessment

Flooding (A Zone)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	15	25%	$306,900	$0	0%
Banks	4	2	50%	$1,223,800	$709,300	58%
Church/Non-Profit Offices	132	50	38%	$25,514,700	$14,568,000	57%
Emergency Response	6	3	50%	$2,475,700	$1,226,900	50%
Entertainment and Recreation	37	9	24%	$6,480,600	$2,184,300	34%
General Services	139	38	27%	$32,074,700	$9,459,700	29%
Heavy Industrial	22	5	23%	$2,034,500	$458,800	23%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	2	11%	$6,048,700	$707,900	12%
Medical Office/Clinic	22	2	9%	$23,226,800	$1,481,200	6%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	156	38%	$317,311,600	$80,076,800	25%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	9	24%	$0	$0	0%
Personal/Repair Services	19	5	26%	$3,189,300	$668,200	21%
Professional/Tech. Services	41	9	22%	$4,405,500	$256,400	6%
Retail Trade	112	42	38%	$46,487,700	$12,678,000	27%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	2,275	29%	$1,287,911,200	$357,353,100	28%
Temporary Lodging	11	3	27%	$9,649,200	$431,900	4%
Vacant	1,537	422	27%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	10	11%	$24,229,800	$1,115,900	5%
COLUMN TOTALS:	10,486	3,061		$1,932,607,100	$545,700,500	

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

Parcels and Buildings Vulnerable to Sea Level Rise

Sea Level Rise (1 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	10	17%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	14	11%	$25,514,700	$624,500	2%
Emergency Response	6	0	0%	$2,475,700	$0	0%
Entertainment and Recreation	37	7	19%	$6,480,600	$1,315,100	20%
General Services	139	7	5%	$32,074,700	$2,047,300	6%
Heavy Industrial	22	1	5%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	65	16%	$317,311,600	$63,834,900	20%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	0	0%	$3,189,300	$0	0%
Professional/Tech. Services	41	5	12%	$4,405,500	$195,700	4%
Retail Trade	112	2	2%	$46,487,700	$538,400	1%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	767	10%	$1,287,911,200	$174,528,800	14%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	310	20%	$4,244,000	$1,369,300	32%
Wholesale Trade	91	0	0%	$24,229,800	$0	0%
COLUMN TOTALS:	10,486	1,194		$1,932,607,100	$306,318,600	

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

Results: Vulnerability Assessment

Sea Level Rise (2 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	11	19%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	17	13%	$25,514,700	$1,454,400	6%
Emergency Response	6	0	0%	$2,475,700	$0	0%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,864,300	29%
General Services	139	9	6%	$32,074,700	$2,635,900	8%
Heavy Industrial	22	1	5%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	71	17%	$317,311,600	$64,858,800	20%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	0	0%	$3,189,300	$0	0%
Professional/Tech. Services	41	1	2%	$4,405,500	$211,600	5%
Retail Trade	112	2	2%	$46,487,700	$538,400	1%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	896	12%	$1,287,911,200	$194,985,700	15%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	348	23%	$4,244,000	$1,369,300	32%
Wholesale Trade	91	0	0%	$24,229,800	$0	0%
COLUMN TOTALS:	10,486	1,371		$1,932,607,100	$329,783,000	

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

Sea Level Rise (3 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	11	19%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	18	14%	$25,514,700	$1,454,400	6%
Emergency Response	6	1	17%	$2,475,700	$433,100	17%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,864,300	29%
General Services	139	9	6%	$32,074,700	$2,635,900	8%
Heavy Industrial	22	1	5%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	82	20%	$317,311,600	$67,966,100	21%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	1	5%	$3,189,300	$32,500	1%
Professional/Tech. Services	41	8	20%	$4,405,500	$272,300	6%
Retail Trade	112	3	3%	$46,487,700	$1,159,900	2%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	1,047	13%	$1,287,911,200	$216,749,000	17%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	378	25%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	1	1%	$24,229,800	$204,400	1%
COLUMN TOTALS:	10,486	1,575		$1,932,607,100	$356,794,900	

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

Results: Vulnerability Assessment

Sea Level Rise (4 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	12	20%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	21	16%	$25,514,700	$2,763,800	11%
Emergency Response	6	1	17%	$2,475,700	$433,100	17%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,864,300	29%
General Services	139	11	8%	$32,074,700	$2,913,400	9%
Heavy Industrial	22	1	5%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	89	22%	$317,311,600	$72,528,000	23%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	1	5%	$3,189,300	$32,500	1%
Professional/Tech. Services	41	9	22%	$4,405,500	$272,300	6%
Retail Trade	112	9	8%	$46,487,700	$3,539,400	8%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	1,261	16%	$1,287,911,200	$247,557,500	19%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	399	26%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	3	3%	$24,229,800	$506,900	2%
COLUMN TOTALS:	10,486	1,832		$1,932,607,100	$396,434,200	

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

Sea Level Rise (5 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	13	22%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	25	19%	$25,514,700	$3,352,000	13%
Emergency Response	6	1	17%	$2,475,700	$433,100	17%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,864,300	29%
General Services	139	12	9%	$32,074,700	$2,913,400	9%
Heavy Industrial	22	2	9%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	100	25%	$317,311,600	$74,629,300	24%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	2	5%	$0	$0	0%
Personal/Repair Services	19	3	16%	$3,189,300	$310,600	10%
Professional/Tech. Services	41	9	22%	$4,405,500	$272,300	6%
Retail Trade	112	12	11%	$46,487,700	$5,046,300	11%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	1,456	19%	$1,287,911,200	$273,051,600	21%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	428	28%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	5	5%	$24,229,800	$656,700	3%
COLUMN TOTALS:	10,486	2,083		$1,932,607,100	$426,552,600	

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

Results: Vulnerability Assessment

Sea Level Rise (6 foot)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	15	25%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	32	24%	$25,514,700	$5,638,200	22%
Emergency Response	6	1	17%	$2,475,700	$433,100	17%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,864,300	29%
General Services	139	12	9%	$32,074,700	$4,620,800	14%
Heavy Industrial	22	3	14%	$2,034,500	$71,600	4%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,167,400	5%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	114	28%	$317,311,600	$77,180,900	24%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	4	11%	$0	$0	0%
Personal/Repair Services	19	3	16%	$3,189,300	$310,600	10%
Professional/Tech. Services	41	10	24%	$4,405,500	$272,300	6%
Retail Trade	112	16	14%	$46,487,700	$6,157,900	13%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	1,666	21%	$1,287,911,200	$302,458,800	23%
Temporary Lodging	11	0	0%	$9,649,200	$0	0%
Vacant	1,537	449	29%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	6	7%	$24,229,800	$865,900	4%
COLUMN TOTALS:	10,486	2,346		$1,932,607,100	$463,825,800	

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

Parcels and Buildings Vulnerable to Storm Surge During Hurricanes

SLOSH (Category 1 Storm)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	13	22%	$306,900	$0	0%
Banks	4	2	50%	$1,223,800	$709,300	58%
Church/Non-Profit Offices	132	25	19%	$25,514,700	$5,638,200	22%
Emergency Response	6	2	33%	$2,475,700	$1,033,000	42%
Entertainment and Recreation	37	9	24%	$6,480,600	$1,941,400	30%
General Services	139	22	16%	$32,074,700	$5,207,200	16%
Heavy Industrial	22	4	18%	$2,034,500	$458,800	23%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$459,900	8%
Medical Office/Clinic	22	2	9%	$23,226,800	$1,481,200	6%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	126	31%	$317,311,600	$76,156,200	24%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	7	19%	$0	$0	0%
Personal/Repair Services	19	5	26%	$3,189,300	$668,200	21%
Professional/Tech. Services	41	8	20%	$4,405,500	$272,300	6%
Retail Trade	112	27	24%	$46,487,700	$7,201,800	15%
Schools	9	3	33%	$127,833,400	$57,556,000	45%
Single Family Dwelling	7,776	1,783	23%	$1,287,911,200	$313,139,200	24%
Temporary Lodging	11	1	9%	$9,649,200	$149,900	2%
Vacant	1,537	409	27%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	7	8%	$24,229,800	$1,010,700	4%
COLUMN TOTALS:	10,486	2,457		$1,932,607,100	$477,851,400	

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

Results: Vulnerability Assessment

SLOSH (Category 2 Storm)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	14	24%	$306,900	$0	0%
Banks	4	1	25%	$1,223,800	$239,100	20%
Church/Non-Profit Offices	132	39	30%	$25,514,700	$13,229,600	52%
Emergency Response	6	1	17%	$2,475,700	$193,900	8%
Entertainment and Recreation	37	8	22%	$6,480,600	$3,034,900	47%
General Services	139	32	23%	$32,074,700	$10,396,700	32%
Heavy Industrial	22	4	18%	$2,034,500	$458,800	23%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	1	6%	$6,048,700	$248,000	4%
Medical Office/Clinic	22	2	9%	$23,226,800	$1,481,200	6%
Metals/Minerals Processing	2	0	0%	$14,400	$0	0%
Multi-family Dwelling	407	126	31%	$317,311,600	$94,306,400	30%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	7	19%	$0	$0	0%
Personal/Repair Services	19	5	26%	$3,189,300	$307,100	10%
Professional/Tech. Services	41	8	20%	$4,405,500	$1,324,000	30%
Retail Trade	112	27	24%	$46,487,700	$9,860,900	21%
Schools	9	3	33%	$127,833,400	$57,195,700	45%
Single Family Dwelling	7,776	1,783	23%	$1,287,911,200	$384,042,500	30%
Temporary Lodging	11	1	9%	$9,649,200	$149,900	2%
Vacant	1,537	409	27%	$4,244,000	$2,158,400	51%
Wholesale Trade	91	7	8%	$24,229,800	$609,000	3%
COLUMN TOTALS:	10,486	2,479		$1,932,607,100	$581,845,800	

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

SLOSH (Category 3 Storm)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	14	24%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	39	30%	$25,514,700	$10,394,600	41%
Emergency Response	6	2	33%	$2,475,700	$371,100	15%
Entertainment and Recreation	37	9	24%	$6,480,600	$2,680,800	41%
General Services	139	26	19%	$32,074,700	$8,444,400	26%
Heavy Industrial	22	3	14%	$2,034,500	$122,000	6%
Hospital	1	0	0%	$1,128,300	$0	0%
Light Industrial	18	0	0%	$6,048,700	$0	0%
Medical Office/Clinic	22	0	0%	$23,226,800	$0	0%
Metals/Minerals Processing	2	1	50%	$14,400	$14,400	100%
Multi-family Dwelling	407	116	29%	$317,311,600	$79,902,100	25%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	0	0%	$3,189,300	$0	0%
Professional/Tech. Services	41	9	22%	$4,405,500	$1,128,300	26%
Retail Trade	112	27	24%	$46,487,700	$8,683,100	19%
Schools	9	2	22%	$127,833,400	$57,195,700	45%
Single Family Dwelling	7,776	1,770	23%	$1,287,911,200	$331,630,800	26%
Temporary Lodging	11	4	36%	$9,649,200	$558,200	6%
Vacant	1,537	324	21%	$4,244,000	$1,658,000	39%
Wholesale Trade	91	8	9%	$24,229,800	$604,200	2%
COLUMN TOTALS:	10,486	2,355		$1,932,607,100	$505,997,400	

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

Results: Vulnerability Assessment

SLOSH (Category 4 Storm)

Type of Structure	Number of Parcels			Value of Buildings		
	# in town	# in Hazard area	% in Hazard Area	$ in town	$ in Hazard area	% in Hazard Area
Agriculture	59	20	34%	$306,900	$0	0%
Banks	4	0	0%	$1,223,800	$0	0%
Church/Non-Profit Offices	132	47	36%	$25,514,700	$11,701,100	46%
Emergency Response	6	2	33%	$2,475,700	$371,100	15%
Entertainment and Recreation	37	8	22%	$6,480,600	$2,493,900	38%
General Services	139	27	19%	$32,074,700	$8,401,900	26%
Heavy Industrial	22	3	14%	$2,034,500	$122,000	6%
Hospital	1	1	100%	$1,128,300	$1,128,300	100%
Light Industrial	18	1	6%	$6,048,700	$284,500	5%
Medical Office/Clinic	22	1	5%	$23,226,800	$1,593,100	7%
Metals/Minerals Processing	2	2	100%	$14,400	$14,400	100%
Multi-family Dwelling	407	124	30%	$317,311,600	$173,604,000	55%
Nursing Home	4	1	25%	$6,816,300	$2,609,700	38%
Parking	37	0	0%	$0	$0	0%
Personal/Repair Services	19	0	0%	$3,189,300	$0	0%
Professional/Tech. Services	41	14	34%	$4,405,500	$1,480,800	34%
Retail Trade	112	21	19%	$46,487,700	$7,524,700	16%
Schools	9	3	33%	$127,833,400	$14,685,700	11%
Single Family Dwelling	7,776	1,796	23%	$1,287,911,200	$337,425,300	26%
Temporary Lodging	11	6	55%	$9,649,200	$2,666,700	28%
Vacant	1,537	318	21%	$4,244,000	$1,679,100	40%
Wholesale Trade	91	10	11%	$24,229,800	$1,208,300	5%
COLUMN TOTALS:	10,486	2,405		$1,932,607,100	$568,994,600	

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

Parcels and Buildings Vulnerable to Shoreline Change

Coastal Properties		
	# of Parcels in Hazard area	**$ of Buildings in Hazard area**
Coastal	1,014	$291,672,700
Not Coastal	9,667	$16,415,223,000

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 Bourne 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)
Bourne Police Department	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N
Buzzards Bay Fire Station	Y	Y	Y	N	N	N	N	N	Y	Y	N	N	N
Monument Beach Fire Station	N	Y	Y	N	N	N	N	N	N	N	N	N	N
Pocasset Fire Station	Y	Y	Y	N	N	N	N	N	N	N	N	N	N
Sagamore Fire Station	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Town Hall	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N
Community Building	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N
Bourne Public Library	N	N	Y	N	N	N	N	N	N	N	N	N	N
Bourne Housing Authority	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N
Gallo Ice Arena	N	N	N	N	N	N	N	N	N	N	N	Y	N
Bourne School Admin Office	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Integrated Solid Waste Management Facility	N	N	N	N	N	N	N	N	N	N	N	N	N
Department of Public Works	N	N	N	N	N	N	N	N	N	N	N	N	N
Peebles Elementary School	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne High School	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Middle School	N	N	N	N	N	N	N	N	N	N	N	N	N
Bournedale Elementary School	N	N	N	N	N	N	N	N	N	N	N	N	N
Upper Cape Regional Technical School	N	N	N	N	N	N	N	N	N	N	N	N	N
Cape Cod/Islands Community Health Center	N	N	N	N	N	N	N	N	N	N	N	N	N
Joint Base Cape Cod	N	N	N	N	N	N	N	N	N	N	N	N	N

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)
Bourne Bridge	The bases of the bridges are in the flood hazard areas, but the road surface is elevated above them.												
Sagamore Bridge	The bases of the bridges are in the flood hazard areas, but the road surface is elevated above them.												
Memorial Circle	N	N	N	Y	N	N	N	N	N	N	N	N	N
Belmont Rotary	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N
Bourne Rotary	N	N	N	N	N	N	N	N	N	N	N	N	N
Taylor Point Marina	N	Y	Y	Y	N	N	N	N	N	N	Y	N	Y
Monument Beach Marina	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y
Barlow's Landing	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y
Cape Cod Canal RR Bridge	The bases of the bridges are in the flood hazard areas, but the road surface is elevated above them.												
Cohasset Narrows Bridge	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	Y
Back River Railroad Bridge	Y	Y	Y	Y	N	N	N	N	N	Y	Y	N	Y
Briarwood Ln RR Overpass	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Emmons Rd RR Bridge	Y	Y	Y	Y	Y, Depression	Y, Depression	Y	Y	Y	Y	Y	Y	Y
Valley Bars Cir RR Bridge	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	Y
Old Main Rd RR Bridge	N	N	N	N	N	N	N	N	N	N	N	N	N
Pocasset River RR Bridge	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Shore Rd RR Overpass	y	Y	Y	Y	N	N	N	N	N	N	Y	N	N
Shore Rd RR Overpass (Shipyard Lane)	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y
Scraggy Neck RR Overpass	N	N	N	N	N	N	N	N	N	N	N	N	N
Old Monument Neck Rd RR Overpass	Y	Y	Y	Y	N	N	N	N	N	Y	Y	N	N
Bypass Rd, Buzzards Bay	Partially	Partially	Partially	Partially	N	N	N	N	N	N	Partially	Partially	N
Circuit Ave, Pocasset	Partially	Partially	Partially	Partially	N	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially
Mashnee Rd	Partially	Partially	Partially	Partially	N	N	Partially	Partially	Partially	Partially	Partially	Partially	Partially
Saltmarsh Ln, Pocasset	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially
Scraggy Neck Rd, Cataumet	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially

Vulnerable Populations

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)
North Sagamore Water District	N	N	N	N	N	N	N	N	N	N	N	N	N
North Sagamore Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
Scenic Highway Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
North Sagamore Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
North Sagamore Water Pump Station 1	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N
North Sagamore Water Pump Station 2	N	N	N	N	N	N	N	N	N	N	N	N	N
North Sagamore Water Pump Station 3	N	N	N	N	N	N	N	N	N	N	N	N	N
Buzzards Bay Water District	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N
Buzzards Bay Water Tank 1	N	N	N	N	N	N	N	N	N	N	N	N	N
Buzzards Bay Water Tank 2	N	N	N	N	N	N	N	N	N	N	N	N	N
Buzzards Bay Water Pump Station 1	N	N	N	N	N	N	N	N	N	N	N	N	N
Buzzards Bay Water Pump Station 2E	N	N	N	Y	N	N	N	N	N	N	N	N	N
Buzzards Bay Water Pump Station 3W	N	N	N	N	N	N	N	N	N	N	N	N	N
Buzzards Bay Water Pump Station 4	N	N	N	N	N	N	N	N	N	N	N	N	N
Monument Beach Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
South Sagamore Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N

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)
Bourne Water Tank	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water District	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 1	N	N	Y	Y	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 2	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 3	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 4	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 5	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 6	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 7	N	N	N	N	N	N	N	N	N	N	N	N	N
Bourne Water Pump Station 8	N	N	N	N	N	N	N	N	N	N	N	N	N
Main Street Sewer Pumping Station	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	N	N
Hideaway Village Sewer Pumping Station	N	N	N	Y	N	N	N	N	N	N	N	N	Y

Table 4.14 | Exposure Assessment for Critical Facilities. In the Sea Level Rise section of the table, "Y depression" represents facilities that are inundated because they are in low-lying areas. Roads that intersect hazard areas at any point are labeled as "partially" exposed.

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Vulnerable Populations

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

Coastal Erosion: Coastal erosion is not generally considered an imminent threat to public safety because shoreline changes are gradual over many years. However, drastic changes to the shoreline may occur in a single storm event which can threaten homes and public safety.

Culvert Failure: All populations in a culvert failure inundation zone would be exposed to the risk of culvert failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.

Earthquake: 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.

Wildland and Urban Fire: As demonstrated by historical urban and wildfire events, potential losses include human health and life of residents and responders. The most vulnerable populations include the elderly, children, and disabled as well as emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Flooding: The impact of flooding on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure includes the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by a hazard event (e.g., risk while traveling in flooded areas, or compromised access to emergency services during an event). The degree of such impacts will vary and is not strictly measurable.2 Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.

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

3 Massachusetts State Hazard Mitigation Plan, 2013

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. Of the population exposed, the most vulnerable include the economically disadvantaged and population over the age of 65. Those over the age of 65 are vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. They also may have more difficulty evacuating.

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

Nor'easters: The impact of a nor'easter on life, health and safety is dependent upon several factors including the severity of the event and whether 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.

Severe Weather (wind, thunderstorms, tornadoes, extreme temperatures, drought): For the purposes of this plan, the entire population of the Bourne is exposed to severe weather events. Residents may be displaced or require temporary to long-term sheltering due to severe weather events. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. In general, vulnerable populations include the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard.

Severe Winter Weather (snow, blizzards and ice): According to NOAA's National Severe Storms Laboratory, winter weather indirectly and deceptively kills hundreds of people in the U.S. every year, primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures with dangerous wind chills. These storms are considered

deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. Injuries and fatalities may occur due to traffic accidents on icy roads, heart attacks while shoveling snow or hypothermia from prolonged exposure to cold.

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

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

Summary of Vulnerable Infrastructure

B3b

Below is a description of Bourne infrastructure that is vulnerable to the impacts of natural hazard events.

Essential facilities, including Town Hall, the Community Building, the Bourne Housing Authority, the existing Police Station (construction of the new police station on the bypass road results in a less vulnerable facility) and all but one of the Fire Stations, are vulnerable to storm surge.

Overhead power lines are vulnerable to high winds, heavy snow and ice.

All but two of the railroad bridges are vulnerable to storm surge. Failure of many of these bridges could prevent access to neighborhoods.

There is no history of earthquakes or tsunamis in Bourne. This lack of history provides a false sense of security and lack of preparedness.

Summary of Vulnerable Infrastructure

Below is a list of the vulnerable facilities in each of the critical facility categories:

Essential Facilities

- Bourne Police Department
- Buzzards Bay Fire Station
- Bourne Fire Station
- Pocasset Fire Station
- Bourne Town Hall
- Community Building
- Jonathan Bourne Public Library
- Bourne Housing Authority

Transportation Facilities

- Memorial Circle
- Belmont Rotary
- Taylor Point Marina
- Monument Beach Marina
- Barlow's Landing
- Cohasset Narrows Bridge
- Back River Railroad Bridge
- Briarwood Lane Overpass
- Emmons Road Railroad Bridge
- Valley Bars Circle Railroad Bridge
- Pocasset River Railroad Bridge
- Shore Road Overpass (north of Pocasset River
- Shore Road Railroad Overpass (Shipyard Lane)
- Old Monument Neck Road Railroad Overpass
- Bypass Road
- Circuit Ave
- Mashnee Road
- Saltmarsh Lane
- Scraggy Neck Road

Lifeline Utilities

- North Sagamore Water Pump Station 1
- Buzzards Bay Water District
- Buzzards Bay Water Pump Station 2E
- Bourne Water Pump Station 1
- Main Street Sewer Pumping Station
- Hideaway Village Sewer Pumping Station

Mitigation Strategy

CHAPTER FIVE

Chapter 2 profiled specific hazards that could affect Bourne 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 a way to implement these actions. This so-called "Mitigation Strategy" determines broad goals and outlines specific actions for the next five years. **Chapter 5 reviews the mitigation strategy created in 2004 and outlines a mitigation strategy for the Town of Bourne for the next five years.**

Mitigation Goals and Objectives

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

C3a,b

Mitigation Goals

The Planning Team reviewed the Goals in the 2004 Hazard Mitigation Plan and decided to make minor editorial changes and add one additional goal. Mitigation Goals for the 2017 Bourne Hazard Mitigation Plan are:

1. Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards
2. Develop and distribute hazard awareness information and conduct educational programs for the public
3. Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to natural hazards
4. Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan
5. Coordinate our local hazard mitigation planning and activities with those of Barnstable County and neighboring Towns
6. Ensure mitigation measures are sensitive to natural features, historic resources, and community character

Mitigation Actions

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

Below is a description of how the Planning Team developed the Mitigation Action section of the 2017 Bourne Hazard Mitigation Plan Update:

- **A Progress Determination on Mitigation Actions in 2004:** the Team assigned a status to each mitigation action identified in the 2004 Hazard Mitigation Plan and explained why the action was completed, an existing capability, in progress, deferred or deleted (See ***Table 5.1***).
- **Future Mitigation Actions for the 2017 Hazard Mitigation Plan Update:** the list contains
  - new mitigation actions based on the Vulnerability and Risk Assessment in Chapter 4
  - "In Progress" actions identified in ***Table 5.1*** were carried forward into the Future Mitigation Action List

- **Capability Assessment:** the Team reviewed and revised the Capability Assessment from the 2004 Hazard Mitigation Plan. Also, any action designated as an "existing capability" in ***Table 5.1*** was carried over to the Capability Assessment. (***Table 5.2***)

D2a

Progress Determination on Mitigation Actions since 2004

BBefore identifying new Mitigation Actions for the 2017 Hazard Plan, the Planning Team discussed the status of the mitigation actions identified in the 2014 Hazard Mitigation Plan. One of the following status determinations was given to each mitigation action identified from the 2004 plan:

- **Complete:** The project was implemented and completed in 2004 – 2017.
- **Existing Capability:** The project was implemented and completed in 2004 – 2017, and it will continue to be implemented on an annual basis in the future. These action items are also identified in the capability assessment (***Table 5.2***).
- **In Progress:** The project was started in the 2004 – 2017 timeframe and it is still in progress.
- **Deferred:** The project is important, but it was deferred because there was no funding available or it is not feasible to complete the project.
- **Deleted:** The project is no longer relevant to the community.

In 2004 the Planning Team identified 19 Mitigation Actions. During the plan update, the Planning Team assessed the Town's progress on all actions (***Table 5.1***).

Also in 2004, Barnstable County developed a multiple jurisdictional hazard mitigation plan for the County. None of the actions included in that plan are carried forward here as they were not specific to Bourne. In the process to develop the 2017 Bourne Hazard Mitigation Plan the town has reevaluated all hazards and developed future actions that are in line with the Town's vision for resiliency moving forward.

Progress Determination on Mitigation Actions since 2004

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flooding	ACTION 1: Increase protection of the floodplain by enhancing floodplain management activities within the Town.	Building Inspector, Planning Board, Conservation Commission	Completed	The Floodplain Zoning Bylaw was revised. See Town of Bourne Zoning Bylaw Section 3110(b): Substantial Damage and Substantial Improvements are subject to cumulative costs.
Flooding	ACTION 2: Become a participant in the National Flood Insurance (NFIP) Community Rating System (CRS) program through enhanced floodplain management activities. Explore opportunities to join with Barnstable County as a whole.	Selectmen, Town Planner, Building Inspector, Conservation Commission,	Deferred	Participating in the CRS program continues to be a goal for the Town. Assessing the feasibility of becoming a CRS community is included as a 2017 mitigation action, see Action 1.
Flooding	ACTION 3: Advertise and promote the availability of flood insurance to Town property owners by direct mail at least once a year.	Town Planner, Building Inspector, Local Emergency Planning Committee	Deleted	This action is deleted because the Town determined they can more effectively share information regarding vulnerabilities in other formats and that information specific to flood insurance should come from entities more knowledgeable on the details of the insurance.
All Hazards	ACTION 4: Use the Town's Geographic Information System (GIS) to maintain current building and parcel data for the purposes of conducting more detailed hazard risk assessments and for tracking permitting/land use analysis.	Town Planner, Assessing Department	In Progress	The Town maintains current building and parcel data and will continue this effort moving forward. This is included as a 2017 mitigation action, see Action 13.
All Hazards	ACTION 5: Collect educational materials on preparedness/mitigation measures for individual property owners, for display and distribution at Town Hall, Community Building, Library and Council on Aging offices.	Building Inspector, Town Planner, Local Emergency Planning Committee	In Progress	Materials have been developed and disseminated in paper and via the Town of Bourne website. Town staff will continue to make educational information on preparedness and mitigation measures available to the public. This is included as a 2017 mitigation action, see Action 6.

Table 5.1 | Progress Determination on 2004 Mitigation Actions

Progress Determination on Mitigation Actions since 2004

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Flooding, Erosion, Sea Level Rise	ACTION 6: Continue to acquire and preserve parcels of land subject to repetitive flooding from willing and voluntary property owners.	Town Meeting, Selectmen, Town Planning, Natural Resources Department, Conservation Commission	Deferred	This action is deferred because it has not been feasible for the Town to purchase ocean front property subject to repetitive flooding. No funding was available for this purpose between 2004-2016. The Town has obtained some open space parcels within the floodplain and will continue to seek funds for these acquisitions moving forward. This is included as a 2017 mitigation action, see Action 7.
All Hazards	ACTION 7: Conduct a thorough evaluation of the Town's most at-risk locations identified in the Vulnerability Analysis, and evaluate the potential mitigation techniques for protecting each location to the maximum extent possible.	Department of Public Works, Natural Resources, Board of Health, Building Inspector, Town Planner, Conservation Commission	In Progress	Town departments do this on a continual and routine basis. This is included as a 2017 mitigation action, see Action 16.
All Hazards	ACTION 8: Monitor the Town's emergency response service to identify needs or shortfalls in terms of personnel, equipment or required resources.	Police Chief, Fire Chief, Health Agent, Local Emergency Planning Committee	Existing Capability	Town departments monitor response services and will continue to do so.
Flooding, Erosion, Sea Level Rise	ACTION 9: Revise the Town's Floodplain Zoning Bylaw to incorporate cumulative substantial damage or improvement requirements.	Town Planner, Building Inspector, Planning Board	Completed	The Floodplain Zoning Bylaw was revised. See Town of Bourne Zoning Bylaw Section 3110(b): Substantial Damage and Substantial Improvements are subject to cumulative costs.
Flooding	ACTION 10: Develop an educational flyer targeting NFIP policyholders on the Increased Cost of Compliance (ICC) coverage, to be disseminated following a flood event that results in substantial damage determinations by the Town.	Building Inspector, Local Emergency Planning Committee	Deleted	This action is deleted because the more appropriate entity for this action is the National Flood Insurance Program and insurance agencies.

Progress Determination on Mitigation Actions since 2004

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Wind, Snow, and Ice	ACTION 11: Incorporate the inspection and management of hazardous trees/limbs into the Town's routine monitoring process.	Department of Public Works, Fire Department	Existing Capability	This is done on a continual basis as part of routine monitoring.
Wind, Snow, and Ice	ACTION 12: Augment the enforcement of the State Building Code and related Town Bylaws by encouraging wind-resistant design techniques for new residential construction and reconstruction during the Town's permitting process.	Building Inspector, Planning Board	In Progress	This is done on a continual basis as part of the Town's permitting process. This is included as a 2017 mitigation action, see Action 4.
Flooding	ACTION 13: On an annual basis, contact all owners of FEMA identified repetitive loss properties and inform the owners of the assistance available through the federal Flood Mitigation Assistance (FMA) program, in addition to other flood protection measures.	Building Inspector, Town Planner, Local Emergency Planning Committee	Deleted	This is deleted due to concerns over private property rights.
All Hazards	ACTION 14: Annually host a public hazards and mitigation display for the residents of Bourne, in combination with the Scallop festival or another appropriate community event.	Town Planner, Building Inspector, Local Emergency Planning Committee	Deleted	This action specific to the Scallop Festival is deleted as the Festival is no longer held in Bourne; however, the Town will continue public outreach on hazards and mitigation activities. An action regarding outreach is included as a 2017 mitigation action, See Action 6.

Progress Determination on Mitigation Actions since 2004

Hazard(s) to Mitigate	Action Item Number and Description	Responsible Department	Status	Explanation of Status
Wildfire	ACTION 15: Participate in Barnstable County's Cooperative Extension Service's grant program for wildfire fuel reduction programs.	Natural Resources Department, Fire Department	Completed	A Wildland Fire Protection and Preparedness Plan for Bourne Town Forest, Four Ponds Conservation Area, and Bourne Water District Lands was prepared in 2006 for the Town of Bourne and the Cape Cod Cooperative Extension.
Erosion, Sea Level Rise	ACTION 16: Regular maintenance dredging of harbors	Shore and Harbor, Engineering Department, Natural Resources Department	In Progress	The Shore and Harbor Committee tries to undertake a new dredging project every three years. Since completion of the 2004 Hazard Mitigation Plan, Buttermilk Bay, Gray Gables, Hen Cove, and Monument Beach were dredged. This is included as a 2017 mitigation action, see Action 14.
Flooding, Fire, Erosion, Sea Level Rise	ACTION 17: Continue to participate in marsh restoration project that improves tidal flushing.	Conservation Commission	In Progress	The Town has been engaged in a number of restoration projects including the areas of Hens Cove, Eel Pond, Pocasset River, Gray Gables, Wings Neck and the Sagamore Marsh to improve flushing. The Town will continue to assess marsh restoration and engage in marsh restoration projects, as necessary. This is included as a 2017 mitigation action, see Action 15.
All Hazards	ACTION 18: Develop a map indicating hazard sensitive parcels acquired by Bourne.	Town Planner	Completed	Hazard sensitive parcels acquired by Bourne are included in the open space map.
All Hazards	ACTION 19 Conduct a quantification of potential losses by estimating potential losses at varying degrees of storm surge, wind, and stormwater hazard severity, as well as specific impacts on critical facilities for the PDHMP five (5) year update.	Town Planner	Completed	This analysis was completed for the 2017 Hazard Mitigation Plan and is included in Chapter 4: Vulnerability Assessment.

Mitigation Actions for the 2017 Hazard Plan

This section of the plan is the most dynamic because it is heavily influenced by factors such as grant funding and staff capability. The Mitigation Actions section will be routinely updated to ensure that it remains consistent with current Town priorities.

The Planning Team carried over the 2004 Mitigation Actions that were identified as "In Progress" and developed new Mitigation Actions based on the Vulnerability and Risk Assessments in Chapter 4 (See Future Action List). The mitigation actions described in the future action list are in no particular order.

The Planning Team identified priority designations for each mitigation action identified in the Future Action List. Several variables factored into the designation:

Life Safety/Social:

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

Property Protection:

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

Technical/Legal/Environmental/ Administrative:

- Is the mitigation action technically feasible based on Bourne'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 Bourne's Mitigation Goals and Objectives?
- Does Bourne 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 Priority designations for 2017 Mitigation Actions (high, medium, low) are defined as follows:

- **High Priority:** the Town will begin or complete these projects within three years.
- **Medium Priority:** the Town will begin or complete these projects within four years.
- **Low Priority:** the Town will begin or complete these projects within five years.

Project Timeline for 2017 Mitigation Actions:

The Future Action List is a list of 16 actions recommended by the Planning Team. The list identifies Responsibility, Funding and a Time Frame for the recommended actions. The actions will begin as soon as the plan is approved and the community is eligible for funding, unless otherwise stated, and will be completed in the amount of time as noted in the "Duration" section in the Future Action List.

Future Action List for the 2017 Hazard Plan

Flooding

Mitigation Action #1

Assess feasibility of becoming a participant in the National Flood Insurance (NFIP) Community Rating System (CRS) program through enhanced floodplain management activities.

Project Type:

Planning

Responsible Dept:

Selectmen, Town Planner, Building Inspector, Conservation Commission, Town Engineer

Funding Source(s):

Town Staff Budget, < $50,000

Timeframe:

Duration: 3 years

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004)

Priority: MEDIUM

All Hazards

Mitigation Action #2

Conduct public outreach to increase the number of subscribers to the BourneAlerts notification system. This action will enhance communication to residents and vulnerable populations before, during and after hazard events.

Project Type:

Outreach

Responsible Dept:

Police and Fire Departments, Emergency Management

Funding Source(s):

Town Staff Budget, < $50,000

Timeframe:

Duration: Ongoing

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Develop and distribute hazard awareness information and conduct educational programs for the public

Consistency With Other Town Plans:

Emergency Management Plan

Priority: HIGH

All Hazards

Mitigation Action #3

Continue to gather accurate data on the location, history, extent and impact of natural hazards in Bourne.

Project Type:

Planning

Responsible Dept:

Police and Fire Departments, Department of Public Works, Natural Resources Department, Emergency Management

Funding Source(s):

Town Staff Budget, < $50,000

Timeframe:

Duration: 1 year, annual thereafter

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004)

Priority: MEDIUM

Wind, Snow and Ice

Mitigation Action #4

Encourage wind-resistant design techniques for new residential construction and reconstruction during the Town's permitting process.

Project Type:

Mitigation

Responsible Dept:

Building Inspector, Planning Board

Funding Source(s):

Town Staff Budget, < $50,000

Timeframe:

Duration: Ongoing

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004)

Priority: HIGH

Future Action List for the 2017 Hazard Plan

All Hazards

Mitigation Action #5

Maintain a debris management plan for the Town of Bourne and coordinate with the Barnstable County Regional Emergency Planning Committee about a regional debris management plan.

Project Type:
Planning

Responsible Dept:
Department of Public Works, ISWM, Emergency Management

Funding Source(s):
Town Staff Budget, < $50,000

Timeframe:
Duration: 3 years

Consistency With Mitigation Goals:
Coordinate our local hazard mitigation planning and activities with those of Barnstable County and neighboring Towns

Consistency With Other Town Plans:
Integrated Solid Waste Management Operations Plan, Operations and Maintenance Plan

Priority: MEDIUM

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters

Mitigation Action #6

Distribute educational materials about storm surge, sea level rise, flooding, the Community Rating System and the National Flood Insurance Program at Town Hall, the DNR, and the library. Most of the materials available through County, State, and Federal agencies are available online; therefore, these materials will also be posted on the Town website, Police and Fire Facebook pages.

Project Type:
Outreach

Responsible Dept:
All Departments

Funding Source(s):
Town Staff Budget, < $50,000

Timeframe:
Duration: Ongoing

Consistency With Mitigation Goals:
Develop and distribute hazard awareness information and conduct educational programs for the public

Consistency With Other Town Plans:
Emergency Management Plan

Priority: MEDIUM

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters

Mitigation Action #7

Secure funding for the purchase of parcels of land in the floodplain and/or parcels of land subject to repetitive flooding from willing property owners.

Project Type:

Mitigation

Responsible Dept:

Town Planner, Natural Resources Department

Funding Source(s):

FEMA HMA grants (25% appropriation from Town Meeting), Other Grants, CPA funds, $100,000+

Timeframe:

Duration: 3 years

Consistency With Mitigation Goals:

Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004)

Priority: LOW

Flooding, Shoreline Change, Hurricanes, Tropical Storms, Nor'easters

Mitigation Action #8

Develop, prioritize and seek funding to reduce the vulnerability of local infrastructure from coastal hazards.

Project Type:

Mitigation

Responsible Dept:

Department of Public Works

Funding Source(s):

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

Timeframe:

Duration: 3 years

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan; Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004), Emergency Management Plan, Operations and Maintenance Plan

Priority: LOW

Future Action List for the 2017 Hazard Plan

All Hazards

Mitigation Action #9

Seek funding opportunities to reduce Bourne's vulnerability to natural hazards.

Project Type:
Mitigation

Responsible Dept:
All Departments

Funding Source(s):

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

Timeframe:

Duration: Ongoing, as needed

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan; Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004)

Priority: MEDIUM

All Hazards

Mitigation Action #10

Seek funding to purchase equipment, such as additional variable message boards, to increase the Town's ability to provide notifications and communicate with the public about potential hazards.

Project Type:
Preparedness

Responsible Dept:
All Departments

Funding Source(s):

FEMA HMA grants (25% appropriation from Town Meeting), Other Grants, <$50,000

Timeframe:

Duration: 2 years

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan; Develop and distribute hazard awareness information and conduct educational programs for the public

Consistency With Other Town Plans:

Emergency Management Plan

Priority: HIGH

All Hazards

Mitigation Action #11

Seek funding to digitize paper records located in the basement of Town Hall and identify off site storage locations outside of the floodplain and other known hazard areas. As feasible, relocate records.

Project Type:
Planning

Responsible Dept:
All Departments

Funding Source(s):
Grants, Town Staff Budget, <$100,000

Timeframe:
Duration: 3 years

Consistency With Mitigation Goals:
Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards;Seek and take advantage of funding opportunities to implement the Hazard Mitigation Plan; Ensure mitigation measures are sensitive to natural features, historic resources, and community character

Consistency With Other Town Plans:
Operations and Maintenance Plan

Priority: MEDIUM

All Hazards

Mitigation Action #12

Continue to coordinate with the Barnstable County Regional Emergency Planning Committee and other County and State agencies about disaster preparedness, emergency planning and disaster recovery.

Project Type:
Preparedness

Responsible Dept:
Emergency Management

Funding Source(s):
Town Staff Budget, <$50,000

Timeframe:
Duration: Ongoing, on monthly basis

Consistency With Mitigation Goals:
Coordinate our local hazard mitigation planning and activities with those of Barnstable County and neighboring Towns

Consistency With Other Town Plans:
Emergency Management Plan

Priority: MEDIUM

Future Action List for the 2017 Hazard Plan

All Hazards

Mitigation Action #13

Continue to collect building and parcel data for the purposes of conducting more detailed hazard risk assessments for tracking permitting/land use analysis.

Project Type:

Planning

Responsible Dept:

Town Planner, Assessing Department

Funding Source(s):

Town Staff Budget, <$50,000

Timeframe:

Duration: 1 year, annual thereafter

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards

Consistency With Other Town Plans:

Bourne Local Comprehensive Plan (2004), Operations and Maintenance Plan

Priority: HIGH

Erosion, Sea Level Rise

Mitigation Action #14

Continue the efforts of the Shore and Harbor Committee to undertake regular maintenance dredging of harbors.

Project Type:

Mitigation

Responsible Dept:

Shore and Harbor Committee, Engineering Department, Department of Natural Resources

Funding Source(s):

Town Staff Budget, Town Meeting Appropriation, Waterways Improvement Fund, Grants, $100,000+

Timeframe:

Duration: 3 year

Consistency With Mitigation Goals:

Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Ensure mitigation measures are sensitive to natural features, historic resources, and community character

Consistency With Other Town Plans:

Operations and Maintenance Plan

Priority: HIGH

Flooding, Fire, Erosion, Sea Level Rise

Mitigation Action #15

Evaluate the need for marsh restoration and complete projects, as necessary.

Project Type:
Mitigation

Responsible Dept:
Conservation Commission

Funding Source(s):
Grants, Town Staff Budget, $100,000+

Timeframe:
Duration: Ongoing

Consistency With Mitigation Goals:
Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Ensure mitigation measures are sensitive to natural features, historic resources, and community character

Consistency With Other Town Plans:
Bourne Local Comprehensive Plan (2004)

Priority: LOW

All Hazards

Mitigation Action #16

Continue to evaluate the Town's most at-risk locations, as identified in the Vulnerability Analysis, and continue to evaluate the potential mitigation techniques for protecting each location to the maximum extent possible.

Project Type:
Preparedness

Responsible Dept:
Public Works, Natural Resources, Board of Health, Building Inspector, Town Planner

Funding Source(s):
Town Staff Budget, <$50,000

Timeframe:
Duration: Ongoing

Consistency With Mitigation Goals:
Reduce the loss of life, property, infrastructure and the impacts on environmental and cultural resources in the Town from natural hazards; Mitigate potential financial losses incurred by municipal, residential, and commercial establishments due to natural hazards

Consistency With Other Town Plans:
Operations and Maintenance Plan

Priority: MEDIUM

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 Bourne has 15 Repetitive Loss Properties, all residential.

C2a

Continued compliance with NFIP

To be approved by the Federal Emergency Management Agency (FEMA), the Bourne 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 Bourne. Federally backed flood insurance is available in Bourne as long as the Town agrees to regulate development in their mapped floodplain.[1] To remain compliant with the NFIP, Bourne 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.

An Assessment of the Changes in Priority from 2004 to 2017

The Mitigation Actions described in the 2004 Bourne Hazard Mitigation Plan were prioritized in a way that was consistent with the State and County approach of using both non-structural and structural projects, and to use a non-structural hazard mitigation approach before undertaking a structural approach (see page 19 of the 2004 Hazard Mitigation Plan). However, the Mitigation Actions in the 2017 Bourne Hazard Mitigation Plan were prioritized as high, medium or low using the considerations described earlier in this chapter.

Below are two lists – one highlights activities that remain a priority for the Town of Bourne in 2017 and the other list highlights activities that are slightly different from the 2004 Hazard Plan.

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

Priority Activities identified in the 2004 and 2017 Hazard Plan:

- Bourne remains dedicated to public education on emergency preparedness, awareness for mitigation actions and the impacts of coastal hazards
- Several town departments are committed to assessing local infrastructure for damage to coastal hazards such as storm surge, flooding, and shoreline change and maintaining data that will assist in this assessment.
- Bourne remains committed to their participation in the National Flood Insurance Program and continues to express interest in participating in the Community Rating System.
- The Town remains committed to continuing management of coastal areas via dredging projects and marsh restoration.

Change in Priority:

- In the 2017 Bourne Hazard Mitigation Plan, the Planning Team added actions to protect essential town records (Action 11).
- The Town added an action to maintain their debris management plan and work with Barnstable County on a regional debris management plan (Action 5).
- The Town further committed to public outreach and awareness, with a specific action to increase subscribers to the BourneAlerts notification system (Action 2). In addition, the Town added an action to purchase additional notification equipment to better reach Bourne citizens (Action 10).

Capability Assessment

During the update process for the Bourne Hazard Mitigation Plan, members of the Planning Team reviewed and updated the capability assessment in the 2004 Hazard Mitigation Plan (See ***Table 5.2***). The table reflects the Town's current ability to implement capabilities, but cannot expand at this time; however, the Community will revisit the capabilities during the evaluation and maintenance process to discuss the Town's ability to expand and improve.

Capability Assessment

Natural Hazard	Explanation of Capability	Responsible Department
All Hazards	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) as well as material on the availability of flood insurance. 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."	**Department of Natural Resources, Town Planner**
All Hazards	Mutual Aid: Bourne opted-in to the Public Works Mutual Aid Agreement through MEMA. By opting in, Bourne 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 and/or be activated for any public safety incident/event. Bourne also has mutual aid agreements with neighboring communities.	**Police and Fire Departments, Department of Public Works**
All Hazards	Emergency Communication: The Town owns large variable message boards which displays 3-4 lines of text. They are usually placed on roadways to notify residents of hazards, lane closures and parking instructions.	**Police and Fire Departments, Department of Public Works, Emergency Management, Town Administrator**
All Hazards	Emergency Planning: Town staff determine supplies, equipment and communications needs and prioritize purchases so that Bourne is prepared for any needed emergency response to any natural hazard event. The Emergency Manager attends the monthly Barnstable County Regional Emergency Planning Committee meetings.	**Emergency Management**
All Hazards	Bourne is a Storm Ready community	**Emergency Management**
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.	**Police Department, Department of Public Works, Town Manager**
All Hazards	Generators: An inventory of Town owned generators is continually reviewed and monitored by Town staff.	**Police and Fire Departments, Emergency Management, Department of Public Works**

Table 5.2 | Capability Assessment

Future Action List for the 2017 Hazard Plan

Natural Hazard	Explanation of Capability	Responsible Department
All Hazards	Shelter: Equipment inventories and needs for the regional shelter are assessed during monthly meetings of the Barnstable County Regional Emergency Planning Committee.	**Police and Fire Departments, Department of Public Works, Emergency Management**
All Hazards	Grant Funding: Town Departments have proactively applied for grant funding for mitigation projects.	**Town Manager**
All Hazards	Town staff use Geographic Information System (GIS) to maintain current building and parcel data for the purposes of conducting more detailed hazard risk assessments and for tracking permitting/land use analysis.	**Town Planner, Assessing Department**
Fire	Fire Code: Town observes State, Federal and local fire codes. New sprinkler system laws are continually enforced. The Fire Department seeks input from the Building Inspector on where to place sprinklers in local businesses. The plans are reviewed jointly.	**Fire Department, Building Inspector**
Flooding	Education: The Bourne Police and Fire Departments collaborate with other Departments to send out press releases about the locations of regional shelter and natural hazards.	**Police and Fire Departments, Emergency Management**
Flooding	Coastal Infrastructure: Department of Public Works and Department of Natural Resources assess infrastructure that is vulnerable to flooding and storm surge in collaboration with regional, State and Federal partners	**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.	**Building Inspector, Conservation Commission, Planning Board**
Flooding	Flood Insurance Rate Map (FIRM): voters amended the Bourne Zoning Bylaw to make it consistent with the newly updated FIRMs for Barnstable County.	**Town Manager**
Flooding	Bourne Zoning Bylaw: This bylaw is consistent with NFIP regulations and the State Building Code. The Town reviews the bylaw to ensure it is as protective as possible and reflects current floodplain science and policy.	**Town Planner**

Future Action List for the 2017 Hazard Plan

Natural Hazard	Explanation of Capability	Responsible Department
Flooding	Conservation Commission: the Conservation Commission reviews the local regulations on an annual basis and regulates development within and adjacent to wetland resource areas	**Conservation Commission**
Flooding, Sea Level Rise, Severe Winter Storms, Nor'easters, Shoreline Change, Hurricanes/Tropical Storms	Stormwater: Clean out the stormwater catchments and other infrastructure on a regular basis.	**Department of Public Works**
Hurricanes, Tropical Storms, Severe Winter Storms, Nor'easters, Wind	Education: The Department of Department of Natural Resources works directly with boat owners to educate them on appropriate actions to take during a storm event. These interactions usually occur in person at the Department of Department of Natural Resources office.	**Department of Natural Resources**
Wind	State Building Code: State Building Code regulates construction for specific wind loads. The Town augments enforcement of the State Building Code and related Town Bylaws by encouraging wind-resistant design techniques for new residential construction and reconstruction during the Town's permitting process	**Building Inspector, Planning Board**
Dam/Culvert Failure	The Town assesses and mitigates issues with dams and culverts in Bourne.	**Department of Natural Resources, Department of Public Works**
Shoreline Change	The Town has partnered with Federal agencies to nourish, vegetate and monitor dunes in Bourne.	**Department of Natural Resources, Conservation Commission**
All Hazards	The Town evaluates at-risk locations and evaluates potential mitigation techniques for protecting these locations to the maximum extent possible.	**Department of Public Works, Department of Natural Resources, Health Agent, Building Inspector, Town Planner, Conservation Commission**
All Hazards	The Town monitors their emergency response service to identify needs or shortfalls in terms of personnel, equipment or required resources on an ongoing basis.	**Police and Fire Departments, Health Agent, Emergency Management, Local Emergency Planning Committee**
Wind, Snow, and Ice	The Town inspects and manages hazardous trees and limbs during routine monitoring.	**Department of Public Works, Fire Department**

Table 5.2 | Capability Assessment (Cont.)

Future Action List for the 2017 Hazard Plan

Natural Hazard	Explanation of Capability	Responsible Department
Erosion, Sea Level Rise	The Town completes regular maintenance dredging of harbors.	**Shore and Harbor Committee, Engineering Department, Department of Natural Resources**
Flooding, Fire, Erosion, Sea Level Rise	The Town assesses marsh restoration needs and engages in marsh restoration projects, as necessary.	**Conservation Commission**

Plan Evaluation and Maintenance

CHAPTER SIX

Once the 2017 Bourne Hazard Mitigation Plan is adopted by the Board of Selectmen, the plan enters into a five-year "maintenance" phase. **Chapter 6 describes how the Bourne 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 Bourne 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 is assigned to a specific "lead" department as a way to assign responsibility and accountability and increase the likelihood of subsequent implementation.

The Bourne Town Manager 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:

- Plan Monitoring:
  - Members of the Planning Team will meet annually to discuss the implementation status of each Mitigation Action identified in Chapter 5. During these meetings, the Planning Team will also describe and document any new hazard data that can be incorporated in the Hazard Profile section of the plan; specifically new hazard locations, extent and impacts.
  - After the annual meeting, members of the Planning Team will present to the Board of Selectmen 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 Selectmen can vote to adopt the change and amend the Bourne Hazard Mitigation Plan.
- Plan Evaluation:
  - A subset of the Planning Team (Emergency Management Director, Town Planner, and Town Manager) will meet annually to evaluate the stated purpose and goals of the Bourne Hazard Mitigation Plan. During this annual meeting, this smaller group will ensure that the plan continues to serve its purpose through the following activities:
    - Review the six Mitigation Goals in the 2017 Bourne Hazard Mitigation Plan
    - Discuss any recent activities to reduce the loss of life and property in Bourne such as grants received/applied for and any completed Mitigation Actions
    - Distribute an online survey to gauge the public's awareness of the risks posed by natural hazards

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

- Plan Update:
  - The Bourne 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 half years before the plan is set to expire.

When will the plan be maintained?

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

Following a disaster declaration, the Bourne 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 Bourne 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 Bourne 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 Bourne Board of Selectmen.**

Timeline for Plan Adoption

The timeline for Plan Adoption is as follows:

- **August 2017:** After approval by the Board of Selectmen at its meeting on August 22, 2017, the Planning Team submitted the Bourne Hazard Mitigation Plan to the Massachusetts Emergency Management Agency (MEMA) in August 2017. MEMA reviewed the plan and returned it to the Town of Bourne with required edits. The updated Bourne Hazard Mitigation Plan was then submitted to the Federal Emergency Management Agency (FEMA) for final review.
- **November 2017:** FEMA issued an Approved Pending Adoption status and the Bourne Board of Selectmen officially adopted the Bourne Hazard Mitigation Plan during its meeting on November 14, 2017.

E1a

Plan Adoption

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

Certificate of Adoption
Bourne, Massachusetts
Board of Selectmen
A Resolution Adopting the 2017 Bourne Hazard Mitigation Plan

WHEREAS, the Town of Bourne established a Committee to prepare the Hazard Mitigation Plan; and

WHEREAS, the Town of Bourne participated in the development of the Bourne 2017 Hazard Mitigation Plan; and

WHEREAS, the Bourne 2017 Hazard Mitigation Plan contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Bourne, and

WHEREAS, a duly-noticed public meeting was held by the Bourne Board of Selectmen on August 22, 2017 for the public and municipality to review prior to consideration of this resolution; and

WHEREAS, the Town of Bourne authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan, and

NOW, THEREFORE BE IT RESOLVED that the Town of Bourne Board of Selectmen, formally approves and adopts the Bourne 2017 Hazard Mitigation Plan, in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this 14th Day of November, 2017

George G. Slade, Jr., Chair
Peter J. Meier, Vice Chair
Judith MacLeod Froman, Clerk
Donald J. Pickard
Michael A. Blanton

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

Appendix

Local Mitigation Plan Review Guide

October 1, 2011

FEMA

4.1 ELEMENT A: PLANNING PROCESS

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

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

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

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

Introduction: Local Mitigation Plan Review Guide, FEMA

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

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

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

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

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

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

Introduction: Local Mitigation Plan Review Guide, FEMA

4.3 ELEMENT C. MITIGATION STRATEGY

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

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

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

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

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

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

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

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

Introduction: Local Mitigation Plan Review Guide, FEMA

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

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

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

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

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

4.5 ELEMENT E. PLAN ADOPTION

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

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

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

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

Chapter 1: Meeting Attendance Sheets

Bourne Hazard Mitigation Plan
Planning Team Meeting #1

February 28, 2017
9:30am
Lower Conference Room, Bourne Town Hall

Sign In Sheet

Name	Title/Department
Charles Noyes	Emergency Mgmt
Terri Guarino	Health Agent
Roger Laporte	Nobody special
Tom Guerino	Town Admin
Lynn Sala	DPW
Samuel Haines	Conservation

Bourne Hazard Mitigation Plan
Planning Team Meeting #2

March 21, 2017
9:30am
Lower Conference Room, Bourne Town Hall

Sign In Sheet

Name	Title/Department
John Stowe	DSgt. Bourne Police
Charles Noyes	Director-Emerg Mgmt
Samuel Haines	Conservation Agent
Tom Guerino	Town Administrator
Terri Guarino	Health Agent
Tim Mullen	DNR Director

Chapter 1: Meeting Attendance Sheets

Bourne Hazard Mitigation Plan
Planning Team Meeting #3

April 25, 2017
9:30am
Lower Conference Room, Bourne Town Hall

Sign In Sheet

Name	Title/Department
John R Stowe	Dept Bourne PD
Charles Noyes	Bourne EMD
Coreen Moore	Bourne Planning
Samuel Haines	Bourne Conservation
Timothy Lydon	Bourne Engineering

Bourne Hazard Mitigation Plan
Planning Team Meeting #4

May 16, 2017
9:30am
Lower Conference Room, Bourne Town Hall

Sign In Sheet

Name	Title/Department
Charles K Noyes	Bourne EMD
Tim Mullen	DNR
Coreen Moore	Planning
Roger L Haggett	Inspection
Samuel Haines	Conservation

Chapter 1: Public Survey Questionnaire

PUBLIC SURVEY
Bourne Hazard Mitigation Plan

CAPE COD COMMISSION

The Town of Bourne, with technical assistance from the Cape Cod Commission, is working to update the Bourne Hazard Mitigation 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 9 questions and it will take just a few minutes to complete.

If you have any questions regarding this survey, please contact Charles Noyes at cnoyes@townofbourne.com/508-759-0600 x1336 or Erin Perry at eperry@capecodcommission.org/508-744-1236. Thank you for participating!

Please place completed surveys in the collection boxes located at the Town Clerk's office and the Public Library.

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

☐ Yes ☐ No

2 Which of the following events have you experienced while in Bourne? 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.

- ☐ 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 or Heat
- ☐ Winter Storms (snow, blizzards, ice storms)
- ☐ Tsunami
- ☐ Sea Level Rise
- ☐ Other (please specify)

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

- ☐ Coastal Erosion and Shoreline Change
- ☐ Dam Failure
- ☐ Drought
- ☐ Earthquake
- ☐ Fire (Urban and Wildfire)
- ☐ Floods
- ☐ Hurricanes and Tropical Storms
- ☐ Landslides
- ☐ Nor'easter
- ☐ High Wind
- ☐ Lightning/Thunderstorms
- ☐ Tornado
- ☐ Extreme Cold or Heat
- ☐ Winter Storms (snow, blizzards, ice storms)
- ☐ Tsunami
- ☐ Sea Level Rise
- ☐ Other (please specify)

4 How concerned are you about the possibility of a natural disaster impacting Bourne?

- ☐ 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 an Emergency Notification System hosted by Barnstable County
☐ Yes ☐ No

Purchased flood insurance
☐ Yes ☐ No

Participated in educational activities and trainings about hazard and emergency preparedness
☐ Yes ☐ No

Obtained information pamphlets about natural hazards at Town Hall
☐ Yes ☐ No

Removed debris and hazardous materials from my property
☐ Yes ☐ No

Pruned trees on or near my property
☐ Yes ☐ No

Obtained an emergency response kit
☐ Yes ☐ No

Other (please specify)

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

You can select more than 1 answer.

- ☐ Local newspaper
- ☐ Public Television
- ☐ Radio Advertising
- ☐ Internet (Town website/Facebook)
- ☐ Email
- ☐ Mail
- ☐ Public workshops/meetings
- ☐ Other (please specify)

7 What steps can your local government take to reduce risk from natural hazards and protect the buildings and people of Bourne?

You can select more than 1 answer.

- ☐ Improve the alert/warning/notification systems
- ☐ Develop climate change adaptation plans and implement them
- ☐ Continue to improve regional shelters
- ☐ Remove debris and hazardous materials as well as prune trees on town property
- ☐ Improve drainage on area roads
- ☐ Educate the public on evacuation methods
- ☐ Apply for funding to reduce Bourne's risk to natural hazards
- ☐ Perform detailed risk assessments
- ☐ Work to reduce flood insurance for residents through the Community Rating System
- ☐ Educate the public on the science of natural hazards and emergency preparedness
- ☐ Improve the communication system during hazard events (i.e. radio towers, cellular services)
- ☐ Continue to work with regional partners to prepare for and recover from natural disasters
- ☐ Improve water control structures (i.e. culverts)
- ☐ Assess the vulnerability of low lying critical roads to flooding
- ☐ Other (please specify)

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

- ☐ Year-round resident
- ☐ Part-time resident
- ☐ I own a home in Bourne
- ☐ I rent a home in Bourne
- ☐ I am not a resident of Bourne, but I am employed in Bourne
- ☐ I am a business owner in Bourne
- ☐ Other (please specify)

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

Name _____

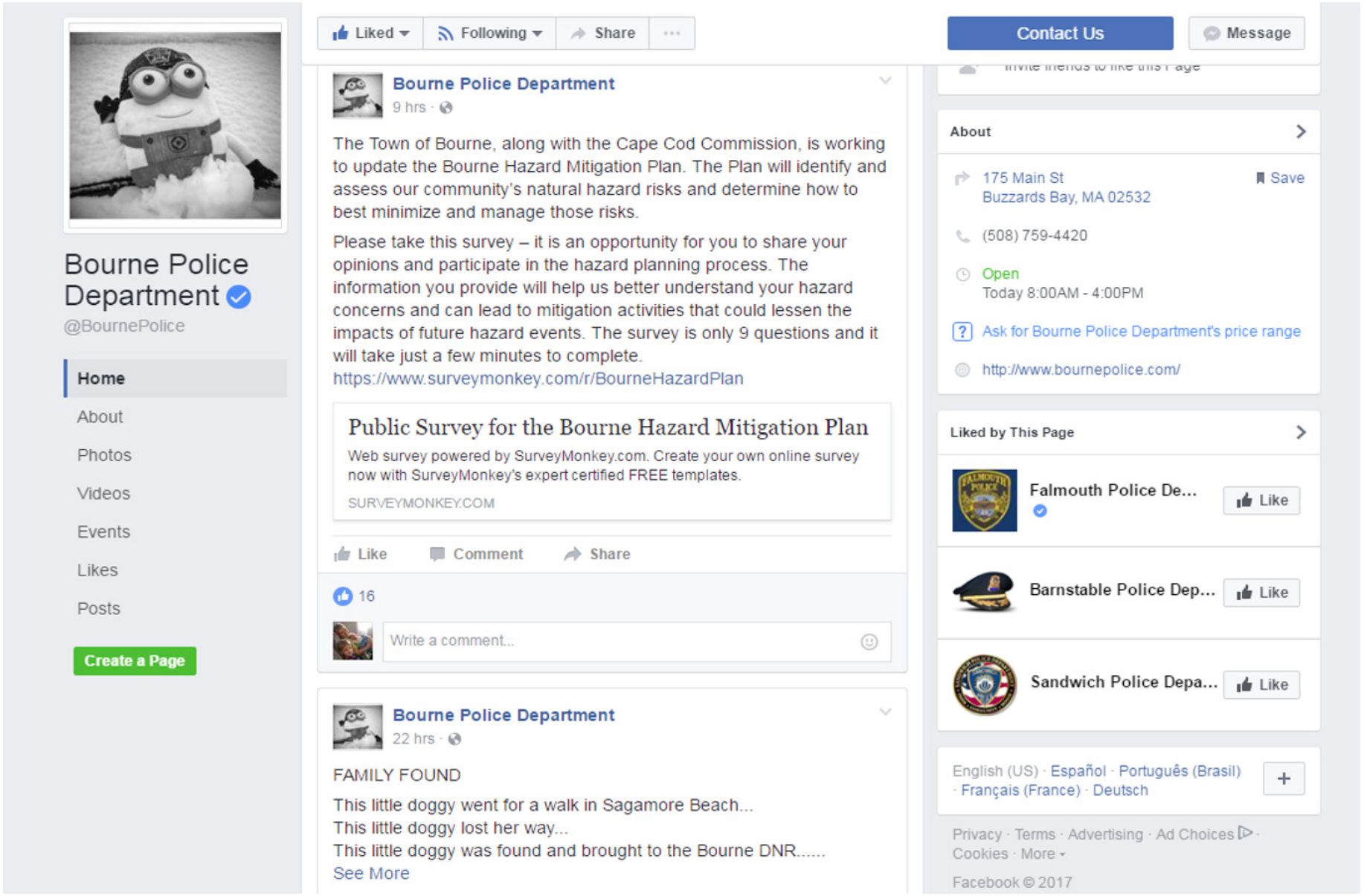
Email _____

Alternate Contact Information

Ch
Po


www.townofbourne.com/emergency-management/pages/hazard-mitigation-plan-survey
Town of BOURNE Massachusetts
Search
Town Info
Departments
Boards & Committees
For Residents
Doing Business
Help CENTER
Bourne Emergency Notification System - CodeRED
Bourne Residents and the Cape Emergency Traffic Plan
Cape Cod Emergency Traffic Plan
Disaster Preparedness for Pets
Hazard Mitigation Plan Survey
Hurricane Evacuation Zones
Hurricane Preparedness
Local Emergency Planning Committee
Massachusetts Emergency Management Agency Notifications
Other Agencies and Resources
Preparing for an Emergency
Shelter Information
Tornado Safety
Winter Storms
Home ›› Departments ›› Emergency Management
Hazard Mitigation Plan Survey
Bourne Hazard Mitigation Plan Survey
The Town of Bourne, along with the Cape Cod Commission, is working to update the Bourne Hazard Mitigation 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 9 questions and it will take just a few minutes to complete.
https://www.surveymonkey.com/r/BourneHazardPlan
Thank you,
Charles K Noyes, Director
Bourne Emergency Management/Local Emergency Planning Committee

Chapter 1: Public Survey Posting and Documentation



Bourne Police Department
@BournePolice

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Bourne Police Department
9 hrs ·

The Town of Bourne, along with the Cape Cod Commission, is working to update the Bourne Hazard Mitigation 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 9 questions and it will take just a few minutes to complete.
https://www.surveymonkey.com/r/BourneHazardPlan

Public Survey for the Bourne Hazard Mitigation Plan
Web survey powered by SurveyMonkey.com. Create your own online survey now with SurveyMonkey's expert certified FREE templates.
SURVEYMONKEY.COM

Like Comment Share

16

Write a comment...

Bourne Police Department
22 hrs ·

FAMILY FOUND

This little doggy went for a walk in Sagamore Beach...
This little doggy lost her way...
This little doggy was found and brought to the Bourne DNR.....
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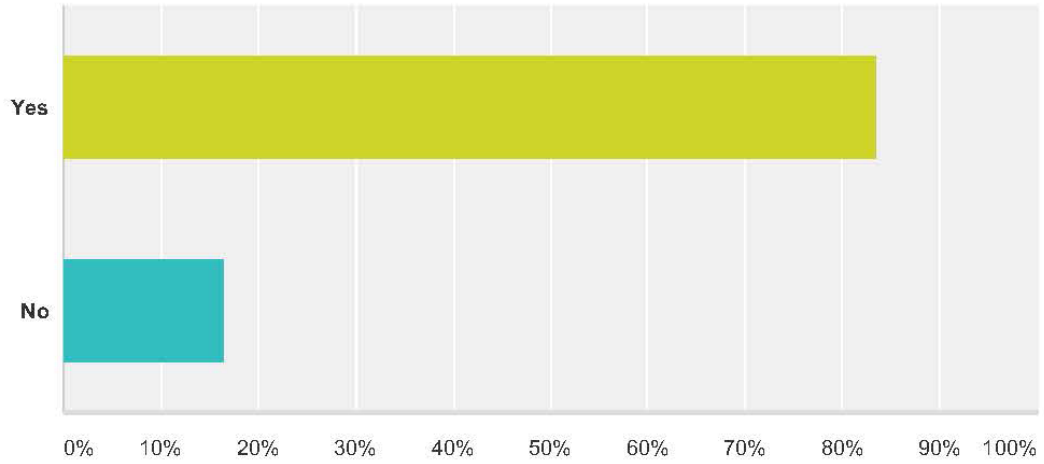
Public Survey for the Bourne Hazard Mitigation Plan

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

Answered: 195 Skipped: 0



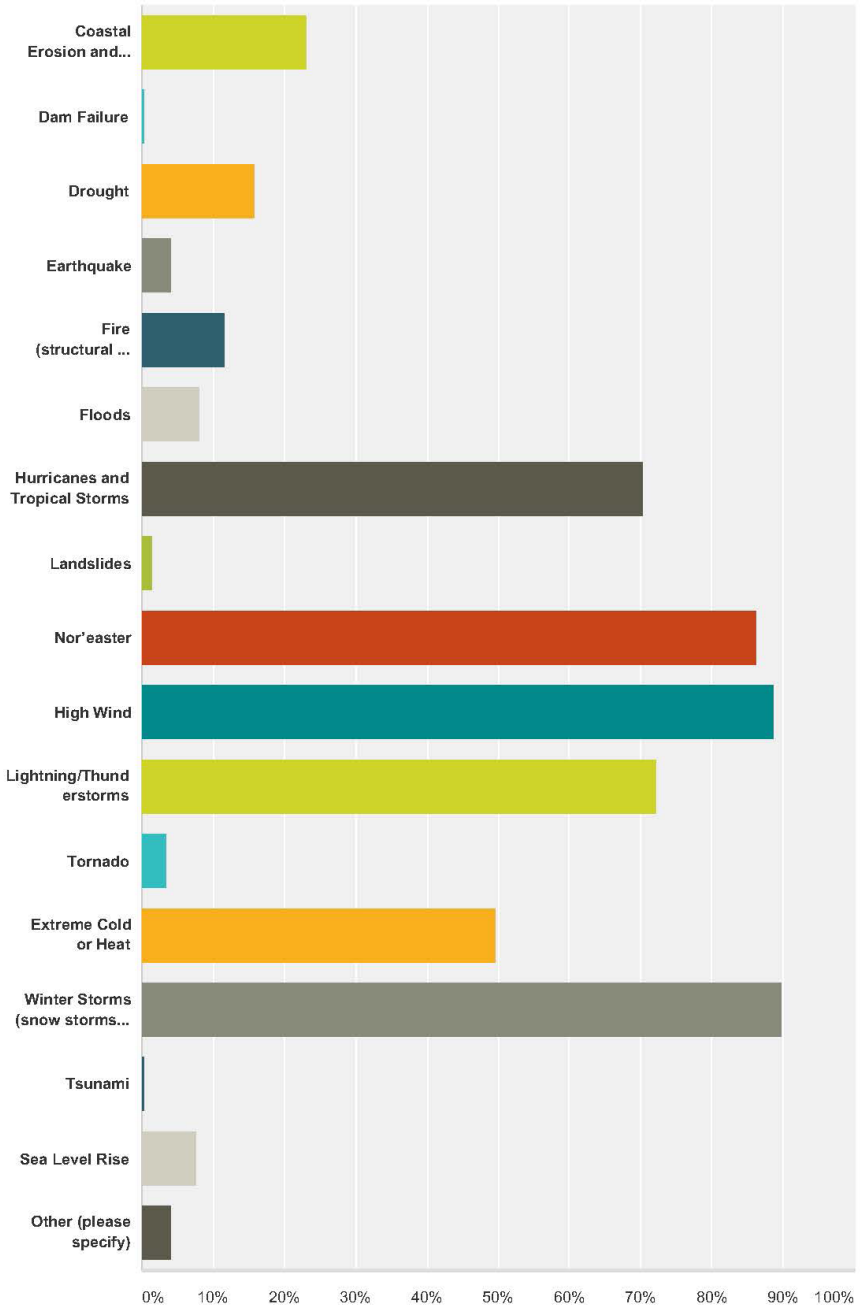
Chapter 1: Public Survey Results

Public Survey for the Bourne Hazard Mitigation Plan

Q2 Which of the following events have you experienced while in Bourne? 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: 195 Skipped: 0

Public Survey for the Bourne Hazard Mitigation Plan

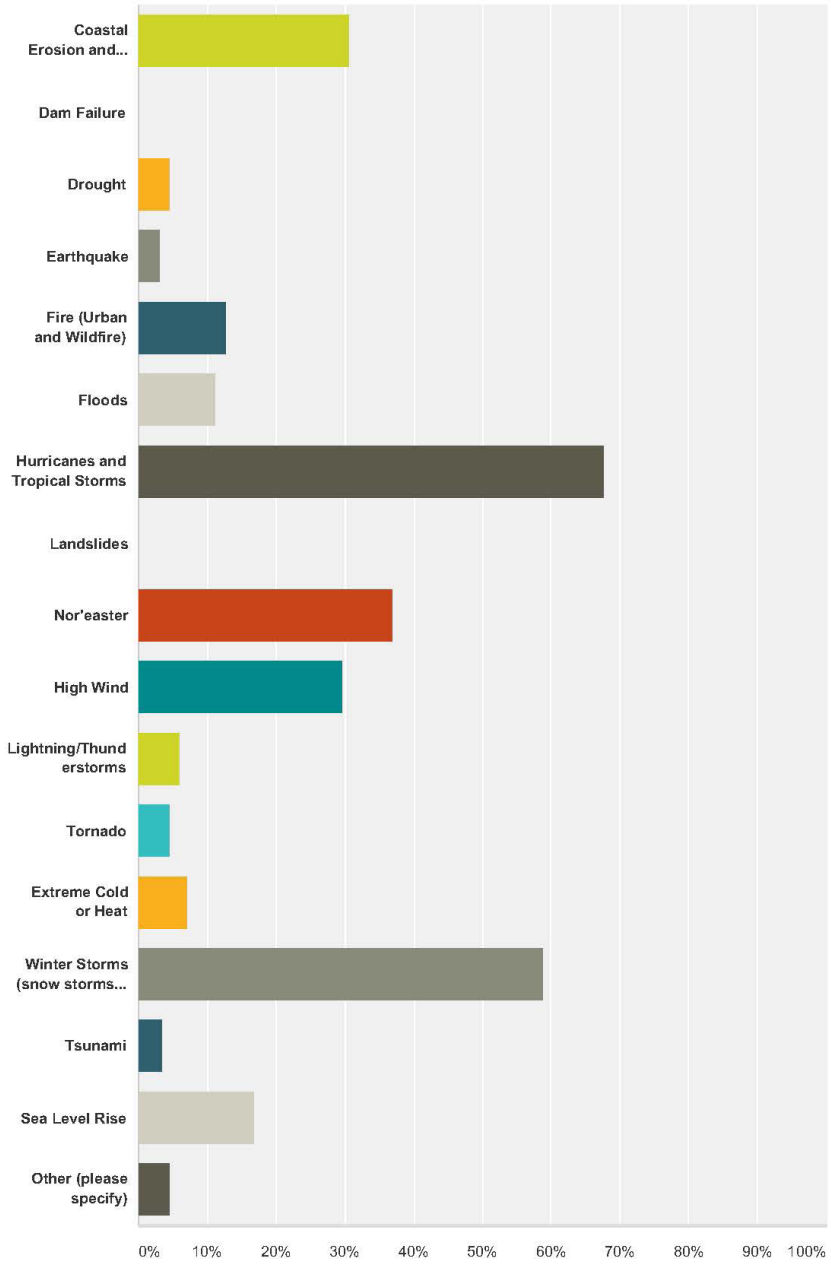


Public Survey for the Bourne Hazard Mitigation Plan

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

Answered: 195 Skipped: 0

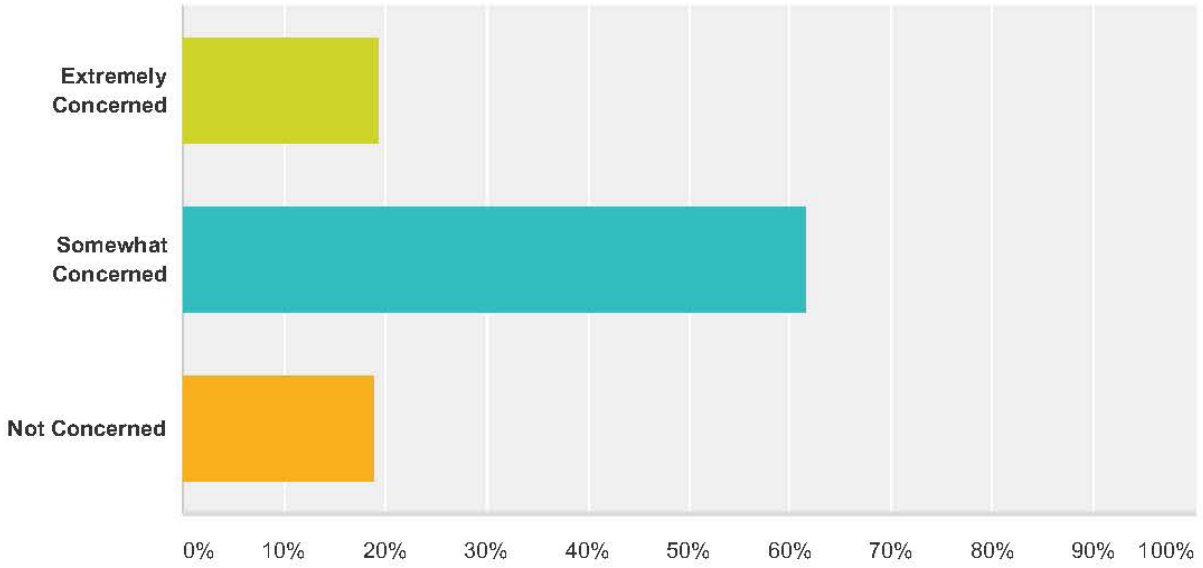
Public Survey for the Bourne Hazard Mitigation Plan



Public Survey for the Bourne Hazard Mitigation Plan

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

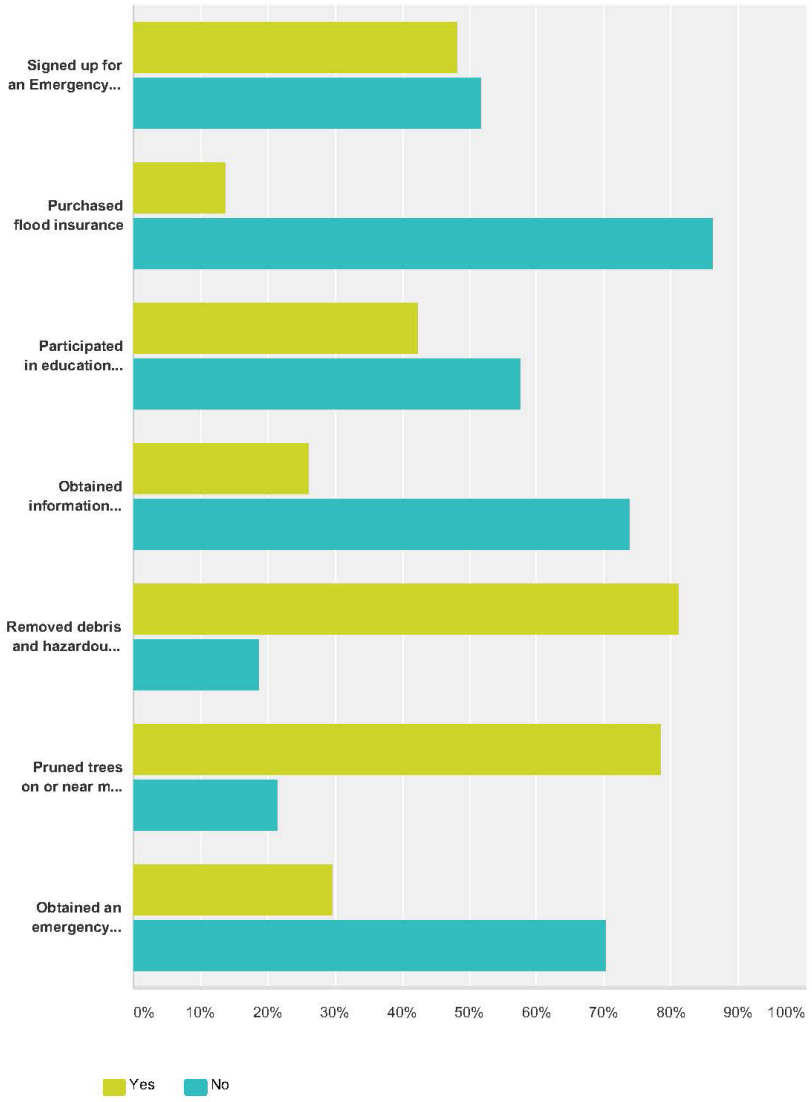
Answered: 195 Skipped: 0



Public Survey for the Bourne Hazard Mitigation Plan

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

Answered: 182 Skipped: 13

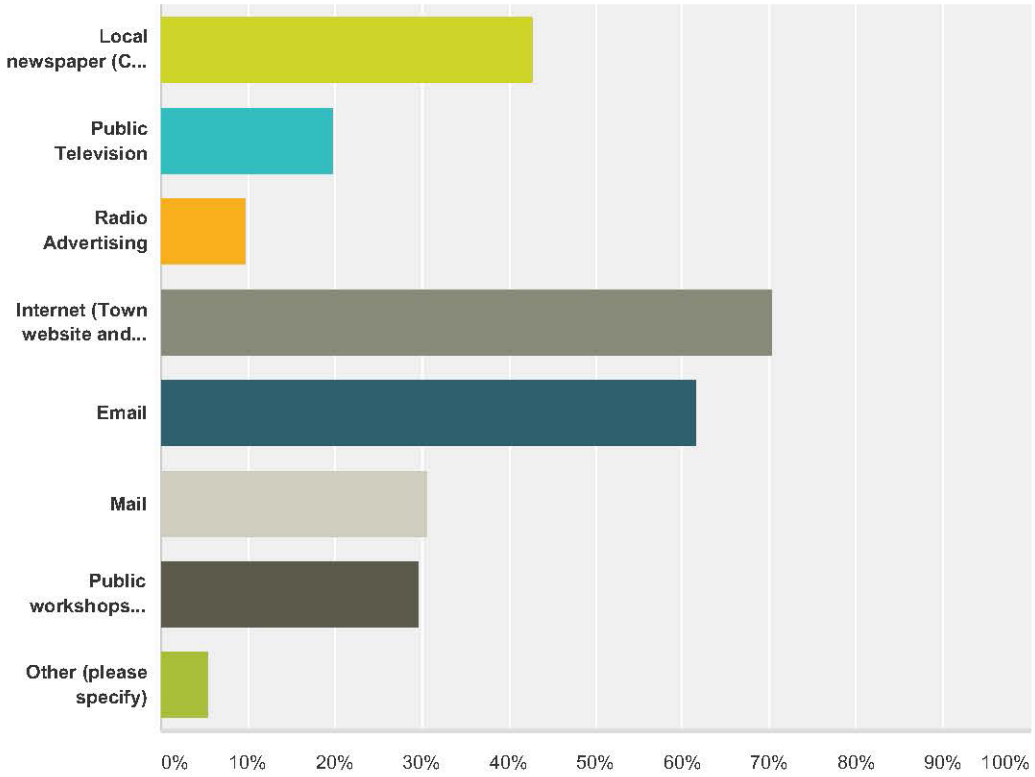


Chapter 1: Public Survey Results

Public Survey for the Bourne Hazard Mitigation Plan

Q6 What is the most effective way to engage you in hazard planning and emergency preparedness activities? You can select more than 1 answer.

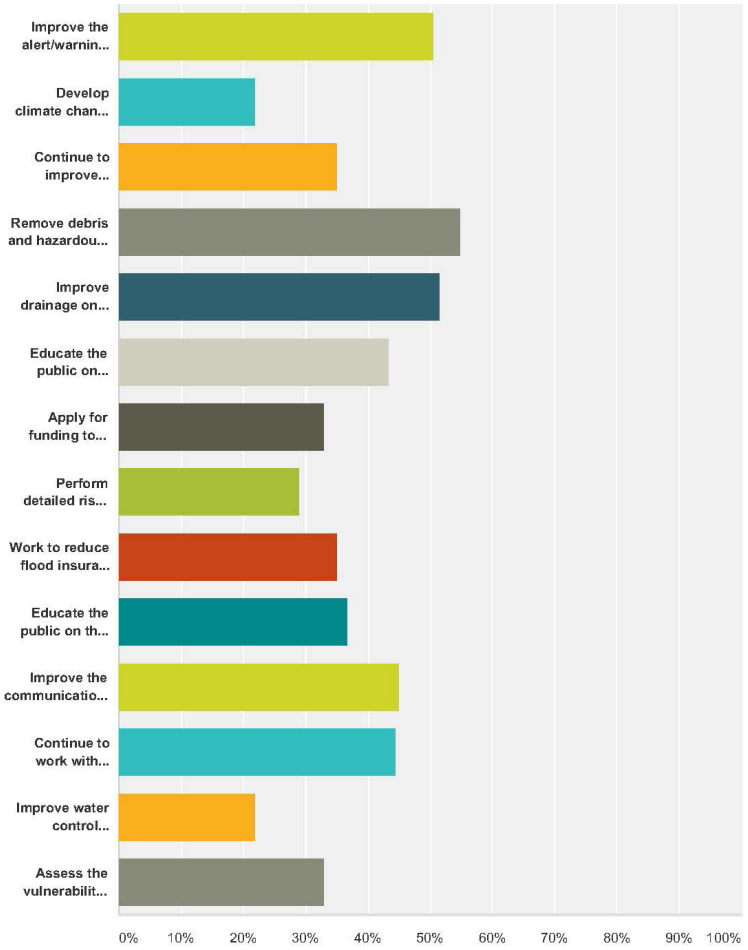
Answered: 182 Skipped: 13



Public Survey for the Bourne Hazard Mitigation Plan

Q7 What steps can your local government take to reduce risk from natural hazards and protect the buildings and people of Bourne? Please select more than 1 answer.

Answered: 182 Skipped: 13

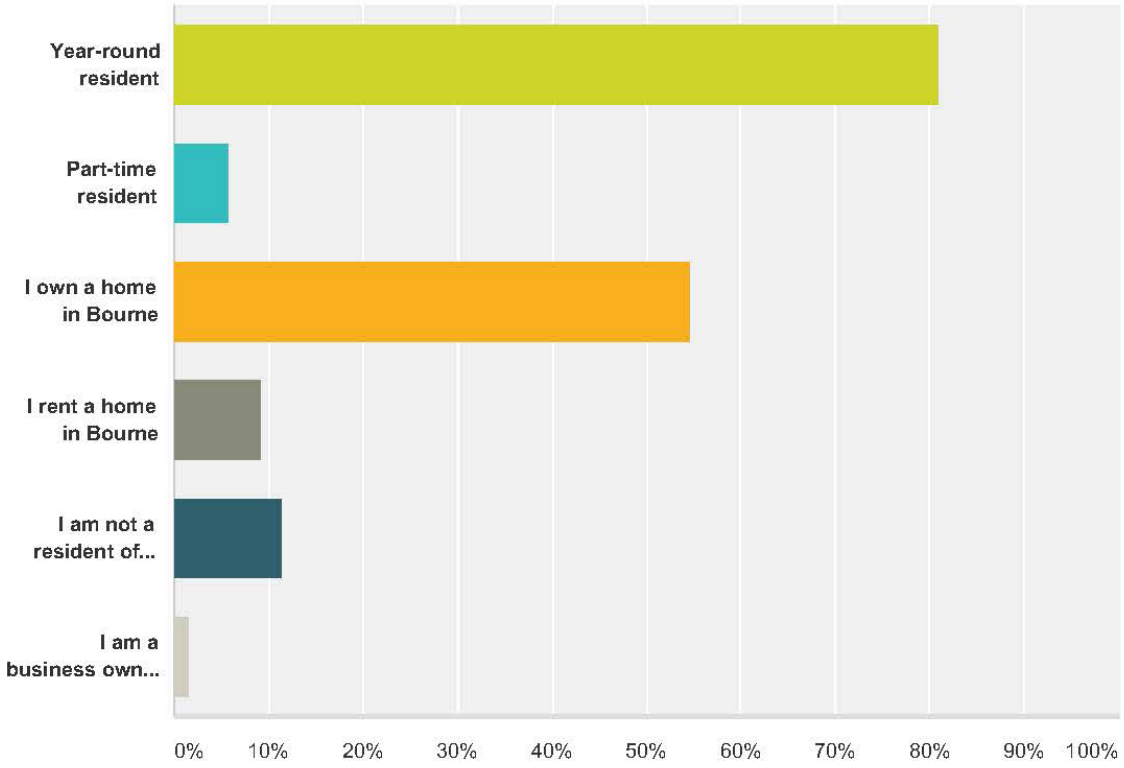


Chapter 1: Public Survey Results

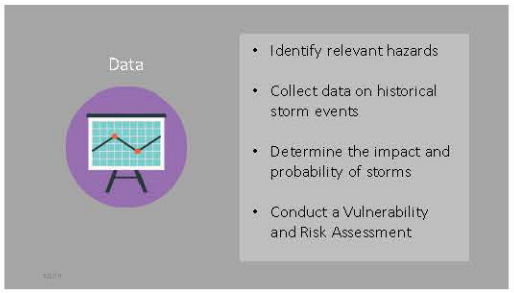
Public Survey for the Bourne Hazard Mitigation Plan

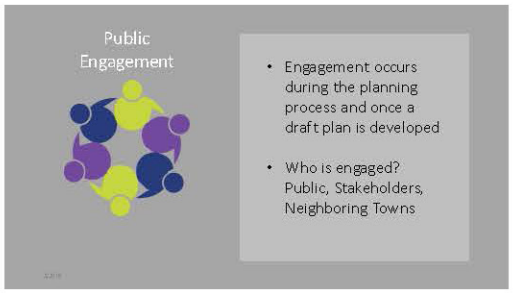
Q8 Please tell us about yourself. Select all that apply to you.

Answered: 174 Skipped: 21

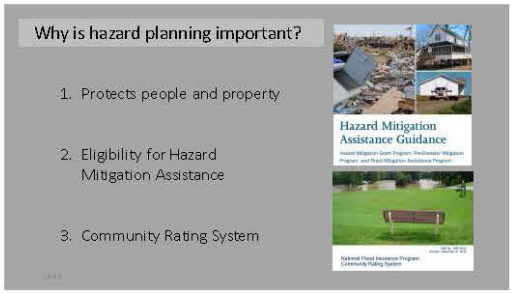


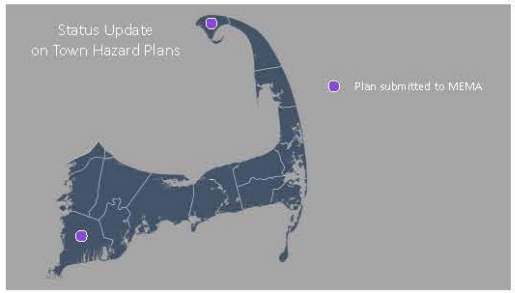
BCREPC Presentation





BCREPC Presentation





BCREPC Presentation

FEMA Requirement 201.6(b)(2):
Give neighboring communities the opportunity to be involved in hazard mitigation activities

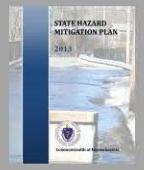
- A lot of towns are working on their plans!
- BCREPC meeting is a great opportunity to fulfill this requirement!
- Specifically, the towns would like to engage the BCREPC in the development of their hazard profiles

How is a Hazard Profile developed?

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

Review the natural hazards in the MA State Hazard Plan → Determine which natural hazards are relevant to the Town → Engage public stakeholders and neighbors

Town reviews the natural hazards in the MA State Hazard Plan

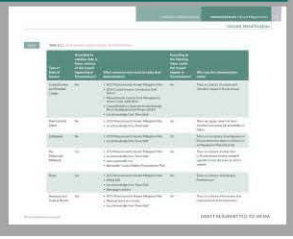


- Erosion + Shoreline Change
- Dam/Culvert Failure
- Earthquake
- Fire: Wildland and Urban
- Flood
- Hurricanes + Tropical Storms
- Landslide
- Nor'easters
- High Winds
- Thunderstorms
- Extreme Temperatures
- Tornadoes
- Drought
- Severe Winter Weather
- Tsunami
- Sea Level Rise

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

SurveyMonkey

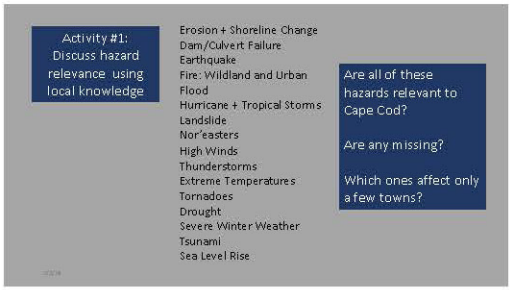
Seek the public input on:
- History and impact of storms in town
- Level of concern that a storm will occur again

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

BCREPC Presentation



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 Gaumond, 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.

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

BCREPC Meeting Notes

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

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.

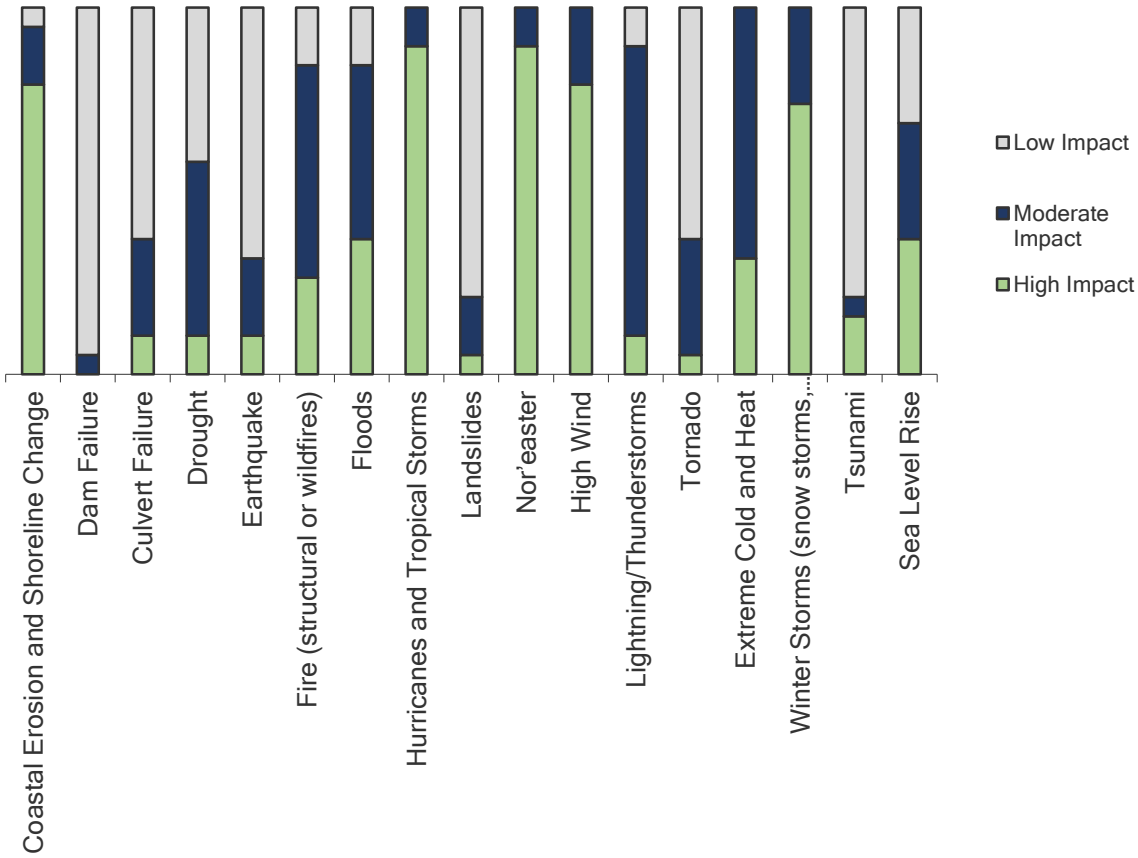
VII. Public Comments

None

VIII. Adjourn

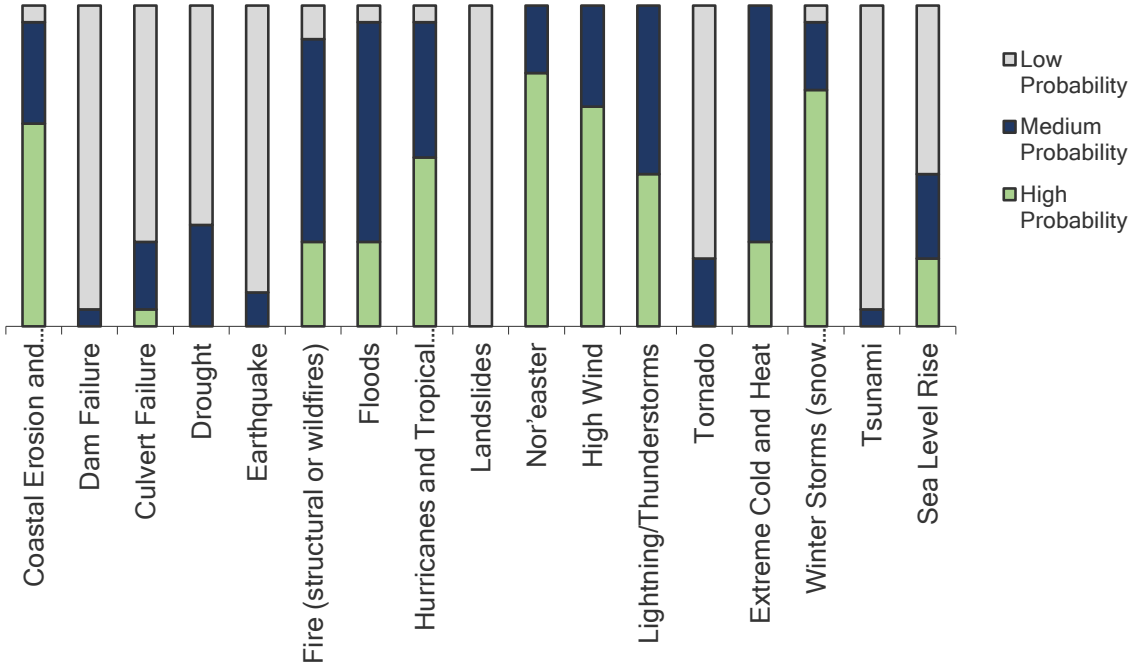
A motion for adjournment was made by Joe Gordon; seconded by Brian Gallant. The meeting was adjourned at 1445

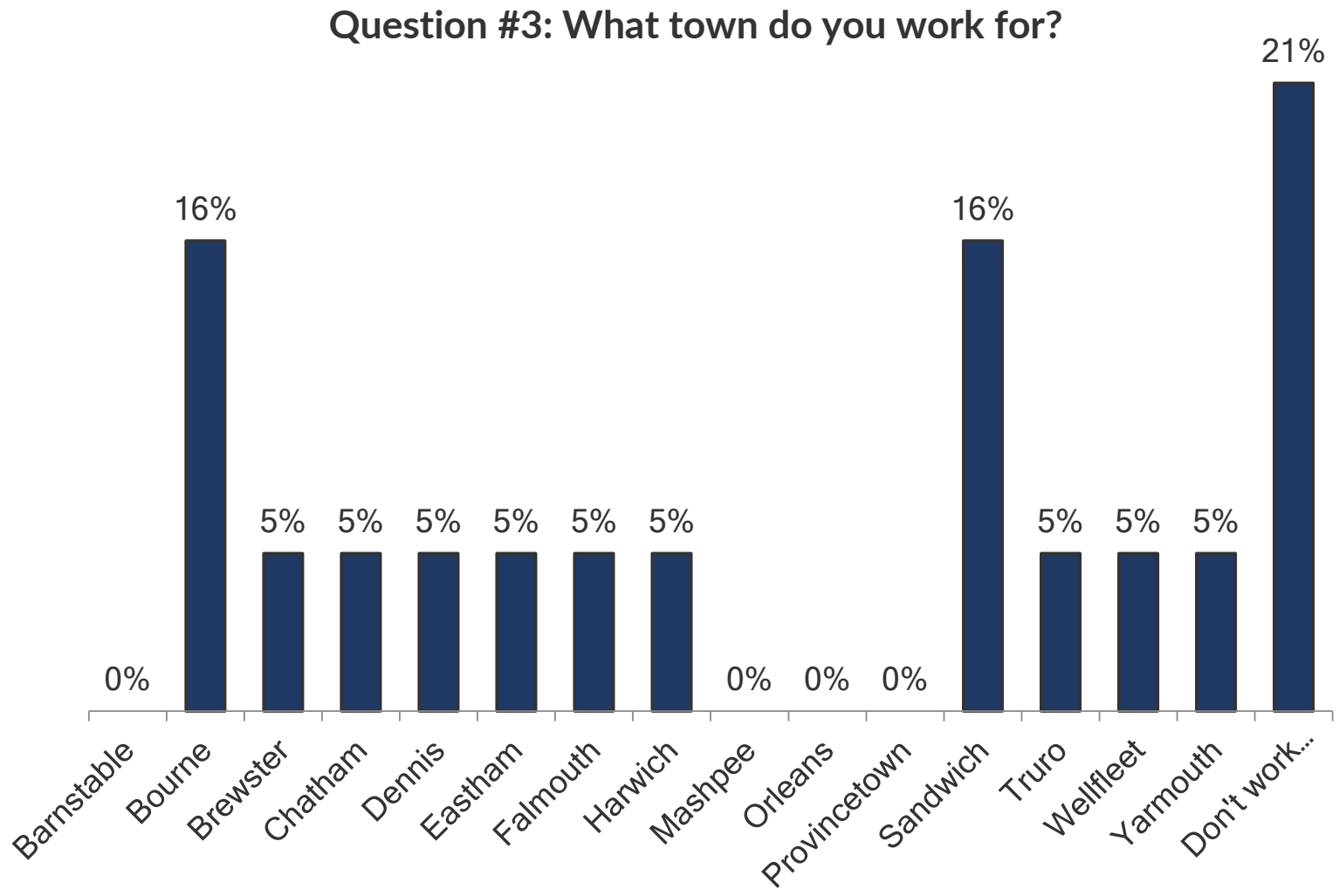
Question 1: For each hazard listed below, please identify if it will have a "low," "moderate" or "high" impact on Cape Cod. The towns would like you to use your local knowledge of Cape Cod. According to FEMA, impact is defined as the damage or consequence



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




Question #3: What town do you work for?
0%
16%
5%
5%
5%
5%
5%
5%
0%
0%
0%
16%
5%
5%
5%
21%
Barnstable
Bourne
Brewster
Chatham
Dennis
Eastham
Falmouth
Harwich
Mashpee
Orleans
Provincetown
Sandwich
Truro
Wellfleet
Yarmouth
Don't work...

Bourne 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