FUSS & O'NEILL

Town of Carver

2010 flooding on Holmes St. in Carver caused by two back-to-back 100-year storms

Hazard Mitigation Plan

2022

FUSS & O'NEILL

Project No. 1998 828 D12

Town of Carver
Hazard Mitigation Plan
Acknowledgements and Credits

This plan was prepared for the Town of Carver by Carver's Local Hazard Mitigation Planning Committee under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR).

Credits

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1 Introduction

Introduction and Purpose of the Plan

Carver is a rural community with great natural beauty. The landscape features cranberry bogs, natural wooded areas, and largely low-density residences. Over 50 percent of the town is wetlands. The New England weather means natural hazards are a fact of life in Carver with each season presenting its own challenge—heavy spring rains, summer droughts, early fall hurricanes, or winter snowstorms. The intersection of these natural hazards with the man-made environment can transform these routine events into natural disasters.

This plan examines natural hazards facing the Town of Carver, assesses vulnerabilities of the area's residents and businesses, and makes recommendations on ways to mitigate the negative effects of typical natural hazards. The effort has drawn from the local knowledge of a group of officials and residents; the recommendations presented are meant to be realistic and effective steps for mitigating natural hazards. Ultimately it is hoped that these actions will translate into savings – fewer lives lost, less property destroyed, and minimal disruption to essential services.

Timeline

On June 15, 2021 the Carver Board of Selectmen invited individuals to join the Hazard Mitigation Plan Committee and charged them with updating Carver's 2016 Hazard Mitigation Plan (HMP). A list of Committee members is provided above. The group included representatives from: Emergency Management, the Select Board, the Assessor's Board, Operations and Maintenance, Conservation, and Planning. The group held five working meetings to discuss and update the plan—July 1, 2021, August 5, 2021, September 2, 2021, October 7, 2021, and November 4, 2021. Each member was assigned research or portions of the Plan for development at each meeting.

At our kickoff meeting, held on July 1, 2021, the Committee reviewed the Hazard Mitigation Plan (HMP) process and necessary steps, discussed the public outreach strategy, reviewed the state hazard list and data requirements, and assigned members with various tasks, mostly gathering data, to complete prior to the next meeting. Minutes which were created based on the agendas can be found in Appendix B.

At our first working meeting, held on August 5, 2021, we refined the critical facilities list, confirmed the hazards to be included in the HMP, reviewed the main sources of data to cite in the plan, made a plan to acquire any additional data, and finalized the public survey questions. Tom Walsh was assigned with distributing paper copies of the survey to several locations while several other committee members were tasked with posting the link to the survey in various places online.

From August 8, 2021 through August 23, 2021 our public survey was open. The survey was posted on the Town website and Facebook page. Hard copies were also made available at the Town Hall, Fire Department Central Dispatch, Library, and the clubhouses at several mobile home communities in Town: Cranberry Village, South Meadow Village, and Water View Village. The public survey and summarized survey responses can be found in Appendix B.

At our second working meeting, held on September 2, 2021, the committee reviewed public survey results, finalized critical facilities list, which can be found in Appendix C, updated the vulnerability assessment chart, and reviewed 2016 mitigation actions and goals.

During the third working meeting, held on October 7, 2021, we reviewed hazard data and maps, looked over the draft quantitative vulnerability assessment, conducted a qualitative vulnerability assessment, finalized our hazard rankings, and began a discussion regarding goals of the plan. We also focused on preparation of our upcoming public presentation on October 26, 2021.

The Hazard Mitigation Committee held our public presentation on October 26, 2021, at Town Hall in order to inform the residents of Carver about the Hazard Mitigation Plan, progress to-date, and to invite public comment. The public presentation was posted in accordance with appropriate Open Meeting Laws.[1] A flyer was created to help advertise the public presentation. The flyer was posted in several locations online, including several Facebook pages and in a few spots on the town website. Outreach documentation in the form of public announcements on the Carver town website and Facebook for both the public presentation and the survey can be found in the Appendix B. The Public Presentation Agenda can also be found in Appendix B. Only one member of the public came to the meeting and no public comments were made. The presentation was recorded by Area 58, the community access cable TV program, and the slides were posted on the Town website.

The fourth and final working meeting, held on November 4, 2021, we reviewed goals and confirmed the status of 2016 actions again. We then spent most of the meeting reviewing actions and details for the 2021 plan and determining prioritization of those actions. The Grant Funding Sources chart (Appendix C) was used to help determine which grants the Town of Carver could apply for in order to fund these mitigation projects.

A full draft version of the HMP was circulated to the committee members on December 3, 2021 to solicit feedback and comments. The committee had two weeks to review the draft report, and comments and feedback were due to the consultants by December 17, 2021.

Revisions were made to the HMP and an updated draft of the HMP was posted to the Town website on January 10, 2022. This public comment period was closed on January 21, 2022.

The HMP was finalized and submitted to MEMA on February 4, 2022. The certificate of adoption can be found in Appendix D.

Development and Update of the Plan

Carver's 2016 Hazard Mitigation Plan was used as a template to update the current plan. Several other state and town documents were used to support this iteration of the plan including the Town of Carver Open Space & Recreation Plan (2010-2015), the Town of Carver Master Plan (2017), the Community Resilience Building Workshop Summary of Findings (2018), the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2018), the Climate Change Water Resource Vulnerability and Adaptation Strategy Assessment – Integrated Management Plan (2019), and the Massachusetts Drought Management Plan (2019). The FEMA Local Mitigation Plan Review Guide and FEMA Local Mitigation Plan Review Tool (Appendix A) were both used as guides in the development of this plan.

[1] Massachusetts General Law Chapter 30A, Section 20.

Each chapter from the 2016 plan was updated to reflect current conditions in Carver. All data and statistics in Chapter Two, "Profile of the Community and Existing Mitigation," were updated with special emphasis on the impacts of population growth on the town's ecosystems such as wetlands and the potential that these impacts must create other damaging consequences.

Chapter Three, "Hazard Identification and Risk Assessment," was reviewed by the committee and all data and references were brought up to date. Substantial changes were made to the organization of the hazards as we modeled the natural hazards in Carver after those listed in the 2018 Massachusetts State Hazard Mitigation Plan. Other severe weather was a new category used in the state plan and in this plan, it was used to group wind, excessive precipitation, and thunderstorms. These hazards were, however, ranked separately due to their vast differences. Wind was previously described in the Tornado hazard section but was moved to the Other Severe Weather hazard due to the notable differences between frequencies of strong winds and tornadoes in Carver. Thunderstorms were also grouped with the Other Severe Weather hazard. Excessive precipitation was created as a hazard under Other Severe Weather due to its frequency in Carver and its interconnected nature, serving as a common thread between many hazards. We felt it important to discuss excessive precipitation separately. Dam Failure was changed to Dam/Culvert Failure to reflect the broad category more accurately it encompasses. The Extreme temperature hazard was updated to read Average/Extreme Temperatures in accordance with the Massachusetts State Hazard Mitigation Plan. The state plan included Severe Winter Storms as a hazard. Nor'easters, snow and blizzards, ice storms, and ice jams were previously independent hazards that were grouped and ranked under the severe winter storm hazard to align with the state plan. Flash floods were also removed as an independent hazard and referred to in the flooding, excess precipitation, and ice jam sections. To mirror the state plan, the flood hazard was split into two separate hazards for ranking purposes. Coastal flooding and coastal erosion were two hazards included in the most recent state hazard mitigation plan but were largely excluded from Carver's plan because Carver is not a coastal town. Due to additional data, landslides were described and ranked in the current Hazard Mitigation Plan. Invasive species were listed as a hazard in the state plan and were added to Carver's Hazard Mitigation Plan for the first time this year.

The Hazard Vulnerability Analysis chart was reviewed and updated by the Hazard Mitigation Committee given the new data collected since the previous hazard mitigation plan from 2016. All members agreed with the frequency, severity, area of impact, and occurrence as outlined in Table 3-1.

The "Existing Protection Matrix" chart, that previously made up the entirety of Chapter Four, was reviewed and updated. Each member of the Hazard Mitigation Committee reviewed categories of the matrix that were appropriate to their departmental responsibilities and made any updated comments. Reference of this chart was moved to Chapter Five where it fit better and the chart itself was moved to Appendix C. Chapter Four "Vulnerability Assessment" describes the quantitative and qualitative vulnerability assessment exercises conducted to capture as much data as possible on the vulnerability of Carver's critical facilities to natural hazards.

Chapter Five, "Mitigation Measures," lists the Town's mitigation goals, and was updated to reflect efforts that have been made since 2016, to outline the currently proposed mitigation actions, and to describe the prioritization method used to rank those proposed mitigation actions. The Status of Proposed Mitigation Actions from the 2016 Hazard Mitigation Plan, Current Proposed Mitigation Actions, and the Mitigation Action Prioritization Table are all included in Appendix C.

Chapter Six, "Monitoring, Evaluation, and Update of Plan," was also updated, discussing the processes of monitoring, evaluation, and updating the 2016 Hazard Mitigation Plan and of incorporating this Plan with other local plans and continuing to engage public awareness of disasters and preparedness.

2 Profile of the Community and Existing Mitigation

Geography, Geology, Topography, and Climate

The Town of Carver is located in southeastern Massachusetts and is bordered by Middleborough on the west, Plympton on the north, Kingston on the northeast, Plymouth on the east, and Wareham on the south. Carver is 40 miles southeast of Boston and 39 miles east of Providence, Rhode Island. It has a total land area of 39.47 square miles.

Geologists classify the southeastern Massachusetts area as part of the Northeast Coastal Lowlands/Coastal Plain region. The area is characterized by the conditions created over 12,000 years ago when massive glaciers receded. These characteristics include low hills; highly porous soils; deposits of sand and gravel; multiple swamps, lakes, rivers, and ponds; and a high-water table. The glaciers left behind glacial till that contains thick deposits of both sand and gravel, lying over bedrock. There are occasionally boulders, known as glacial erratics, of different rock types that were carried from northern regions and left behind as the glaciers receded. Carver has rolling hills with elevation changes from 50 to 150 feet above sea level.

About half of the town is covered with wetlands, and surface waters that form an intricate network protecting and feeding the Plymouth/Carver Sole Source Aquifer that provides drinking water for the whole town and six neighboring communities. The Winnetuxet, Wankinco, and Weweantic Rivers are in Carver, as are many smaller brooks and several major ponds: Sampson's Pond, Atwood Reservoir, Muddy Pond, Wenham Pond, Dunham Pond, Federal Pond, John's Pond, Barrett's Pond, Raccoon Pond, Golden Field Pond, Fresh Meadow Pond, Ward Pond, Clear Pond, and Cooper's Pond. In total there are 39 ponds and reservoirs in Carver. The Great South Meadow Cedar Swamp, an area within the floodplain, covers a total of approximately 600 acres.

Within Carver there are 2,200 acres of the 14,000 acre Myles-Standish State Forest and the Carver State Forest. In addition, the Rocky Gutter Wildlife Management Area is located directly across the southwestern town border in Middleborough. Most of the forest soils are sandy, droughty, and excessively well-drained, with little organic matter. Myles Standish has a history of significant and devastating wildfires. Recent construction has increased the risk by placing homes within highly-flammable, vegetated areas in a town largely without a public water supply available. The Carver Fire Department reports that during the past 35 years there have been numerous fires around Myles Standish ranging from 100 acres up to 1,000 acres. Carver is one of three local fire departments, including Plymouth and Wareham, that are responsible for combating fires in Myles Standish State Forest.

Carver is distinguished by having the most dams of all the communities within the Southeastern Regional Planning and Economic Development District (SRPEDD) region—a total of 56 covered by the Office of Dam Safety. Many of these facilities are smaller dams (or flumes) associated with the cranberry industry and are used to manage water supply relative to cranberry growing and harvesting.

The Office of Dam Safety (ODS), a division of the Department of Conservation Recreation (DCR), under the Executive Office of Energy and Environmental Affairs, has jurisdictional authority over dams that meet the following criteria: dam structure six feet or higher, or impoundment of 15 acre-feet or more, or a significant downstream hazard as determined by staff review (e.g. campground, densely-developed area, major thoroughfare, etc.). For reference, one acre-foot is the amount of water that fills one acre of land to a depth of

one foot, so one acre-foot is roughly 326,700 gallons of water.[2] This jurisdictional authority includes state, municipal, and privately-owned dams but exemptions exist for certain barriers and pertinent works used in agriculture.

Dam owners, either public or private entities, are responsible to comply with dam safety regulations, including dam registration, arranging required dam safety inspections, and preparing and updating emergency action plans, including dam breach inundation mapping when required by the ODS. Dam owners are responsible for the operation and maintenance of their dam. Dam owners have exposure to liability for the water stored behind the dam should the water be released through operational error or an unintended dam breach that releases water downstream.

Dam failures can result in a release of water that inundates the downstream area, potentially causing loss of life, property damage, and disruption to important public utilities, highways, or other important facilities. This risk to town assets and infrastructure may occur within the area downstream of a dam within Carver or dams located outside of town, with breach limits that may extend into Carver.

Massachusetts in general has a humid climate with temperatures that average 68 to 72 degrees in the summer and about 28 to 32 degrees in the winter. Average July temperatures in Plymouth County generally sit between 61 and 81 degrees Fahrenheit while average January temperatures sit between 22 and 40 degrees Fahrenheit.[3]

The normal annual precipitation in Plymouth County is 48 inches. The growing season, from the last killing frost in the spring to the first killing frost in the fall, runs between 180 – 200 days. The area is subject to a variety of severe weather events: hurricanes, Nor'easters, thunderstorms, blizzards, tornadoes, drought, and more. Weather, climate, and natural hazards Carver experiences are described in Chapter 4 in more detail.

Population Characteristics and Political Structure

The 2020 Census, provided by the United States Census Bureau, indicates that Carver has a total population of roughly 11,645.[4] With a land area of 39.78 square miles the average population density is 293 persons per square mile. A swath of the northern part of Carver along with a small area in the southern part are classified by the Census as urbanized; the majority of the land area is developed as a low-density rural/agricultural community. The population can be broken down by ages in the following manner: 5.0% under 5 years; 16.2% between 5 and 19 years old; 41.0% between 20 and 64 years old; and 19.8% 65 years or older.

Carver experienced a massive boom in population between 1980-1990, but growth over the following two decades has slowed significantly (see Figure 2-1). Shorter term, over the course of the last five years, residential development has continued at a similar pace from between 2011 to 2016. In addition to increased housing stock population growth leads to construction of new roadways and commercial development. Continued urban sprawl results in the conversion of agricultural land and woodland areas to include impervious cover. This, in turn, cause more stormwater run-off and road run-off and can affect the quality and quantity of our groundwater. Less groundwater recharge due to more and more impervious surfacing can negatively impact the ability of a fire department to access water for fire suppression, especially in a town such as Carver where

[2] http://montecitowater.com/how_many_gallons_of_water_in_a_c.htm
[3] https://weatherspark.com/m/26829/1/Average-Weather-in-January-in-Plymouth-Massachusetts-United-States#Figures-Temperature
[4] United States Census Bureau, Census.gov
https://www.census.gov/quickfacts/fact/table/carvertownplymouthcountymassachusetts,US/PST045221

the Fire Department depends on local ponds (that are largely groundwater-fed) and reservoirs for its fire suppression water supply. Less groundwater recharge can also lead to vegetation drying and becoming more susceptible to wildfire. Impervious surfaces can also affect the ability of natural ecosystems such as wetlands to perform their functions, one of which is flood prevention through flood storage. Too many impervious surfaces too near to wetlands can overwhelm these sensitive systems. The more wetlands that stop functioning properly or are filled for development, the less the remaining wetlands systems will be able to perform their disaster-mitigating functions. In addition, development encroaching on the fringes of state forestland continues to increase the risk for wildfires. Increased development has increased Carver's vulnerability to many hazards.

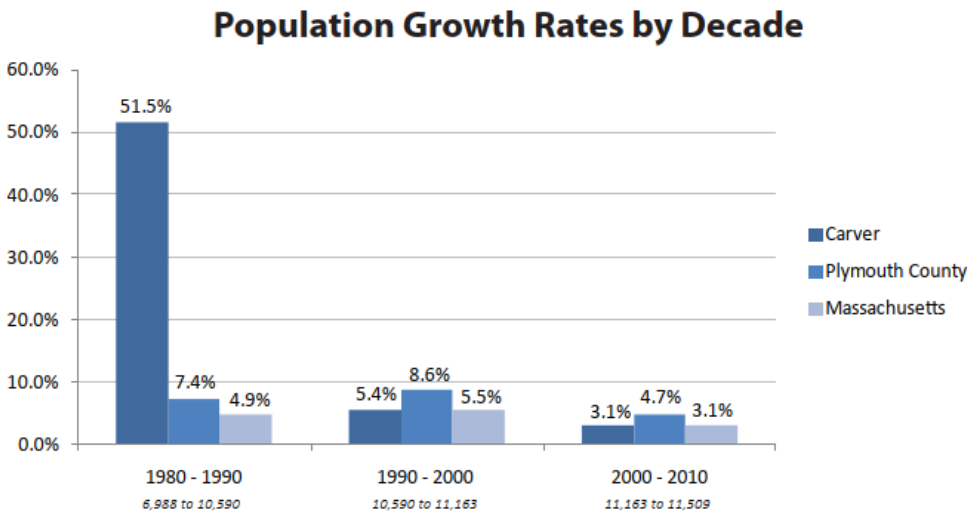


Figure 2.1. Carver Population Growth Rates by Decade
Source: Town of Carver Master Plan (2017)[5]

Figure 2.1 indicates census population figures and growth projections prepared by the Southeastern Regional Planning and Economic Development District (SRPEDD) & MassHighway. Consistent with national trends, Carver has seen a steady increase in the absolute number of residents who are over 65 years of age. This is a trend that is expected to continue as the "baby-boomer" generation ages. The number of residents over the age of 65 has increased from 510 in 1980 to 1,396 in 1990, 1,650 in 2000, 1,911 in 2010, and 2,306 in 2020. From 2010 to 2020, this segment of the population increased from 16.6% of the total Carver population to 19.8%. This population generally has a higher incidence of special needs for emergency response—due to health afflictions and mobility restrictions—although overall this population is a healthier and more active group than they were thirty years ago. The Federal Administration on Aging notes the following as reasons the elderly are more vulnerable to disasters:

- ✓ They have difficulty getting assistance due to progressive physical and mental impairments and other frailties that accompany aging;
- ✓ They are slower to fill out forms for disaster notification and/or disaster relief assistance;
- ✓ They are often at higher post-disaster nutritional risk and medication risk;
- ✓ They are often targeted by fraudulent contractors; and
- ✓ They may be susceptible to abuse as overall family stress levels increase in the later stages of a disaster.[6]

[5] Town of Carver Master Plan https://srpedd.s3.amazonaws.com/wp-content/uploads/2020/07/13213443/Carver-Master-Plan-022817.pdf
[6]"Disaster Preparedness for Older Americans", 2002. Business Publishers, Inc.: Silver Spring, MD, p.1. See also American Journal of Geriatric Psychiatry. 2009 Nov, 17(11):916-24. "AAGP position statement: disaster preparedness for older Americans: critical issues for the preservation of mental health." Sakauye, K. M., et al.

Other vulnerable populations are youth and the disabled. Youth are vulnerable due to their need for supervision and guidance in times of emergency—especially groups of children under the care of a limited number of adults. This is best assessed at the local level through critical facilities identification of childcare centers and schools. There are thirty-eight critical facilities in Carver. These facilities were broken out into two tiers. Tiers 1 facilities are needed to remain functional during a disaster and are essential to hazard response. Tier 2 facilities will need additional support and attention from the Town during and after natural disasters. There are twenty-four critical facilities that were designated Tier 1 facilities, including: emergency response buildings, schools/shelters, densely populated residential areas, public water resources, and communications facilities. There are also fourteen critical facilities that were designated Tier 2 facilities, including: daycare centers, animal shelters, and buildings storing hazardous materials. A list of these critical 'facilities can be found in Appendix C.

The 2000 Census represented the first time that data on the disabled was collected. The Census allowed respondents to select one or more of the following disabilities of various types:

-hearing difficulty
-vision difficulty
-cognitive difficulty
-ambulatory difficulty
-self-care difficulty
-independent living difficulty[7]

According to the 2019 American Community Survey, 1,387 people, or roughly 11.8% of respondents in Carver, indicated that they are living with at least one disability.[8] Due to the ability to select more than one category, this translates into a smaller number of residents. In the Public Opinion Survey (see Appendix B), we distributed to solicit public feedback about feelings about and responses to natural hazards, three of the 129 respondents (just over 2%) indicated they had access or functional needs. The special circumstances of the disabled population that may affect disaster response include:

- ✓ the visually impaired are reluctant to leave familiar surroundings;
- ✓ those with cognitive impairments may not understand, may become confused, and may need additional assistance;
- ✓ guide dogs and other assistance animals may become disoriented in a disaster;
- ✓ proper transport techniques are required to bring people to safety;
- ✓ many respiratory illnesses are aggravated by stress;
- ✓ medically dependent individuals may not be able to communicate their needs; and
- ✓ helpful or lifesaving devices may not function in power outages
- ✓ all temporary shelters must meet accessibility standards.

The governing body of Carver is a five-member elected Select Board, with the legislative body being Town Meeting. The Planning Board and Board of Health are elected positions. The Select Board hires a Town Administrator. The Town has an Emergency Management Director, Conservation Agent, Building Commissioner, Health Agent, DPW Director, and Director of Planning & Community Development (currently vacant as of January 2022).

[7] SRPEDD Regional Natural Hazard Disaster Mitigation Plan https://srpedd.s3.amazonaws.com/wp-content/uploads/2019/10/13215353/Pre-Disaster-Mitigation-Regional-Plan-092204.pdf
[8] United States Census Bureau, Census.gov
https://data.census.gov/cedsci/table?q=carver%20massachusetts&t=Disability&y=2019&tid=ACSST5Y2019.S1810

Transportation Network

Carver has a total of 104.68 miles of roadway and 10.1 miles of sidewalks.[9] Route 58/Main Street acts as the only major north/south route and Route 44 serves as the major east/west route. The Myles Standish Forest, in the southeastern area of town, serves as a barrier to through travel. In Plymouth County, 6.7% of bridges are structurally deficient.[10] The bridge at Rochester Road, which was previously considered functionally obsolete, has been fixed since the previous hazard mitigation plan in 2016.[11] Carver does not currently have any bridges classified by MassHighway as functionally obsolete or structurally deficient.[12]

The re-location of Route 44 in Carver was completed in December of 2005 and has improved the connection between Carver and Route 3. This project included an upgrade of the drainage system along existing stretches of the highway from an open ditch system to a closed treatment system.

Table 2-1. Types of Roads in Carver
Source: Mass.gov Road Inventory Report 2020[13]

Miles of Roadway	Interstate	Arterial	Collector	Local	Total
Centerline miles	0	24.44	3.84	76.40	104.68

Carver does not have a dedicated fixed route public transportation system (buses that arrive at scheduled intervals or a rail service); its only existing transit service is demand response public transportation (Dial-A-Ride) provided by the Greater Attleboro-Taunton Regional Transit Authority (GATRA) and operated by the Carver Council on Aging (COA).[14]

[9] https://srpedd.org/community/carver/
[10] https://www.washingtonpost.com/graphics/national/structurally-deficient-bridges/#25023
[11] https://www.wickedlocal.com/story/carver-reporter/2020/07/24/ride-new-rochester-road-bridge-in-carver/114693876/
[12] MASS DOT Bridges https://geo-massdot.opendata.arcgis.com/datasets/bridges/explore?filters=eyJUb3duIjpbIkNhcnZlciJdfQ%3D%3D&location=41.868798%2C-70.809817%2C12.00&showTable=true
[13] https://www.mass.gov/doc/2020-road-inventory-year-end-report/download
[14] Carver Master Plan 2017 https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/carver-master-plan-022817_1.pdf

Land Use: Housing, Commerce, Industry, and Agriculture

The 2017 Carver Master Plan indicates the following breakdown of land uses for 25,422 total acres of Carver:

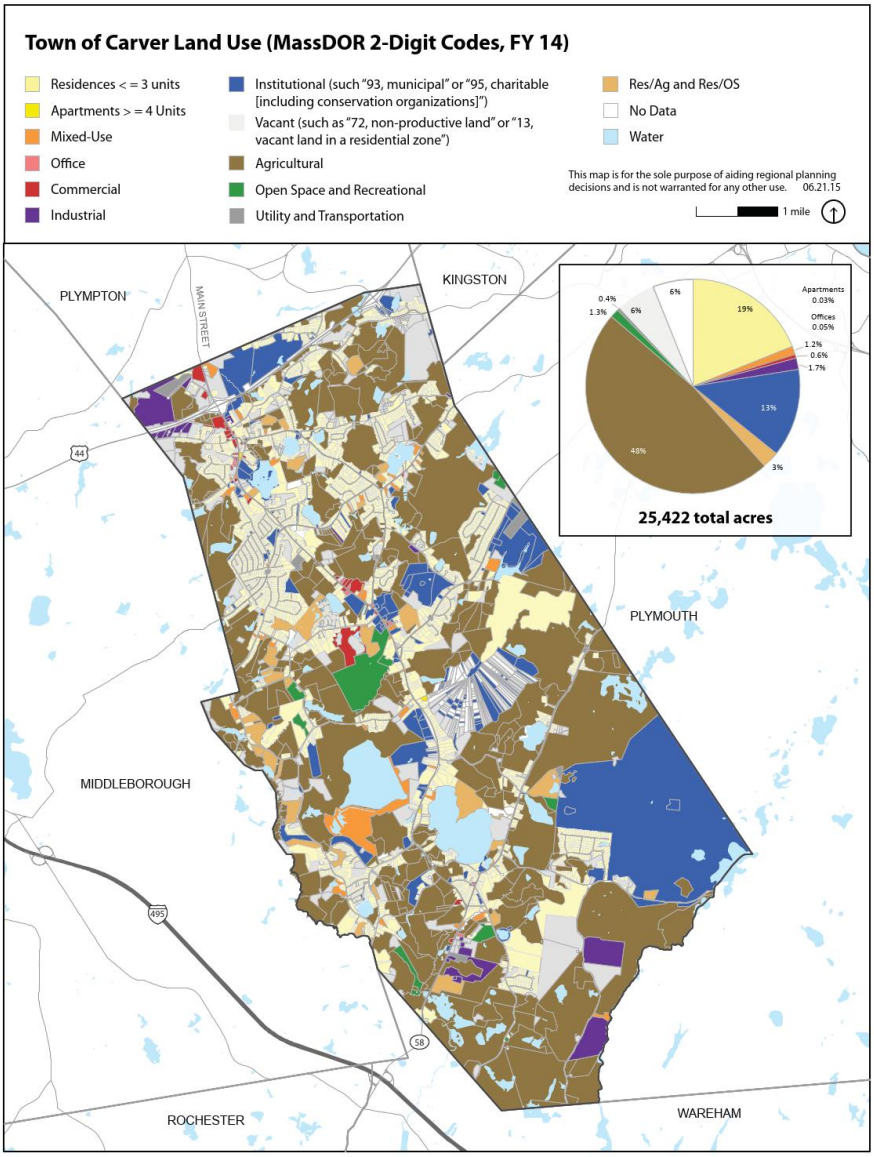


Figure 2-2. Carver Land Use
Source: Town of Carver Master Plan (2017)[15]

Residential growth has been steady. Between 2017 and 2021, 121 residential building permits were issued, an average of 24 per year. Carver has a development by-law that limits building permits to 30 per year. This is to

[15] Town of Carver Master Plan, 2017, p. 11 https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/carver-master-plan-022817_1.pdf

ensure that, due to Carver's environmental constraints—our sole source aquifer, our wetlands, and our sandy, permeable soils that are easily contaminated—housing is built at a more gradual rate than elsewhere and with protection of these resources in mind.

There are three village district areas in Carver: North Carver, Center Carver, and South Carver. According to the 2017 Master Plan, Carver's housing stock is primarily single-family homes (69%), and secondarily semi-permanent manufactured/mobile homes (26%). Most manufactured homes are age-restricted (55 years-old and older). Most housing (72%) was built during Carver's 1970-1999 population boom.[16]

Table 2-2. Mobile Home Communities in Carver, MA

Mobile Home Park	Approx. Number of Units
South Meadow Village	522
Cranberry Village	279
Pine Tree Village	186
Meadow Woods	64
Waterview Village	67

The five mobile home parks (Table 2-X) are a concern because four of these five mobile home parks, excluding Pine Tree Village, are specifically geared toward individuals over the age of 55. In addition to housing many elderly residents, the parks are also located in forested areas. The Carver Fire Department notes that "the nature of these housing units, the age of the occupants, and the surrounding fuel source for fires are a deadly combination." The Carver MVP Community Resilience Building Workshop Summary of Findings also notes that these residents may need additional support to deal with extreme temperatures or storms.[17]

There are two private campgrounds in Carver: Pinewood Way with 100 sites and Yogi Bear's Jellystone Park™ Camp-Resort Cranberry Acres with 280 sites. The Emergency Management Director coordinates evacuations with the campground directors.

National Flood Insurance Program Participation

Participation in the National Flood Insurance Program (NFIP) is voluntary for communities and is based on an agreement between each participating community and FEMA. The Town of Carver has been a participant in the NFIP since 1985. Participating in the NFIP has three basic aspects that are discussed on the next page.

Flood plain identification and mapping

NFIP participation requires community adoption of a floodplain bylaw. Carver's floodplain bylaw was adopted and became effective on December 31, 2009. Draft maps of Carver's new floodplain were also received in 2009 and the recommended action was that the Town adopt these maps when they are finalized by the state. Mapping flood hazards creates broad-based awareness of the flood hazards and provides the data needed for our community to effectively administer a floodplain management program. The Town of Carver passed articles on its 2012 Annual Town Meeting Warrant that adopted the maps that have been finalized by the state to date.

[16] Town of Carver Master Plan, 2017, p. 14
[17] Town of Carver, Community Resilience Building Workshop Summary of Findings, 2018

The flood maps can be viewed by the public and are located in the Conservation Department located at the Carver Town Hall and on Carver's website at www.carverma.org under the Conservation Department. Maps can also be accessed from FEMA's website at http://msc.fema.gov/. In June 2012, the Town submitted its certified 2012 flood plain bylaws that were adopted at its 2012 Town Meeting to the Department of Conservation and Recreation (DCR). In an e-mail of June 21, 2012, Colleen Bailey at DCR advised Sarah Hewins, our former Conservation Agent, that Bailey had received these certified bylaws and was entering Carver into FEMA's system for approval on their end. Our former Conservation Agent, Hewins, also converted the FEMA mapping abbreviations to a decoded legend and produced flood plain maps for North Carver, Center Carver, and South Carver.

Floodplain management

Floodplain management can be defined as a community program of corrective and preventative measures for reducing flood damage. The program is led by the Town's Conservation Agent and aided by the Building Commissioner, Town Planner, and Health Agent. These measures take a variety of forms and generally include requirements for wetlands and floodplain protection, zoning, subdivision or building, and special-purpose floodplain bylaw. In Massachusetts, a majority of the required regulations are covered under state laws that are enforced locally. Those regulations are as follows:

- Massachusetts State Building Code: 780 CMR 3107.0, "Flood Resistant Construction"
- Wetlands Protection Regulations: 310 CMR 10.00
- Inland Wetlands Regulations: 302 CMR 6.00
- Coastal Wetlands Regulations:302 CMR 4.00
- Minimum Requirements for Subsurface Disposal of Sanitary Sewage 310 CMR 15, Title 5

Carver's local floodplain management bylaw (Carver Zoning Bylaws; Section 3700) enforces minimum floodplain management regulations on new or improved structures and provides additional protection to natural resource areas and buffer zones. Carver passed this floodplain zoning at Town Meeting on May 19, 2009 and updated that bylaw in June 2012. In April of 2021, Carver amended the Zoning Bylaw, boosting floodplain protections.

As stated earlier, the Town participates in the NFIP. 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. As of 2021, the Town of Carver has 1 Repetitive Loss Property and no Severe Repetitive Loss (SRL) properties.

Insurance

Since Carver participates in the NFIP, property owners and renters residing anywhere in the community (not only in a special flood hazard area) are able to purchase insurance as a protection against flood losses.

Cultural and Historical Sites

Carver has two historic district areas, Lakenham Historic District and Savery Historic District, listed on the State Register of Historic Properties.[18] The historic cemeteries, churches, stonewalls, streets, rivers, cranberry bogs, are just a few of Carver's significant cultural and historical resources. Below is a list The Town of Carver Master Plan (2017) lists numerous additional historic sites and special places in town.[19]

Utilities

In Carver there is some localized municipal water, but no wastewater facilities. Each home or business must have its own private well water and septic system. Such a system is more vulnerable to power outages, as pumps in residential wells will not run without electricity. Individual homeowners would need generators to keep water running. All of Carver's shelters have back-up generators available to cover this need. There are several community well systems that serve groups of households in Carver, including:

- one in the center of town that services the Town Hall, Library, and an elderly and low-income housing complex.
- four additional community wells that service Mobile Home parks.
- three that serve condominium developments.

There is also a municipal water system in North Carver, called the North Carver Water District, that serves most businesses and some residents in a restricted area. Eversource is the provider of electricity and gas in Carver for a significant number of residents. Some, however, rely on private propane tanks. For medical emergencies, residents of Carver use the Beth Israel Deaconess Hospital in Plymouth or Tobey Hospital in Wareham.

Carver was located within the 10-mile emergency planning zone of the Pilgrim Nuclear Power Plant in Plymouth, MA. The Pilgrim Nuclear Power Plant shut down and permanently ceased producing energy on May 31, 2019. It is unknown exactly how long decommissioning and remediation of the site will take.[20]

[18] Carver Open Space and Recreation Plan, 2010-2015 p. 58 https://www.carverma.gov/planning-department/pages/open-space-and-recreation-plan
[19] Town of Carver Master Plan (2017) https://srpedd.s3.amazonaws.com/wp-content/uploads/2020/07/13213443/Carver-Master-Plan-022817.pdf
[20] https://www.wbur.org/news/2019/05/30/plymouth-nuclear-plant-decommissioning

Conclusions

The following general characteristics, drawn from this profile, are relevant to the design of a disaster mitigation strategy:

- Carver is a growing community, though population growth in Carver has slowed, it does still continue to grow, putting pressure on natural resources as development continues to expand.
- The substantial agriculture resources of Carver are at risk from natural hazards.
- The rural nature of the community makes communication more difficult.
- The town is located in the Pine Barrens area with highly flammable fire-dependent vegetation. The presence of a large state forest, abutting wildlife management area, and major undeveloped tracts make Carver more vulnerable to wildfires than other areas. New construction is occurring in areas vulnerable to wildfire and the Town lacks a town-wide public water supply. Most residents rely on private wells.
- High water table areas are subject to private well and basement flooding and flooding of drainage areas, as noted below in the flooding section.
- Mobile homes are particularly vulnerable to natural hazards and Carver has a sizeable number of mobile homes. Most of these mobile home communities are 55+ so it is assumed that much of this population is elderly.
- In general, Carver is a wet town – with swamps, bogs, ponds, streams, and rivers. Flooding can be an issue and can be exacerbated when natural vegetation debris collects in the many miles of connected waterways in the town. However, flooding of drainage basins, or retention ponds, is more likely to occur in neighborhoods with high water tables than flooding of Carver's natural waterways.

3 Hazard Identification and Risk Assessment

This chapter will discuss the natural hazards and evaluate the risk they pose residents, homes, and businesses. Each natural hazard is identified, defined, and profiled with information on the hazard's previous occurrences and extent, the probability of this hazard occurring in Carver, and the impact. Risk will be examined in terms of the likelihood of the natural hazard occurring; the frequency with which it impacts Carver; the severity of the potential impacts; and the geographic area that the natural hazard could affect. The "likelihood" or probability of an event occurring is determined by reviewing historical events and consulting expert opinion, while historical data and maps are used to evaluate the area that could be affected. Information on the development characteristics of Carver from the profile chapter is used to estimate the impacts of natural hazards on critical facilities, vulnerable populations, and infrastructure.

Potential Vulnerability to Future Natural Hazards

In Table 3-1 below, the areas with "X" indicate the likely level of frequency, severity, extent, and likelihood of occurrence of each hazard. Coastal erosion and coastal flooding are not historically hazards that have ever occurred in the Town of Carver and, therefore, were not analyzed. In this assessment, public infrastructure is defined as roads, bridges, trains, airports, public parks, etc. and essential services are utilities, hospitals, schools, etc. The following is a description of the criteria for each category.

Frequency Categorization

Very low: events that occur less frequently than once in 100 years (Less than 1% per year)
Low: events that occur from once in 50 years to once in 100 years (1% to 2% per year)
Medium: events that occur from once in 5 years to once in 50 years (2% to 20% per year)
High: events that occur more frequently than once in 5 years (Greater than 20% per year)

Severity Categorization

Minor: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
Serious: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.
Extensive: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
Catastrophic: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

Area of Impact *(extent of impact on any locality for a particular event)*

Isolated: a single whole or partial community impacted
Local: One community to several communities impacted
Regional: many communities to a county impacted
Widespread: multiple counties impacted

Area of Occurrence *(the areas and the size of the areas that are likely to experience this type of hazard in the future)*

Isolated: Scattered areas around the state can experience this hazard
Regional: Multiple communities and counties can experience this hazard
Statewide: The entire state can experience this hazard

Table 3-1. Hazard Vulnerability Analysis

	Frequency				Severity				Area of Impact				Area of Occurrence			Totals
	Very Low	Low	Medium	High	Minor	Serious	Extensive	Catastrophic	Isolated	Local	Regional	Widespread	Isolated	Regional	Statewide	
Hurricane/ Tropical Storm				4			3					4			X	11
Wind Other Severe Weather				4			3					4			X	11
Excessive Precipitation Other Severe Weather				4		2						4			X	10
Severe Winter Storm				4		2						4			X	10
Drought				4	1							4			X	9
Mosquito-borne Illness				4	1							4	X			9
Wildfire			3				3			2				X		8
Inland Flooding				4		2				2					X	8
Average/ Extreme Temperature			3		1							4			X	8
Thunderstorm Other Severe Weather				4		2				2					X	8
Dam/Culvert/ Flume Failure			3			2			1					X		6
Invasive Species				4	1				1				X			6
Tsunamis	1					2				2					X	5
Tornado		2			1				1						X	4
Earthquake		2			1				1						X	4
Landslides		2			1				1				X			3
Coastal Flooding	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Coastal Erosion	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3-2 below shows any previous federal/state disaster declarations that have occurred in Plymouth County since 1991 and that have affected the Town of Carver.

Table 3-2. Federal / State Disaster Declarations in Plymouth County Since 1991
Source: FEMA Disaster Declarations[21]

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 Projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 Projects)
December Blizzard (December 1992)	FEMA Public Assistance Project Grants	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk (7 Projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
May Windstorm (May 1996)	State Public Assistance Project Grants	Counties of Plymouth, Norfolk, Bristol (27 communities)

[21] https://www.fema.gov/disaster/declarations?field_dv2_state_territory_tribal_value=MA&field_year_value=All&field_dv2_declaration_type_value=All&field_dv2_incident_type_target_id_selective=All

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 Projects)
1997	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 Projects)
1998	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 Projects)
February Snowstorm (February 17-18, 2003)	FEMA Public Assistance Project Grants	All 14 Counties
December Snowstorm (2003)	FEMA Public Assistance Project Grants	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
October Flood (2005)	FEMA Individual Household Program FEMA Public Assistance Project Grants	All 14 Counties
May Rainstorm / Flood (2006)	Hazard Mitigation Grant Program	Statewide

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
April Nor'easter (April 15-27, 2007)	FEMA Public Assistance Project Grants Hazard Mitigation Grant Program	Barnstable, Berkshire, Dukes, Essex, Franklin, Hampden, Hampshire, Plymouth Statewide
Severe storm/ Flooding (December 2008)	FEMA Public Assistance Project Grants	All 14 Counties
Flooding (March 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loans	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Hurricane / Tropical Storm Irene (August 28, 2011)	FEMA Public Assistance	Statewide
Super Storm Sandy (October 29, 2012)	FEMA Public Assistance	Statewide
Blizzard (February 8-9, 2013)	Emergency Protective Measures and Debris Removal	Statewide
Severe winter storm/ snowstorm/ flooding (April 2013)	FEMA Public Assistance	All 14 Counties
Blizzard (January 26-28, 2015)	Emergency Protective Measures and Snow Removal	Statewide
Severe winter storm/ snowstorm/ flooding (April 2015)	FEMA Public Assistance	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm/ flooding (March 2018)	FEMA Public Assistance Hazard Mitigation Grant Program	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth

The Impact of Climate Change on Weather

The climate of Massachusetts is changing and has warmed by over 2 degrees (F) in the last century. Carbon dioxide and other greenhouse gasses in the atmosphere have greatly increased since the 1700s largely due to the burning of fossil fuels for energy and transportation. Greenhouse gasses trap heat that, in turn, warms the surface of the Earth, increasing evaporation, that increases humidity, average rainfall, and the frequency of heavy rainstorms in many places but contributes to drought in others. As a direct result of climate change, Massachusetts is projected to experience more frequent and intense storms, heavier spring downpours, higher precipitation in both the winter and the spring, drier and hotter summers, more intermittent droughts, increased inland and coastal flooding, sea level rise along the coast, and a reduction in snowfall.[22] Consequences of a changing climate include several health and safety issues including an increase in air pollution, allergens, vector-borne diseases, wildfires, temperature extremes, water quality issues, and mental health and stress-related disorders due to the overwhelming and destructive climate-related disasters.[23] In the coming years, these impacts are anticipated to continue and worsen.

The important takeaway is that climate change is causing more frequent and intense storms that have and will continue to affect the climate in Massachusetts. In order to be best prepared for the impacts of climate change in regard to this Hazard Mitigation Plan, we need to assume that most of the natural hazards we experience will worsen over time.

[22] What Climate Change Means for Massachusetts, US EPA, August 2016 https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ma.pdf

[23] Town of Plymouth Open Space and Recreation Plan Addendum Climate Change Resiliency, p.6 https://www.plymouth-ma.gov/sites/g/files/vyhlif3691/f/uploads/jan_11_2021_plan_final_0.pdf

Hurricanes and Tropical Storms

Tropical storms and hurricanes are fast-moving storm systems that rotate around areas of low pressure, producing strong winds, heavy rain, and storm surge.[24] When wind speeds reach 39 miles per hour, the storm is considered a tropical storm and when wind speeds reach 74 miles per hour, the storm is officially a hurricane.[25]

Hurricanes are measured using the Saffir-Simpson Hurricane Wind Scale, in Figure 3-1 below. This scale is a 1 to 5 rating based on a hurricane's maximum sustained wind speed. This scale does not take into account other dangerous hazards associated with hurricanes including storm surge, flooding caused by rainfall, and tornadoes. The Saffir-Simpson Hurricane Wind Scale estimates the potential for property damage. Though all hurricanes can produce dangerous wind speeds, hurricanes ranked in category 3 and above are considered major hurricanes. Major hurricanes can produce deadly storm surge, flooding caused by intense rains, and tornadoes, often requiring evacuations to keep individuals safe.

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.

Figure 3-1. Saffir-Simpson Hurricane Wind Scale
Source: NOAA National Hurricane Center and Central Pacific Hurricane Center[26]

A typical hurricane affects an area that is a few hundred miles wide with the strongest, hurricane-force winds within the middle 100-mile diameter.[27] When hurricanes come anywhere near Carver, due to their vast size and area of impact, the entire town is affected. According to NOAA's Historical Hurricane Tracks, only two hurricanes or tropical storms have ever made landfall in Carver – an unnamed tropical storm from 1923 and Hurricane Hermine in 2004. Due to the large radius of damage that these storms can cause, it is more important to look at hurricanes and tropical storms in a broader context. Hurricanes and tropical storms can be several hundred miles wide. For example, Hurricane Sandy affected Carver but the closest it ever got to Carver was roughly 225

[24] https://www.rmets.org/resource/what-is-a-hurricane
[25] https://scijinks.gov/hurricane/
[26] https://www.nhc.noaa.gov/aboutsshws.php
[27] http://www.hurricanescience.org/science/science/hurricanestructure/

nautical miles away. It is important to look at far more than just hurricanes that have made landfall in Carver. Figure 3-2 shows a map of all the recorded historical hurricane tracks within 60 nautical miles of Carver. Figure 3-3 shows all historical hurricane tracks within 250 nautical miles of Carver.

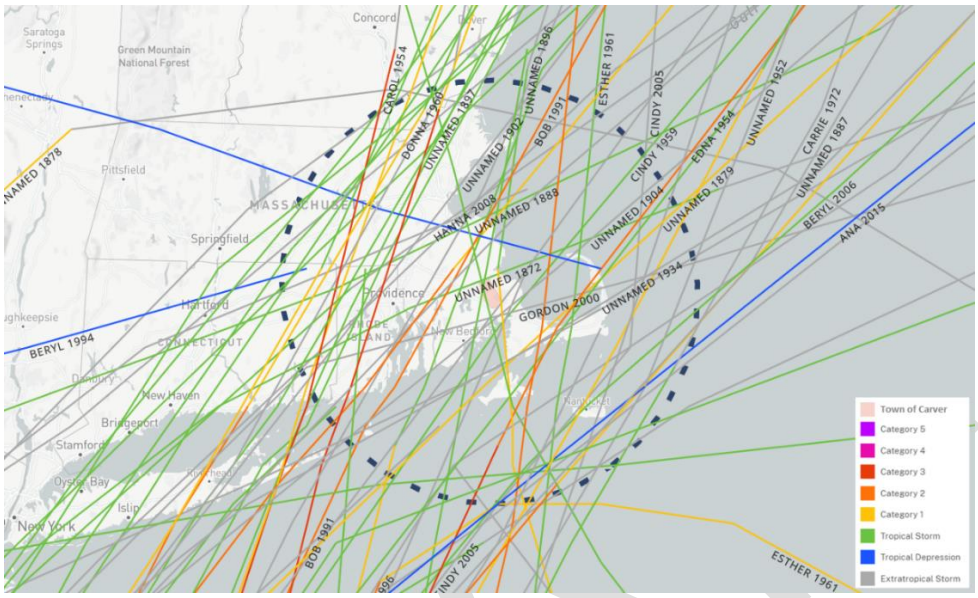


Figure 3-2. Historical hurricane tracks within 60 nautical miles of Carver, MA
Source: NOAA Historical Hurricane Tracks[28]

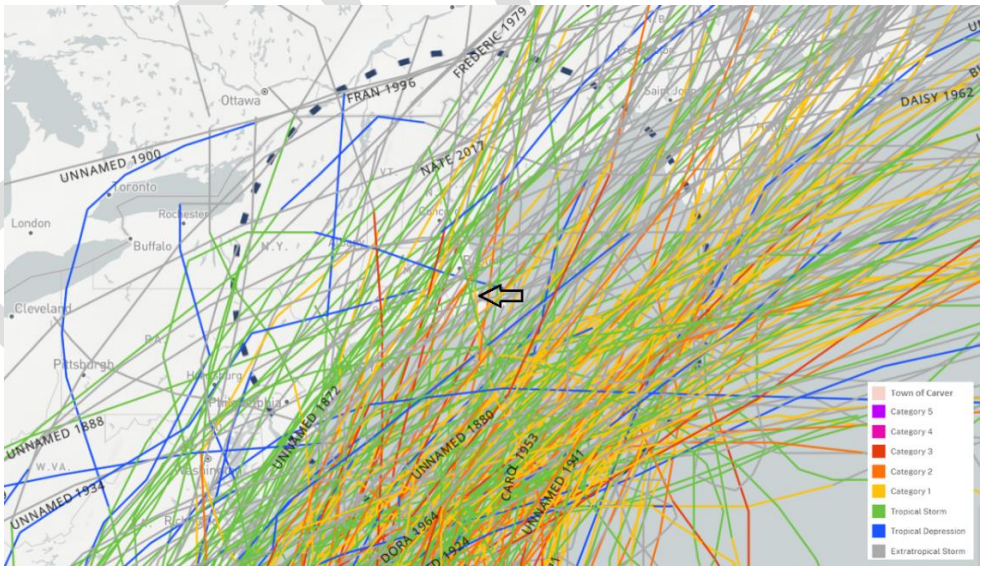


Figure 3-3. Historical hurricane tracks within 250 nautical miles of Carver, MA
Source: NOAA Historical Hurricane Tracks[29]

[28] https://coast.noaa.gov/hurricanes/#map=4/32/-80
[29] https://coast.noaa.gov/hurricanes/#map=4/32/-80

Figure 3-3 above makes it clear that hurricanes and tropical storms are very common in New England. Though New England is not the area of the United States most burdened by hurricanes, the Atlantic coast of the United States can expect to see, on the average, close to seven hurricanes every four years (~1.75 per year). According to the NOAA Storm Events Database there have been 5 hurricanes that have impacted Plymouth County in the last 10 years. We can estimate a 50% chance of a hurricane impacting Carver each year. About three major hurricanes cross the U.S. coast every five years (0.60 per year)[30] and New England can expect one major landfall in each decade.[31]

The National Weather Service reports, "Southern New England has been affected by forty-one hurricanes between 1900 and 2002, 12 of which made landfall with significant impact."[32] In the state of Massachusetts, there is an average of one hurricane every two years.[33] This is in part due to the geography of Massachusetts—its projection easterly into the Atlantic Ocean places it in the typical path of storms originating in Cape Verde or the Bahamas. As hurricanes move in a large counterclockwise spinning spiral, it is common that areas east of landfall experience the most hurricane damage. The most damaging storms have made landfall and tracked to the west of this region**,** including the major 1938 unnamed hurricane that made landfall in Milford, Connecticut and the 1954 Hurricane Carol that made landfall in Old Saybrook, Connecticut. Several tropical storms and hurricanes that have impacted Carver in the past ten years, between 2011 and 2021, include Hurricane Irene, Hurricane Sandy, Tropical Storm Jose, Tropical Storm Dorian, and Tropical Storm Isaias (Table 3-3).

[30] http://www.aoml.noaa.gov/hrd/tcfaq/E19.html (*Last Revised April 22, 2010)*. See also Blake, E.S., E.N. Rappaport, J.D. Jarell, and C.W. Landsea, 2005: "The Deadliest, Costliest, and Most Intense United States Hurricanes from 1851 to 2004 (and Other Frequently Requested Hurricane Facts.) *NOAA Technical Memorandum* NWS-TPC-4, 48 pp. See also Jarell, J.D., B.M. Mayfield, E.N. Rappaport, and C.W. Landsea, 2001: "The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 to 2000 (and Other Frequently Requested Hurricane Facts.) *NOAA Technical Memorandum,* NWS-TPC-3, 30 pp.

[31] Vallee, David R., "A Centennial Review of Major Land-Falling Tropical Cyclones in Southern New England," 2002, National Oceanic and Atmospheric Administration, National Weather Service Forecast Office, Taunton, MA, can be viewed at http://www.mass.gov/czm/coastlines/2002/pdf/c12.pdf

[32] https://www.weather.gov/media/box/science/Centennial_Review.pdf

[33] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Table 3-3. Hurricanes and Tropical Storms affecting Plymouth County 2011-2021
Source: NOAA Storm Events Database[34]

Storm Name	Date	Duration (days)	Highest Category Reached	Max Wind Speed (mph)	Wind Speeds in/around Plymouth County	Event Description in Plymouth County
Tropical Storm Irene	08/28/2011	10	3	120	Sustained wind speed of 33mph, gusts ranging from 54-62mph	Sustained wind speeds for 6-12 hours, lots of power outages, large trees down, heavy rains, storm surge, inland and coastal flooding, wind damage, roughly 1.34in of rain
Hurricane Sandy	10/29/2012	11	3	115	Gusts reached 83mph on outer Cape Cod and Buzzard's Bay	Power lines down causing fires, several trees down[35], the power company was much more prepared after Irene: 47% of Carver without power 9pm Monday 10/29, 2% without power 11am Tuesday 10/30[36]
Tropical Storm Jose	09/20/2017	22	4	155	Gusts reached 62mph	Strong wind gusts and heavy rains, many trees down blocking roads and on power lines and cars
Tropical Storm Dorian	09/07/2019	17	5	184	Brief sustained winds just above 40mph, wind gusts 60mph	Minor wind damage, trees down
Tropical Storm Isaias	08/04/2020	6	1	92	Gusts from 60-63mph recorded	Minimal wind damage in Eastern Plymouth County, likely scattered tree and power line damage

Many of the storms that start in the south as hurricanes make their way to the northeast and either approach the coast or make landfall as Tropical Storms. According to the Massachusetts State Hazard Mitigation Plan, the winds of these storms are usually not the greatest threat; rather, the rains, flooding, and severe weather associated with these storms are what often cause more significant problems.[37] However, according to the NOAA Storm Events Database episode narratives, the past ten years of hurricanes and tropical storms detailed in Table 3-3 have primarily impacted Carver due to strong winds. These strong winds impact power distribution and travel due to downed power lines and trees. Property is also often damaged due to trees falling on homes or cars. Trees can fall on power lines, property, or they can fall and block roads, making power restoration that much more difficult.

[34] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Tropical+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2011&endDate_mm=11&endDate_dd=08&endDate_yyyy=2021&county=PLYMOUTH%3A23&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=25%2CMASSACHUSETTS

[35] Sandy blows through Carver - News - Wicked Local - Boston, MA

[36] Pers. Com. Tom Walsh, Emergency Management Director, Town of Carver

[37] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Chapter 4, p. 4-209, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

In assessing the magnitude or severity of damage from a hurricane in southeastern Massachusetts, consideration must be given to the timing of the event. Hurricanes that make landfall during high tide will have much greater storm surge and thus flood larger areas. In addition, hurricane season runs from June 1 to November 30, a period that includes the summer population swells experienced by several southeastern Massachusetts communities.

The severity of an event considers the potential for loss of life, property damage, and critical facility or business interruption. The timing of the storm relative to other weather events also has a bearing on the overall impact of the hurricane. If a hurricane follows another hurricane or a major rain event, the effects can be magnified as flooding is greater, and weakened or loosened trees are more susceptible to toppling. The severity of a hurricane event in Carver is considered extensive. According to the NOAA Storm Events Database, hurricanes over the past ten years in Plymouth County have caused wind damage, heavy rains, inland flooding, fires, and have significantly affected essential services due to power outages and fallen trees blocking access routes. The entire town, neighboring counties, and likely a substantial amount of the state would be affected since hurricanes have a wide path, usually several hundred miles wide.

Most experts anticipate that the probability has increased that the next major New England hurricane will have severe impacts because present residents are unaware of the serious dangers and major property investment has also increased the value of structures in the region. Given that it has been several years since a serious hurricane has caused extensive damage in Carver, there is concern that those who have relocated to the area during this period or come of age during this period, are unaware of the real danger posed by a powerful hurricane. The National Oceanic and Atmospheric Administration (NOAA) estimates that 80-90% of the population now living in United States coastal areas has never experienced a major hurricane.[38] This lack of firsthand knowledge can cause lax response to warnings and poor or little preparedness.[39] When residents are slow to respond to warnings the severity of impacts can be expected to be greater.

Though prediction methods are continually improving, still one of the greatest difficulties with hurricanes and tropical storms is their unpredictability. At this time, a 120-hour hurricane forecast can get within 175 miles from the actual track of the hurricane, though models are usually around 200 miles off. At 24 hours prior to landfall, the estimated error is around 40-45 miles. This inability to accurately predict the track of the storm makes it that much more difficult for people to prepare.[40]

The surge in Carver's population growth between 1980 and 2000 caused residential construction to skyrocket. This greatly increased the potential for loss of life and property from an incoming hurricane. Between the years of 1980 and 2000, Carver constructed additional housing to accommodate an additional 4,175 persons (+ 60%). Carver was eligible for over $96,000 in recovery costs for Hurricane Bob in 1991. This included cleaning and clearing; tree removal, and road repairs. The 1986 Hurricane Gloria did less damage in Carver, with reimbursement for clean-up at $42,250.

The potential for loss of life and property is also increased in Carver due to the large number of mobile homes (1118) with over 900 of these in communities made up of residents at least 55 years old. Nearly all of these mobile homes were manufactured prior to improvements in regulations that required stronger construction

[38] "Hurricanes: Unleashing Nature's Fury," Revised January 2007, NOAA, FEMA, American Red Cross. p. 10. This can be viewed at http://www.nws.noaa.gov/om/hurricane/pdfs/HurricanesUNF07.pdf.
[39] Jarrell, J. "The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 – 2000. NOAA Technical Memorandum NWS TPC-1, [Available at www.aoml.noaa.gov/hrd/Landsea/deadly/index.html], p. 8.
[40] https://www.nationalgeographic.com/science/article/hurricane-path-forecasts-have-improved-can-they-get-better#:~:text=In%20the%20Atlantic%2C%20a%20120,from%2045%20miles%20to%2040.

after Hurricane Andrew's devastation in Florida in 1992. Many mobile homes constructed prior to updates in the building codes do not have tie-downs and are located close to towering Eastern White Pine (*Pinus strobus*) trees that will be very vulnerable in a major wind event due to their shallow roots and Carver's sandy soil.

Massachusetts state building code now requires many new structural mitigation devices for new buildings including wind engineering measures and construction techniques that may include structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles. Massachusetts building code also requires tie-downs with anchors and ground anchors appropriate for the soil type for mobile homes. Due to these updated building codes, these communities should be better prepared in the future in case of a hurricane and associated hazards.

The elderly population in these mobile homes also is often reluctant to move to shelters since they have never experienced a hurricane in their mobile home and don't fully understand or accept the weakness of the structure; many will refuse to leave unless they can bring pets, creating a challenge for Carver's sheltering plans. In addition, these vulnerable populations may have mobility challenges making it difficult to evacuate if the need arose.

Efforts to mitigate this increased risk have centered on community education. Our Emergency Management Director visits our mobile home communities on a regular basis, giving public talks and delivering educational handouts containing information about mobile homes and hurricane safety. Those living in mobile homes, in particular, have been educated about the need for advanced preparation, detailed Hurricane Emergency Management Plans, and shelter plans that will accommodate animals if required to do so. Our Emergency Management Director, in coordination with our school system's Facilities Manager, has also developed a pet-friendly shelter. Carver has one of the few pet-friendly shelters in the area which was designed specifically to encourage our elderly mobile home community residents to evacuate their homes and move to the shelter in the event of hurricanes.

Other Severe Weather - Wind, Excessive Precipitation, Thunderstorms

Wind

Strong winds are often associated with several other natural hazards including hurricanes, tropical storms, winter storms, like Nor'easters, and tornadoes. High winds can cause trees and power lines to fall and can carry dangerous debris. Wind has primary and secondary impacts. That is, property damage may occur as roofs are blown off or power lines blown down, but this is often followed by secondary impacts as the debris from one structure is blown into another structure or vehicle, and downed power lines cause fire or electrocution. Wind strengths are measured using the Beaufort Wind Scale, detailed in Table 3-4.

Table 3-4. Wind Speeds and Descriptions
Source: National Weather Service, Estimating Wind Speed[41]

Estimating Wind Speeds with Visual Clues			
Beaufort number	Description	Speed	Visual Clues and Damage Effects
0	Calm	Calm	Calm wind. Smoke rises vertically with little if any drift.
1	Light Air	1 to 3 mph	Direction of wind shown by smoke drift, not by wind vanes. Little if any movement with flags. Wind barely moves tree leaves.
2	Light Breeze	4 to 7 mph	Wind felt on face. Leaves rustle and small twigs move. Ordinary wind vanes move.
3	Gentle Breeze	8 to 12 mph	Leaves and small twigs in constant motion. Wind blows up dry leaves from the ground. Flags are extended out.
4	Moderate Breeze	13 to 18 mph	Wind moves small branches. Wind raises dust and loose paper from the ground and drives them along.
5	Fresh Breeze	19 to 24 mph	Large branches and small trees in leaf begin to sway. Crested wavelets form on inland lakes and large rivers.
6	Strong Breeze	25 to 31 mph	Large brances in continous motion. Whistling sounds heard in overhead or nearby power and telephone lines. Umbrellas used with difficulty.
7	Near Gale	32 to 38 mph	Whole trees in motion. Inconvenience felt when walking against the wind.
8	Gale	39 to 46 mph	Wind breaks twigs and small branches. Wind generally impedes walking.
9	Strong Gale	47 to 54 mph	Structural damage occurs, such as chimney covers, roofing tiles blown off, and television antennas damaged. Ground is littered with many small twigs and broken branches.
10	Whole Gale	55 to 63 mph	Considerable structural damage occurs, especially on roofs. Small trees may be blown over and uprooted.
11	Storm Force	64 to 75 mph	Widespread damage occurs. Larger trees blown over and uprooted.
12	Hurricane Force	over 75 mph	Severe and extensive damage. Roofs can be peeled off. Windows broken. Trees uprooted. RVs and small mobile homes overturned. Moving automobiles can be pushed off the roadways.

Towns along the coast tend to experience stronger winds than inland towns. Most of the time, Carver experiences mild winds. On average, Carver has wind speeds of 4.5 to 4.99 m/sec or roughly 10 to 11 mph or less at 30 meters, or 98 feet. Modeled wind speeds for Southeastern Massachusetts can be seen in Figure 3-4.

[41] https://www.weather.gov/pqr/wind

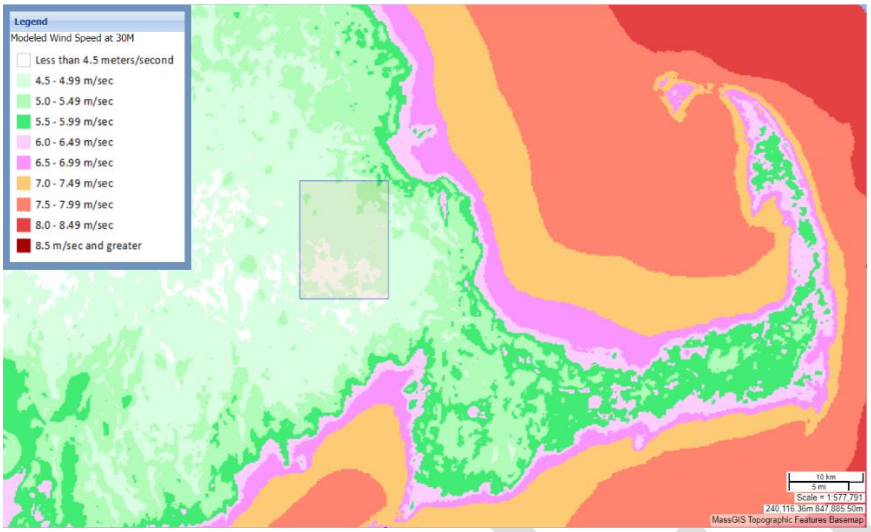


Figure 3-4. Modeled Standard Wind Speeds at 30 meters in Southeastern MA
Source: Mass GIS[42]

Since Carver is just several miles from the coast, Carver can experience strong winds. When strong winds occur in this area, Carver, neighboring towns, and the entire county are vulnerable. According to the strong and high wind reports from the NOAA Storm Events Database between 2010 and 2021, Plymouth County experiences roughly 9 days each year with powerful winds. Plymouth County has on average 6 days with strong winds, between 40 and 56 miles per hour. According to Table 3-4, winds at these speeds can break twigs and small branches, scattering them across the ground, and cause structural damage, like blowing the tiles off roofs and damaging chimney covers and television antennas. Plymouth County also experiences an average of 3 days with high winds, over 56 miles per hour (Table 3-5). These winds can cause considerable structural damage to roofs and can even uproot small trees. In Carver, with its sandy soils, where Eastern White Pines with shallow roots can grow to heights of 100-150 feet or more[43], strong winds frequently uproot even these tall trees. According to the Carver Hazard Mitigation Public Opinion Survey (2021) responses, 100 of the 129 respondents, or roughly 78% of respondents, indicated that they had experienced damage to their home or property from winds and/or storms. Summarized survey results can be found in Appendix B.

The main concerns with powerful winds are falling trees which can cause damage to homes, property, and can block roads, and downed power lines and wires that can cause power outages and potentially even fires. The majority of respondents to the survey, over 80%, have experienced power outages due to storms. If the wind is strong enough, it can remove some of the siding from houses, cause shingles from the roof to blow off, and can cause fences to fall over. Additional information about strong winds can be found in the Tornado section. Based on data from the previous twelve years, found in Table 3-5, Plymouth County has roughly a 2.5% chance of experiencing wind speeds greater than 40 miles per hour each year.

[42] https://www.mass.gov/info-details/massgis-data-modeled-wind-speed-grids
[43] https://newenglandforestry.org/2018/04/23/meet-the-eastern-white-pine/

Table 3-5. Strong and High Wind Reports 2010-2021
Source: NOAA Storm Events Database[44]

Wind speed (mph)	Number of instances where the maximum speed was:
≤ 40	2
≤ 45	18
≤ 50	90
≤ 55	42
≤ 60	80
≤ 65	20
≤ 70	7
≤ 75	2
≤ 80	2
≤ 85	1
≤ 90	1

Climate models and projections often overlook wind, but wind speeds have been changing as a result of climate change. Global air circulation depends on the differences in temperature between the cold polar regions and the warm equator. This temperature difference is what drives the jet stream, a fast-moving river of wind that blows all around the northern hemisphere, creating highs and lows in our weather patterns. When the north-south temperature difference is large, the jet stream blows very strongly. In contrast, when the north-south temperature difference is smaller, the jet stream gets weaker.[45] The Arctic is warming at an alarmingly fast rate, causing the difference in temperature between regions to decrease. This means that average wind speeds will likely slow down, having significant impacts on storm systems and precipitation patterns.[46] As a result, the weather we experience in the Northeast will hang around for a longer time. Nor'easters, stormy periods, cold spells, eat waves, and droughts are all examples of weather conditions that will become more persistent due to the weakening of the jet stream.[47]

[44] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+High+Wind&eventType=%28Z%29+Strong+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2010&endDate_mm=11&endDate_dd=29&endDate_yyyy=2021&county=PLYMOUTH%3A23&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=25%2CMASSACHUSETTS

[45] https://www.wbur.org/news/2020/09/14/warming-arctic-weather-q-and-a

[46] https://news.climate.columbia.edu/2021/01/06/westerly-winds-climate-change/

[47] https://www.climatesignals.org/climate-signals/surface-wind-speed-change

Excessive Precipitation

Excess precipitation is described as instances where the amount of rain or snow in a particular location substantially exceeds what is normal.[48] Substantial precipitation is closely associated with several other natural hazards, including hurricanes, Nor'easters, tornadoes, thunderstorms, and inland flooding. Rainfall affects a wide area so during periods of excessive precipitation, the entire town of Carver, neighboring towns, and even the entire county can be affected.

Between 2000-2021, the Plymouth Municipal Airport, which is just 2.9 miles from Carver, experienced roughly 48 inches of rain per year on average. The maximum precipitation recorded in one year was roughly 61 inches in 2018 and the minimum was roughly 34 inches in 2016. Table 3-6 shows the monthly rainfall totals for the weather station at the Plymouth Municipal Airport. The average rainfall per day at the Plymouth Municipal Airport and, therefore, also in Carver, is estimated at 0.13 inches. Based on data from Table 3-6, Carver has a roughly 30% chance in any given month of having over 5 inches of rain.

[48] https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation

Table 3-6. 2000-2021 Monthly Rainfall Totals at the Plymouth Municipal Airport
Source: NOAA Online Weather Data (NOWData)[49]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	3.94	4.00	5.38	7.90	3.36	4.09	4.39	2.78	3.05	3.76	3.53	3.81	49.99
2001	2.87	2.08	12.11	2.31	4.68	5.23	2.65	4.46	3.12	1.41	1.17	3.27	45.36
2002	3.22	2.39	5.16	3.83	5.78	3.39	0.75	1.39	4.23	4.02	5.91	7.09	47.16
2003	2.69	3.93	5.99	6.14	2.92	6.40	4.52	5.92	3.24	5.45	2.68	6.06	55.94
2004	1.56	M	2.29	6.21	2.80	1.81	2.65	5.40	5.94	1.89	4.38	4.05	M
2005	3.84	2.60	5.76	5.03	7.04	0.79	2.02	5.43	3.83	11.12	6.89	2.57	56.92
2006	6.83	1.47	0.38	2.22	7.86	11.48	1.62	3.17	2.22	5.02	6.61	2.47	51.35
2007	3.62	1.66	6.38	8.03	2.75	2.91	5.48	0.55	3.27	2.83	3.92	5.15	46.55
2008	2.81	6.24	5.51	3.59	2.46	3.75	4.78	2.94	10.13	3.41	6.48	6.20	58.30
2009	3.86	1.37	3.09	5.44	3.16	4.82	7.60	5.70	2.23	7.35	2.22	4.51	51.35
2010	4.34	3.63	13.79	1.65	2.55	1.63	4.83	4.17	2.57	5.67	4.05	3.45	52.33
2011	2.47	4.29	2.60	5.66	2.42	3.41	4.96	M	5.97	7.31	3.61	3.04	M
2012	2.56	1.05	1.19	2.17	4.87	3.82	3.61	4.28	5.16	2.91	2.97	5.56	40.15
2013	1.78	3.50	3.58	1.85	4.28	10.32	2.97	2.26	1.78	1.19	4.29	3.53	41.33
2014	3.15	3.62	4.82	4.31	2.26	1.63	6.27	2.34	0.75	6.32	6.28	5.56	M
2015	2.47	2.08	3.56	1.93	2.51	3.43	0.75	2.52	4.54	3.78	4.11	4.79	36.47
2016	3.23	3.14	2.12	2.87	4.30	0.95	2.07	1.26	2.25	6.46	2.61	2.42	33.68
2017	4.83	2.00	3.62	7.06	5.64	3.81	2.26	2.02	4.60	4.26	3.45	2.81	46.36
2018	5.70	5.25	6.15	5.59	1.66	3.90	1.36	5.15	6.54	6.35	9.26	4.16	61.07
2019	6.33	2.86	2.97	6.15	3.18	5.50	7.88	3.23	2.19	9.42	M	9.25	M
2020	1.67	3.27	3.76	7.10	2.64	1.52	2.33	1.59	1.28	5.78	5.25	6.19	42.38
2021	2.39	6.29	2.29	4.79	4.78	2.15	6.87	0.02	11.48	M	M	M	M
Mean	3.46	3.18	4.66	4.63	3.81	3.94	3.76	3.17	4.11	5.03	4.48	4.57	48.04
Max	6.83 2006	6.29 2021	13.79 2010	8.03 2007	7.86 2006	11.48 2006	7.88 2019	5.92 2003	11.48 2021	11.12 2005	9.26 2018	9.25 2019	61.07 2018
Min	1.56 2004	1.05 2012	0.38 2006	1.65 2010	1.66 2018	0.79 2005	0.75 2002	0.02 2021	0.75 2014	1.19 2013	1.17 2001	2.42 2016	33.68 2016

Climate change is causing a warmer atmosphere that can hold more moisture than a colder one. This is causing changes in large-scale weather patterns, which affects where precipitation occurs, thus causing an increase in precipitation in the Northeast.[50] In addition to climate change science, historical observations indicate that precipitation in the Northeast is increasing. The average annual precipitation in the Northeast has increased by 10 percent in the 116 years between 1895 and 2011. Figure 3-5 shows the annual total precipitation in Plymouth County since 1951. Based on changes in precipitation between 1971 and 2000, precipitation is projected to continue to increase.

[49] https://www.weather.gov/wrh/climate?wfo=box
[50] https://nca2014.globalchange.gov/report/our-changing-climate/precipitation-change

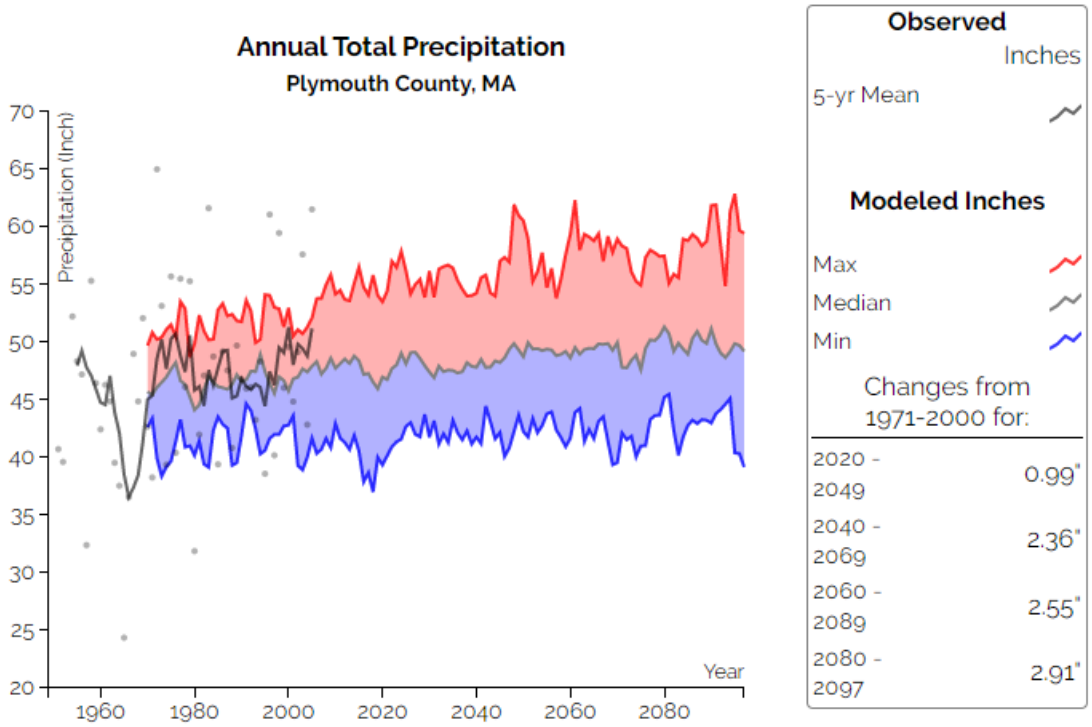


Figure 3-5. Plymouth County Precipitation Projections
Source: Resilient MA[51]

In addition to being more frequent, rainstorms have become more intense. According to the U.S. Global Change Research Program, the largest increase in heavy precipitation events has occurred in the Northeast, with annual precipitation in Massachusetts projected to increase 7.3 inches by the end of the century.[52] Since 1958, the northeast has seen a 70% increase in precipitation from very heavy storm events, defined as the heaviest 1% of all daily events.[53] Even seemingly small increases in annual precipitation can have a large impact on runoff, stream flow, and flooding. To put this in perspective, the total precipitation at the Plymouth Municipal Airport for any given month is 3 to 5 inches.[54] The number of downpours releasing greater than 2 inches of rain per day in Massachusetts is expected to rise from less than 1 day per year to 0.9-1.5 days per year by 2100. Rain events releasing greater than 1 inch of rain per day could increase as high as 8-11 days per year by 2100.[55]

The Standardized Precipitation Index (SPI) is widely used to characterize meteorological drought on a range of timescales. The SPI is the number of standard deviations that observed cumulative precipitation deviates from the climatological average. SPI graphs are generally used to show drought patterns, but because rainfall and drought are so closely linked, we can use this graph to illustrate deviations in rainfall as well. The SPI graphed in Figure 3-6 clearly shows the patterns in increased rainfall in Plymouth County over the past hundred years or so. The thicker the lines, the longer Plymouth County experienced these conditions, and the darker the color, the greater deviation from the average climate conditions. It is clear from this image that the frequency and

[51] https://resilientma.org/datagrapher/?c=Temp/county/pcpn/ANN/25023/
[52] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[53] What Climate Change Means for Massachusetts, US EPA, August 2016 https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ma.pdf
[54] https://www.weather.gov/wrh/climate?wfo=box
[55] https://resilientma.org/changes/changes-in-precipitation#more_frequent_downpours

intensity of rainfall events in Plymouth County is increasing, and the amount of precipitation is getting farther and farther from the normal climatic conditions.

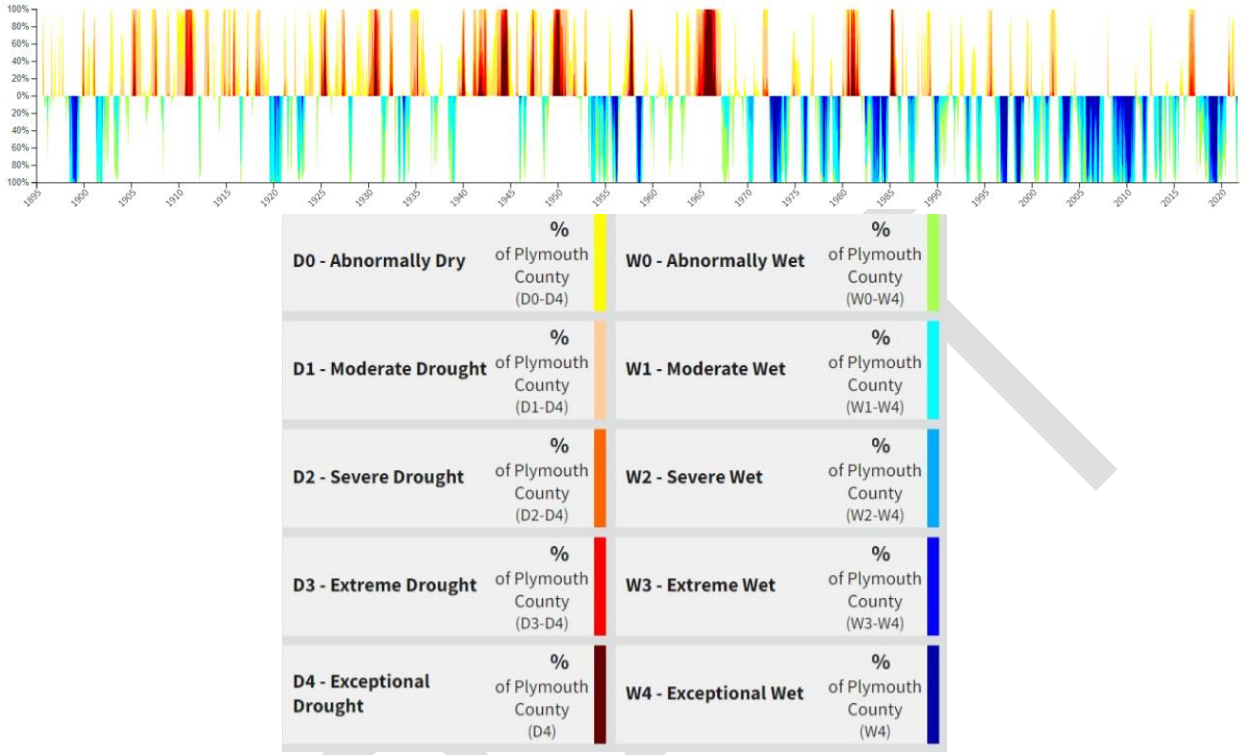


Figure 3-6. Historical Drought Conditions in Plymouth County (1895-2021)
Source: National Integrated Drought Information System (Drought.gov)[56]

The frequency and intensity of excess precipitation events is increasing and will likely continue to increase with time due to climate change. The main risk of more intense precipitation events, where a greater volume of rain falls at one time, is inland flooding and flash flooding. With too much precipitation falling at one time, soils become saturated and unable to store any more water, river flows increase, and stormwater systems become overwhelmed.[57] Flash flooding, which can be very destructive and can destroy many things in its path, becomes possible when a significant amount of precipitation falls in a short amount of time. The Council on Aging experienced basement flooding during the intense rainstorm of September 1st, 2021, where Carver had over 4 inches of rain in a short amount of time. In addition to the impacts described in the inland flooding section, excessive precipitation can cause property damage and could potentially cause the displacement of individuals who would require shelter.

Inland Flooding and excessive precipitation are very closely associated. More information on the impacts of excess precipitation can be found in the inland flooding and dam/culvert/flume failure sections. In order to best prepare for increased precipitation, it will be important to maintain critical infrastructure like bridges, dams,

[56] https://www.drought.gov/historical-information?state=massachusetts&countyFips=25023&dataset=1&selectedDateUSDM=20161115&selectedDateSpi=20090901
[57] Runkle, J., K. Kunkel, R. Frankson, D. Easterling, A.T. DeGaetano, B. Stewart, and W. Sweet, 2017: Massachusetts State Climate Summary. *NOAA Technical Report NESDIS 149-MA*, 4 pp. https://statesummaries.ncics.org/chapter/ma/

and culverts to catch and fix any weaknesses before a large rain event damages the infrastructure, causing an even greater flooding risk.

Thunderstorms

A thunderstorm is a violent, short-lived weather disturbance that is frequently associated with lightning, thunder, dense clouds, heavy rain or hail, and strong gusty winds.[58] Hail is a type of precipitation that is formed when water droplets freeze together in the cold, upper areas of thunderstorm clouds.[59]

Thunderstorms should not be underestimated as they all produce lightning and kill more people each year than tornadoes. In addition, heavy rain from thunderstorms can cause flash flooding which is the primary cause of thunderstorm related deaths. Around 10 percent of thunderstorms each year are considered severe, which means they produce hail at least ¾-inch in diameter, wind at least 58 miles per hour, or tornadoes. In June of 1998 and again in May of 2009, thunderstorms occurred that produced such heavy rains that widespread flooding took place. In fact, during the May 2009 thunderstorm, quarter-sized to golf-ball sized hail occurred in Plymouth County.[60] Hail of any size occurring during peak bloom season of May through June can cause serious damage to Carver's cranberry crop. If it hails early in the budding stage, cranberry buds can be broken off; if it hails when the blossom has set, blossoms can be knocked off and the amount of fruit set is greatly reduced. If hail occurs and it's during the portion of the season when the fruit has already set, hail has the potential to bruise the berries as it did during the May 2009 thunderstorm. Hail also has the potential to cause property damage, including cracks in car windows, and dents to cars or vinyl siding on buildings, depending on the size and density of the hailstones, wind speed, and overall intensity of the storm.[61]

According to the NOAA Storm Events Database, there have been 130 reports of thunderstorm winds in Plymouth County on 73 different days since 2000. [62] Based on these reports, Plymouth County is expected to experience an average of six days with thunderstorms per year. There is roughly a 96% chance Plymouth County will experience a day with thunderstorm winds in at least one town in any given year. Thunderstorms generally occur in the spring or summer months and during the afternoon and evening hours. Roughly 82% of these reported thunderstorms occurred during the summer months, between June and August.

The average thunderstorm is 15 miles in diameter and lasts around 30 minutes.[63] The area of impact of thunderstorms in Carver is usually quite localized, sometimes occurring in one end of town and not in the other. However, when thunderstorms occur, the entire town is vulnerable. Massachusetts experiences around 20 to 30 thunderstorm days per year on average (Figure 3-7).[64] Based on this data, any given day, there is roughly a 7% chance that Massachusetts will experience a thunderstorm. With climate change predicting an increase in the intensity and frequency of severe weather events, it is possible that Carver will experience more thunderstorms in the future.

[58] https://www.britannica.com/science/thunderstorm
[59] https://www.nationalgeographic.org/encyclopedia/hail/
[60] Pers. com. Thomas Walsh
[61] https://www.travelers.com/resources/weather/hail/identifying-hail-damage-to-your-roof
[62] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2000&endDate_mm=12&endDate_dd=29&endDate_yyyy=2021&county=PLYMOUTH%3A23&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=25%2CMASSACHUSETTS
[63] https://www.weather.gov/media/grr/brochures/nwsthunderstorms&lightning.pdf
[64] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

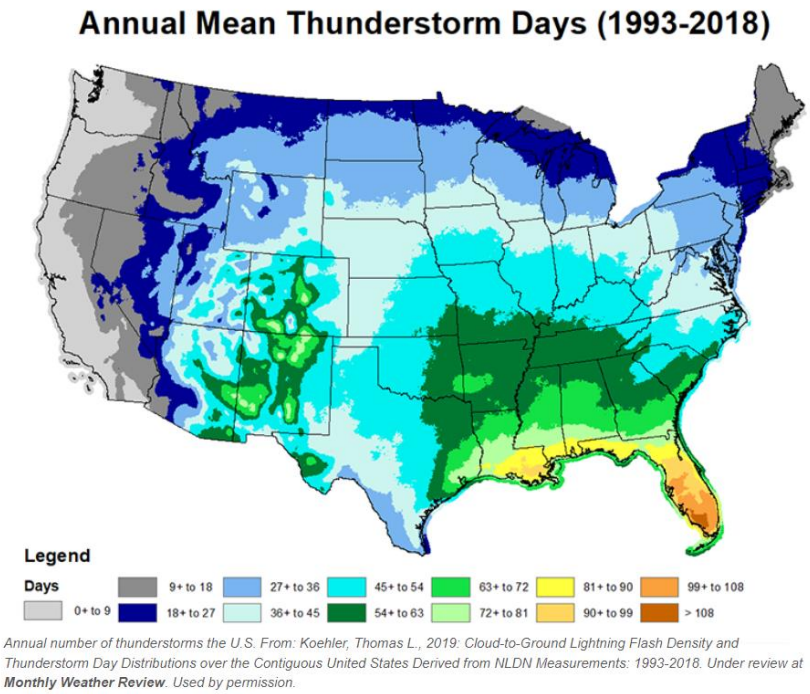


Figure 3-7. Average annual thunderstorm days
Source: National Weather Service[65]

Severe Winter Storm - Nor'easters, Snow and Blizzards, Ice Storms & Jams

Snow

Snow is precipitation in the form of ice crystals. It originates from clouds when temperatures are below the freezing point, when atmospheric water vapor condenses directly to ice, skipping the liquid stage. Once the ice crystal has formed, it freezes nearby water vapor, growing into a snow crystal or pellet that then falls to Earth's surface.[66]

When winter storms occur in Carver, impacts are experienced across the town, county, and likely a large portion of the state and New England region. Carver falls within the Boston Area that includes the northern and central area of southeastern Massachusetts. Table 3-7 indicates the total monthly snowfall in the greater Boston area between the winters beginning in 1999 and ending in 2021. The average seasonal snowfall in this area between the winters of 1999-2000 and 2020-2021 is 47.3 inches per year. During this period, the maximum winter snowfall was 110.6 inches. This region is likely to experience an average of 21 days with snowfall every year.

[65] https://www.weather.gov/jetstream/tstorms_intro
[66] https://nsidc.org/cryosphere/snow

Table 3-7. Monthly Total Snowfall (in inches) for Boston Area, MA
Source: NOAA Online Weather Data (NOWData)[67]

Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1999-2000	0.0	0.0	0.0	0.0	0.0	0.0	13.2	9.2	2.0	T	0.0	0.0	24.4
2000-2001	0.0	0.0	0.0	T	T	4.5	12.4	9.8	19.2	T	0.0	0.0	45.9
2001-2002	0.0	0.0	0.0	T	0.0	5.0	7.9	0.5	1.4	0.3	0.0	T	15.1
2002-2003	0.0	0.0	0.0	T	3.6	11.1	4.2	41.6	8.1	2.3	0.0	0.0	70.9
2003-2004	0.0	0.0	0.0	T	0.0	21.5	4.9	2.4	10.6	T	0.0	0.0	39.4
2004-2005	T	0.0	0.0	0.0	3.9	7.2	43.3	17.7	14.5	T	0.0	0.0	86.6
2005-2006	0.0	0.0	0.0	1.1	T	10.7	8.1	20.0	T	T	0.0	0.0	39.9
2006-2007	0.0	0.0	0.0	0.0	0.0	0.8	1.0	4.6	10.2	0.5	0.0	0.0	17.1
2007-2008	0.0	0.0	0.0	0.0	T	26.9	8.3	15.0	1.0	0.0	0.0	0.0	51.2
2008-2009	0.0	0.0	0.0	0.0	T	25.3	23.7	6.2	10.7	0.0	0.0	0.0	65.9
2009-2010	0.0	0.0	0.0	0.1	0.0	15.2	13.2	7.0	0.2	0.0	0.0	0.0	35.7
2010-2011	0.0	0.0	0.0	0.0	T	22.0	38.3	18.5	1.3	0.9	0.0	T	81.0
2011-2012	0.0	0.0	0.0	1.0	T	T	6.8	0.9	0.6	0.0	0.0	T	9.3
2012-2013	0.0	0.0	0.0	0.0	0.4	3.4	5.0	34.0	20.6	T	0.0	0.0	63.4
2013-2014	0.0	0.0	0.0	0.0	T	11.7	21.8	22.9	2.2	0.3	0.0	0.0	58.9
2014-2015	0.0	0.0	0.0	0.0	2.6	0.3	34.3	64.8	8.6	T	0.0	0.0	110.6
2015-2016	0.0	T	0.0	T	0.0	0.9	9.5	15.0	4.1	6.6	0.0	0.0	36.1
2016-2017	0.0	0.0	0.0	0.0	T	5.9	8.9	21.5	10.1	1.2	0.0	0.0	47.6
2017-2018	0.0	0.0	0.0	0.0	T	9.2	17.8	8.3	23.3	1.3	0.0	0.0	59.9
2018-2019	0.0	0.0	0.0	0.0	0.1	0.1	2.1	11.6	13.5	T	0.0	T	27.4
2019-2020	0.0	0.0	0.0	0.0	T	11.5	3.1	0.5	T	0.7	T	0.0	15.8
2020-2021	0.0	T	0.0	4.3	T	13.0	5.8	15.3	0.1	0.1	0.0	0.0	38.6
Mean	T	T	0.0	0.3	0.5	9.4	13.3	15.8	7.4	0.6	T	T	47.3
Max	T 2004	T 2020	0.0 2020	4.3 2020	3.9 2004	26.9 2007	43.3 2005	64.8 2015	23.3 2018	6.6 2016	T 2020	T 2019	110.6 2015
Min	0.0 2020	0.0 2019	0.0 2020	0.0 2019	0.0 2015	0.0 1999	1.0 2007	0.5 2020	T 2020	0.0 2012	0.0 2021	0.0 2021	9.3 2012

New England is no stranger to severe winter storms. The Northeast Snowfall Impact Scale (NESIS) is used to characterize and rank high-impact Northeast snowstorms with large areas of at least 10-inch snowfall accumulations. There are five categories: Notable, Significant, Major, Crippling, and Extreme. This index shown in Table 3-8, unlike many others, uses population information in addition to meteorological measurements, giving an indication of a storm's societal impacts. This scale was developed in 2004 because of the large impact Northeast snowstorms can have on the rest of the country in terms of transportation and economic impact and this scale makes it easier to compare storms.

[67] https://www.weather.gov/wrh/climate?wfo=box

Table 3-8. Northeast Snowfall Impact Scale (NESIS)
Source: A Snowfall Impact Scale Derived from Northeast Storm Snowfall Distributions[68]

Category	Cat 1 Notable	Cat 2 Significant	Cat 3 Major	Cat 4 Crippling	Cat 5 Extreme
Snow Depth	4-10 inches	10+ inches	10-20 inches	20+ inches	10, 20, or 30 inches
Area	Size of RI	Southern New England	1-3 times NY State	Northeast	Northeast
Population Affected	10 million	10-20 million	20-40 million	50 million	60 million

Between 1956 and 2021, 66 significant winter storms occurred in the Northeast, 35 of which were classified as "major" or greater on the Northeast Snowfall Impact Scale.[69] In the period of 66 winters, the Northeast experienced 66 significant winter storms. In any given year, there is roughly a 100% chance that the Northeast will experience a significant winter storm and a 53% chance that the storm will be ranked as "major" or greater on the NESIS scale. Table 3-9 shows the 29 significant winter storms to impact the Northeast since 2010, their category, and description. Based data collected over the past 12 years, Plymouth County experiences an average of 2.42 significant winter storms per year.

Table 3-9. Significant winter storms in the Northeast since 2010
Source: NOAA National Centers for Environmental Information[70]

Start Date	End Date	NESIS	Category	Description
2/4/2010	2/7/2010	4.38	3	Major
2/9/2010	2/11/2010	4.1	3	Major
2/23/2010	2/28/2010	5.46	3	Major
12/24/2010	12/28/2010	4.92	3	Major
1/9/2011	1/13/2011	5.31	3	Major
1/26/2011	1/27/2011	2.17	1	Notable
2/1/2011	2/3/2011	5.3	3	Major
10/29/2011	10/30/2011	1.75	1	Notable
2/7/2013	2/10/2013	4.35	3	Major
3/4/2013	3/9/2013	3.05	2	Significant
12/13/2013	12/16/2013	2.95	2	Significant
12/30/2013	1/3/2014	3.31	2	Significant
1/20/2014	1/22/2014	1.26	1	Notable
1/29/2014	2/4/2014	4.08	3	Major
2/11/2014	2/14/2014	5.28	3	Major
11/26/2014	11/28/2014	1.56	1	Notable
12/9/2014	12/14/2014	1.49	1	Notable

[68] https://www.ncdc.noaa.gov/snow-and-ice/rsi/docs/kocin-and-uccellini-2004.pdf
[69] https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis
[70] https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis

Start Date	End Date	NESIS	Category	Description
1/25/2015	1/28/2015	2.62	2	Significant
1/29/2015	2/3/2015	5.42	3	Major
2/8/2015	2/10/2015	1.32	1	Notable
1/22/2016	1/24/2016	7.66	4	Crippling
3/12/2017	3/15/2017	5.03	3	Major
1/3/2018	1/5/2018	2.27	1	Notable
3/1/2018	3/3/2018	1.65	1	Notable
3/5/2018	3/8/2018	3.45	2	Significant
3/11/2018	3/15/2018	3.16	2	Significant
3/20/2018	3/22/2018	1.63	1	Notable
12/14/2020	12/18/2020	3.21	2	Significant
1/30/2021	2/3/2021	4.93	3	Major

Heavy snow can greatly impact transportation and the ability of first responders to reach their destinations. The weight of snow can cause roofs to collapse and can knock down trees and power lines, causing power outages.[71] The Town Hall and several schools in Carver have flat roofs but someone is responsible for shoveling the roofs to avoid the buildup of snow. In addition, snow can melt and refreeze creating accumulations of ice. Ice can be extremely dangerous to motorists and pedestrians because it limits vehicle traction and braking ability. It can also build up and get very heavy, bringing down trees, power lines, utility poles, and communication towers.[72]

The frequency of severe winter storms has been increasing. During the 43 winters between 1956 and 1999, there were 28 significant winter storms. Then during the 22 winters between 2000 and 2021, there were 38 significant winter storms.[73] That means there were nearly double the amount of significant winter storms in half the amount of time. Though it may seem counterintuitive, more snowfall during winter storms is an expected impact of climate change. A warmer planet causes more water to evaporate so there is more moisture in the atmosphere. This means more precipitation in the form of heavy snowfall in the colder months and downpours during the warmer months. In warmer months this can cause flooding but in winter months this can cause massive winter storms.[74]

Climate scientists predict that the Northeast will, over time, become increasingly warm and wet, meaning more precipitation will fall as rain than as snow. The average air temperatures in New England are showing the greatest increases in winter months. Over the last 50 years, winter temperatures have increased by over 3 degrees Fahrenheit and the winter season is getting shorter. Due to these projections, the risk of heavy winter snowfall in Carver is likely decreasing, and shifting to increased rainfall, with different associated risks (see Extreme Precipitation section).[75]

[71] https://www.weather.gov/safety/winter-snow
[72] https://www.weather.gov/mkx/wwa-impacts
[73] https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis
[74] https://www.edf.org/card/4-reasons-climate-change-still-happening-despite-cold-weather
[75] https://climateactiontool.org/content/changes-winter

Blizzards

A blizzard is a winter storm defined by sustained winds or frequent gusts over 35 mph with snow blowing around, reducing visibility to 1/4 mile or less for at least 3 hours. Heavy snowfall and severe cold temperatures often accompany blizzards but are not required. Sometimes strong winds can lift snow that has previously fallen, creating a ground blizzard.[76]

Blizzards are very dangerous due to the reduced visibility, making travel very difficult. This poses a problem for emergency responders in getting to their destinations safely. Blizzards and other winter storms most often cause downed trees and power lines, blocking roads and causing power outages. Injury or property damage is also common when trees fall. As a community with a limited public water supply, the loss of power in Carver results in homeowners and businesses that lack a back-up generator to be without running water. While melting snow adds to flooding, snowfall also presents a non-flooding hazard as access to critical facilities may be compromised by large amounts of snowfall. Table 3-10 details the 9 blizzards reported according to the NOAA Storm Events Database between 2000 and 2021. According to the data from the past 21 years, Plymouth County experiences a notable blizzard roughly every 2-3 years. Based on this data, in any given year, there is a 41% chance that Plymouth County will experience a blizzard.

Table 3-10. Blizzards reported in Plymouth County between 2000-2021
Source: NOAA Storm Events Database[77]

Dates	Snowfall	Impacts
2/12/2006	17.5 inches of snow at the Boston Airport, roughly 1-1.5 feet of snow across central and eastern MA	Strong winds brought down tree limbs and wires, low visibility down to less than 1/4 mile at times
12/20/2009	18-20 inches across southeastern MA	Visibilities down to 0 were reported, wind gusts over 35mph, numerous trees and wires down
2/8/2013	2-2.5 feet recorded in most southern NE locations	very strong winds, some gusts exceeded hurricane force (74mph) and gale force gusts (up to 50mph) were also observed, the strong winds combined with wet snow clung to trees in southern New England led to many power outages from downed trees and wires, near blizzard conditions were observed at the Plymouth Municipal Airport (KPYM) station for 2-3 hours prior to the most intense part of the storm, before wind sensors were lost during the height of the storm, storm surge along the coast
1/2/2014	snowfall varied widely	frequent wind gusts up to 43mph, heavy snow, near zero visibilities, combination of winds and heavy snow caused downed wires

[76] https://www.weather.gov/dmx/wintersafety

[77] https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Blizzard&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2000&endDate_mm=11&endDate_dd=29&endDate_yyyy=2021&county=PLYMOUTH%3A23&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=25%2CMASSACHUSETTS

Dates	Snowfall	Impacts
1/26/2015	1-2 feet in southeastern MA, 24-31 inches of snowfall fell across coastal Plymouth County, 2-3 inches per hour was a common snowfall rate	nearby towns experienced 14 hours of blizzard conditions, daily snowfall records were set (January 27th in Boston - 22.1 inches, previous record 8.8 inches in 2011), very strong winds 50-65mph gusts, significant coastal flooding, MA governor issued a travel ban, Boston Logan International Airport was closed through 6am on 1/28/2015, a total of 116 cities and downs declared local states of emergency activating their Emergency Operations Centers, over 40 shelters opened serving 450 individuals, President Obama issued a federal disaster declaration for the eastern parts of MA
2/14/2015	12-17 inches	blizzard conditions met for a brief time, near blizzard conditions continued for 24hrs in Plymouth County, school and work delayed or cancelled, plowing and shoveling became nearly impossible, MBTA reduced or cancelled services several times, wires and trees down, large amount of snow combined with frigid temperatures caused numerous roof collapses
1/23/2016	3-11 inches, difficult to measure due to strong gusts	winds sustained at 40-44mph, gusted as high as 70mph, wires, trees, and a light pole fell onto cars and into roads
2/8/2016	5-8 inches	blizzard conditions met for several hours, 61mph wind gust reported, trees and wires down
3/13/2018	10-20 inches	blizzard conditions observed, wind gusts up to 56mph, frequent gusts above 35mph, trees fell onto roads and several houses, wires were down

As mentioned above, there is a 97% chance in any given year that Carver will experience a significant winter storm and a 53% chance that the storm will be ranked as "major" or greater on the NESIS scale. There is a 41% chance of Carver experiencing a blizzard each year. In Carver, snow and blizzards occur with high frequency and their severity is considered serious. The area of impact of snow and blizzards tends to be widespread, impacting Carver, Plymouth County, and large areas of the state and New England.

Nor'easters

Nor'easters are defined as strong and often devastating storms that occur along the eastern coast of the United States. They generally develop between Georgia and New Jersey, and progress northeastward, attaining maximum intensity near New England and coastal Canadian provinces. Winds around these low-pressure systems blow from the northeast, as depicted in Figure 3-8, thus giving Nor'easters their name.[78] Nor'easters cause heavy rain or snow, gale force winds, rough seas, and occasionally coastal flooding.[79] Impacts of heavy rain, snow, and strong winds are discussed in previous sections. These storms are generally winter storms and are most common from September to April, but can, though rarely, occur during other times of the year.[80]

In early March of 2018, there were two consecutive Nor'easters with whole gale force winds reaching nearly 60 miles per hour. These storms caused major wind damage across Carver and left over 90% of residents without

[78] https://www.nationalgeographic.org/encyclopedia/noreaster/
[79] https://www.weather.gov/safety/winter-noreaster
[80] https://www.mass.gov/doc/section-13-noreaster/download#:~:text=A%20northeast%20coastal%20storm%2C%20known,late%20fall%20and%20early%20winter.

power. Currently, Nor'easters are the most frequently occurring natural hazard in the state of Massachusetts according to the state Hazard Mitigation Plan. Nor'easters cause more damage in Massachusetts than stronger storms like hurricanes, because they occur with a higher frequency, roughly 1-2 each year.[81] It is highly likely that at least one Nor'easter will occur in Carver in the next year, a near 100% chance. They also have a longer duration than hurricanes: Nor'easters can last 12 hours to 3 days while hurricanes only last between 6 and 12 hours. Many communities in Massachusetts experience flooding due to the heavy precipitation associated with Nor'easters. Problems are made worse when melting snow and ice are added into the equation. Large chunks of ice can clog drainage passages and storm drains, exacerbating flooding problems.

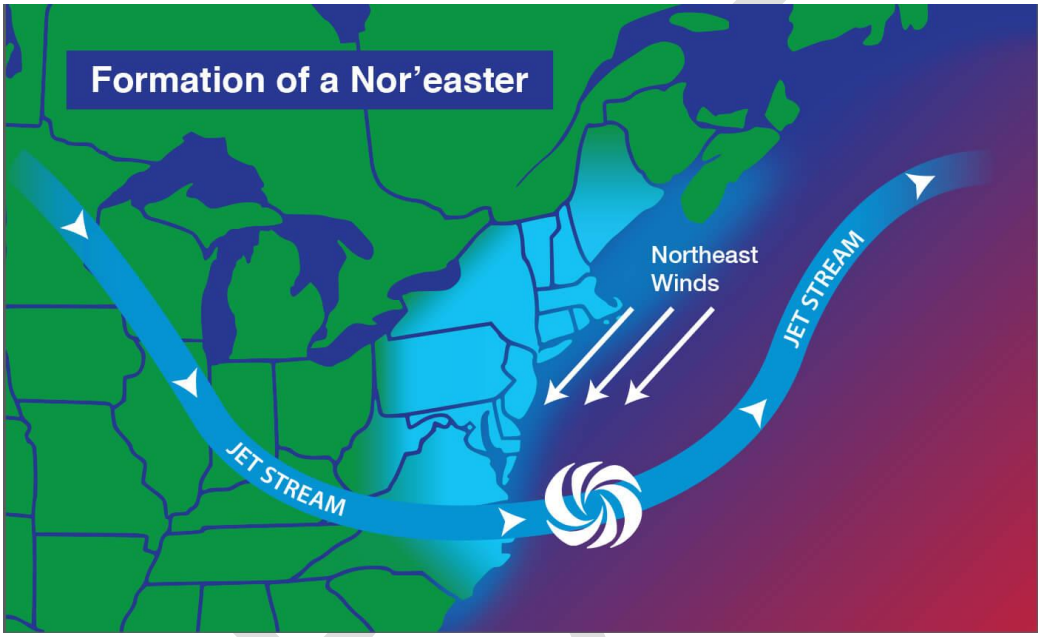


Figure 3-8. Formation of a Nor'easter
Source: NOAA SciJinks[82]

Though high snowfall and ice storms are greater in the higher elevations of Western and Central Massachusetts, coastal areas are more vulnerable to Nor'easters.[83] When Nor'easters do occur in Carver, they blanket large areas of the Northeast with varying degrees. The probability and frequency of Nor'easters occurring in Carver is high. Their severity is rated as serious, and the area of impact and occurrence remains widespread. Increases in the intensity and frequency of extreme weather events as the climate changes may include more nor'easters and higher precipitation amounts during winter storms.

[81] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[82] https://scijinks.gov/noreaster/
[83] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Ice Storms

An ice storm is caused by liquid rain falling and freezing on contact with cold objects resulting in the accumulation of at least ¼ inch of ice on exposed surfaces. Other types of freezing precipitation are ice pellets, sleet, and hail. Ice pellets are small translucent balls of ice that form when raindrops or snowflakes pass through a thin layer of warmer air where they melt, and then pass through a layer of cold air where they freeze.[84] Sleet occurs when falling snow passes through a layer of warm air between the ground and the clouds, referred to as a temperature inversion, where it melts. It then refreezes when it passes through a layer of cold air before reaching the Earth's surface.[85] Sleet is a wintertime phenomenon, while hail tends to occur in the warmer spring and summer months.[86] Hail is discussed in the Thunderstorm hazard. These freezing precipitation events create hazardous driving and walking conditions. Tree branches and powerlines can easily snap under the weight of the ice.

From 1998 to 2017, the National Climatic Data Center (NCDC) reported 28 ice storm events in the state of Massachusetts. All the storms within that period occurred between November and February, most frequently occurring in late December and early January. Ice storms are more common in Western and Central Massachusetts in the higher elevations.[87] It is, however, possible that other areas across Massachusetts could experience ice storms. During an ice storm event, it is likely that many areas across the state would also experience this hazard.

Ice storms occur with only medium frequency, occurring only 8 times in Plymouth County as a whole between 1971 and 2012.[88] However, no significant ice storm events have been reported in Carver. Based on past Plymouth County data, the probability of having an ice storm in Carver sits at nearly 20%. The extent of these ice storms in Plymouth County, meaning their scale and magnitude, has been mild to moderate. The previously-mentioned severe winter storms have been of a higher magnitude—downing power lines and breaking trees—than most of the Plymouth County ice storms ever have.

[84] https://cloudatlas.wmo.int/en/ice-pellets.html
[85] https://www.nationalgeographic.org/encyclopedia/sleet/
[86] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[87] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[88] State Hazard Mitigation Plan, September 2013 https://www.mass.gov/files/documents/2017/01/mp/massachusetts-state-hazard-mitigation-plan.pdf

Ice Jam

Ice jams are where ice accumulates in a river blocking the flow of water. Ice jams can cause flooding and even flash flooding in areas adjacent to rivers when water flows around the ice and creates a path different from the stream channel.[89] The main threat of ice jams is flooding, so ice jam mitigation is the same as that for flooding. According to the Army Corps of Engineers Ice Jam Database, no ice jams have been reported in Carver and therefore are not considered a significant threat. Figure 3-9 shows a map of Southern New England where ice jams are not that common.

Figure 3-9. Ice Jams in Southern New England
Source: Ice Jam Database, Ice Engineering Research Group[91]

Ice jams impact a relatively small area compared to other winter hazards. They block the flow of water which would impact the adjacent area and a significant portion of the watershed both upstream as the water accumulates and downstream when the ice jam breaks, releasing a large volume of water downstream.

[89] https://scijinks.gov/ice-jams/
[91] https://icejam.sec.usace.army.mil/ords/f?p=101:17:3711271468783::NO::P17_WATER_YEAR:1

Average/Extreme Temperatures

In Plymouth County, average temperatures are increasing, days with extreme heat are becoming more frequent, and days with extreme cold are becoming less frequent. Temperatures in the middle of winter in 2021 are generally between 22 and 40 degrees while temperatures in the summer are between 61 and 81 degrees Fahrenheit.[92] Based on trends since 1971, Plymouth County can expect to see average temperatures increase by several degrees over the next thirty years due to climate change.[93]

There is no universal definition for extreme temperatures. The term is relative to the usual weather in the region based on climatic averages. Extreme temperatures can be defined as those that are far outside of the normal ranges for Massachusetts. Over the last twenty years in Massachusetts, there have been an average of 2 extreme heat and 1.5 extreme cold weather events each year.[94] Due to climate change causing summer temperatures to rise in this region, there could be 13-56 extreme heat days during the summer, a drastic increase from an average of 2.[95] The young and elderly as well as those with preexisting health conditions are particularly vulnerable to extreme temperatures. When Carver experiences extreme temperatures, both extreme heat and extreme cold, Massachusetts and neighboring states usually also experience extreme temperatures at varying degrees.

Extreme Heat

Extreme heat is one of the leading causes of weather-related deaths in the United States. Extreme heat or a heat wave in Massachusetts is generally defined as a period of 3 or more consecutive days with temperatures over 90 degrees Fahrenheit. Several watches and warnings, in Table 3-11, are issued if Massachusetts is experiencing excessive heat for shorter periods of time as well.

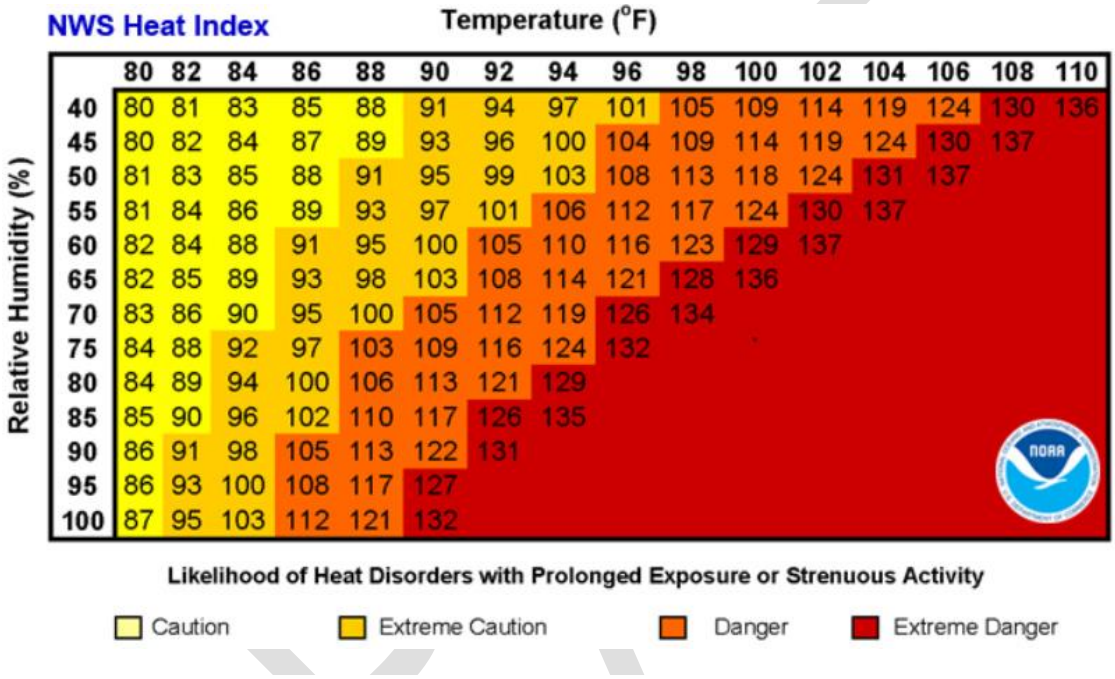
Table 3-11. Massachusetts Extreme Heat Watches and Warnings
Source: Mass.gov Safety Tips for Specific Threats & Hazards[96]

Watches and Warnings	Descriptions
Excessive Heat Watch	Conditions are favorable for an excessive heat warning in the next 24-72 hours.
Heat Advisory	Daytime heat indices of 100ºF–104ºF for two or more hours. The heat index is a measure of how hot it feels when relative humidity is factored in with air temperature.
Excessive Heat Warning	Daytime heat indices of greater than or equal to 105°F for two or more hours.

The Heat Index in Figure 3-10 shows the risk of extreme heat with varying temperatures and relative humidity amounts. There have been three days with excessive heat reported in Plymouth County since 2010. High heat was recorded on July 6, 2010, where heat index values ranged from 100-106 for most of Southern New England,

[92] https://weatherspark.com/m/26829/1/Average-Weather-in-January-in-Plymouth-Massachusetts-United-States#Figures-Temperature
[93] https://resilientma.org/datagrapher/?c=Temp/county/avgt/ANN/25023/
[94] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[95] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[96] https://www.mass.gov/info-details/extreme-heat-safety-tips

and the Plymouth Municipal Airport recorded heat index values between 100-104. Excessive heat was recorded on July 22, 2011, where the Plymouth Municipal Airport recorded heat index values between 105-108 over a seven-hour period.[97] Excessive heat was also recorded on July 3, 2018, where heat index values reached 105-109 in Eastern Massachusetts. On this same day, the Marshfield Airport also recorded a heat index value of 107 for three hours.[98] According to the Heat Index in Figure 3-10, the classification for the 2010 high heat event is "Extreme Caution" indicating the possibility of heat stroke, heat cramps, or heat exhaustion with prolonged exposure or physical activity. The classification for the 2011 and 2018 extreme heat events is "Danger" indicating likely heat cramps and exhaustion and possible heat stroke.



Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Figure 3-10. Heat Index and Effects on the Body
Source: National Weather Service[99]

Extreme heat events can be very dangerous to health and can even be fatal. These very hot days cause an influx of hospital admissions for heat-related illnesses like heat stroke, heat cramps, and heat exhaustion, as well as for respiratory and cardiovascular disorders. Higher temperatures cause higher ozone levels and the buildup of harmful airborne pollutants that can greatly impact the function of respiratory systems.[100] These

[97] https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=334430
[98] https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=765400
[99] https://www.weather.gov/ama/heatindex
[100] https://www.cdc.gov/climateandhealth/pubs/extreme-heat-final_508.pdf

very hot days are especially risky for older adults, children, and individuals who are ill or overweight.[101] Extreme heat can be a huge concern for those working outside as well.

When temperatures reach these heights, there is a much greater demand for electricity to cool homes and businesses, but this high demand can also lower the ability of transmission lines to carry power, potentially causing issues with the reliability of electricity during heat waves. Power outages are one of the greatest concerns during waves of high heat. Other critical infrastructure, including roads, bridges, train tracks, and substations can experience stress due to heat waves as well.

These unusually warm temperatures can also put a stress on crops and livestock, which is of particular concern to Carver because it is an agricultural town. As temperatures increase, aquatic habitats like lakes and ponds warm. Thus, the amount of dissolved oxygen available to both plant and animal species decreases, creating more favorable conditions for harmful algal blooms.[102] In addition to causing health issues, extreme heat can increase evaporation, cause earlier winter and spring snowmelt, exacerbate drought conditions, and dry out forested areas, greatly increasing the chance of wildfires.[103]

Extreme Cold

Similar to how humidity can have a significant impact on how hot it feels, wind speed can greatly impact how cold it feels. As wind increases, it draws heat from the body, causing skin temperature and eventually internal body temperature to drop, making the body feel much colder. Wind chill temperatures indicate how cold people and animals feel when outside. The Wind Chill Chart in Figure 3-10 shows the risk of extreme cold with varying temperatures and wind speeds.

[101] https://www.ready.gov/heat
[102] https://resilientma.org/changes/rising-temperatures
[103] https://www.c2es.org/content/heat-waves-and-climate-change/

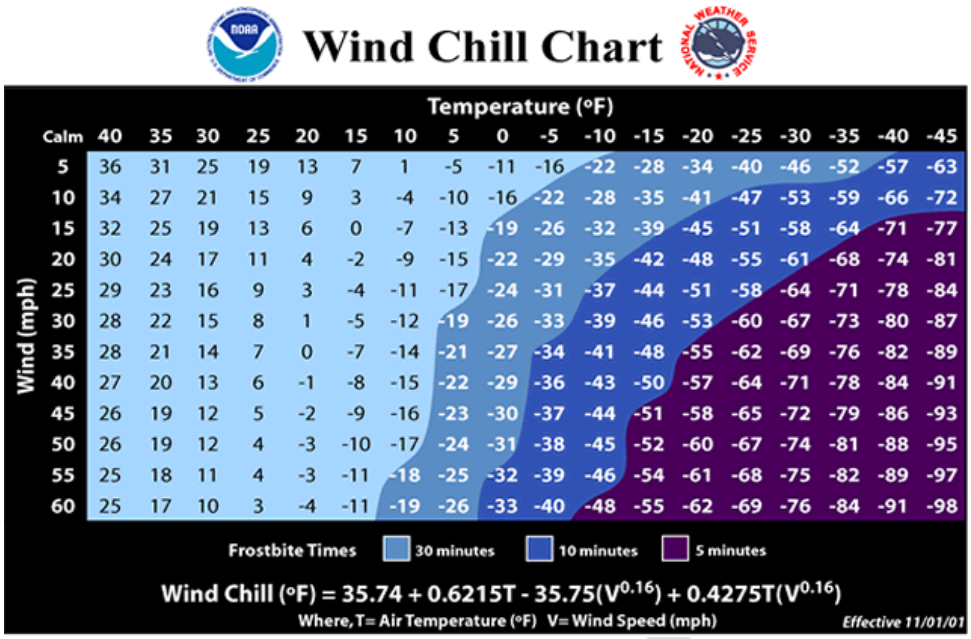


Figure 3-10. Wind Chill Chart
Source: NOAA National Weather Service[104]

Wind chill advisories are issued when the wind chill is forecasted to dip below -15 degrees Fahrenheit for 3 hours or more.[105] Associated watches, advisories, and warnings for extreme cold are detailed in Table 3-12. There have only been two days with extreme cold/wind chill reported in Plymouth County since 2000. Extreme cold/wind chill was recorded on February 16, 2015; the Plymouth Municipal Airport (KPYM), less than 3 miles from Carver, reported wind chills as low as 28 below zero.[106] Wind chills this low indicate frostbite could occur after 30 minutes of being outside. Extreme cold/wind chill was also recorded on February 14, 2016, where wind chills as low as 36 below zero were recorded in nearby Plymouth.[107] Wind chills this low indicate frostbite could occur after only 10-30 minutes of being outside.

Table 3-12. Massachusetts Extreme Cold Advisories and Warnings
Source: Mass.gov Safety Tips for Specific Threats & Hazards[108]

Advisories and Warnings	Descriptions
Wind Chill Advisory	Wind chill index between -15°F and -24°F for at least three hours.
Wind Chill Warning	Wind chill index below -25°F for at least three hours.

Serious health problems can occur from prolonged exposure to the cold, most commonly hypothermia and frostbite. Hypothermia is when body temperatures become abnormally low, which affects the brain, preventing

[104] https://www.weather.gov/safety/cold-wind-chill-chart
[105] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[106] https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=560740
[107] https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=621797
[108] https://www.mass.gov/info-details/extreme-cold-safety-tips

individuals from thinking clearly. Frostbite is when the skin and tissue just below the skin freeze because of extended exposure to the cold. It can permanently damage the body and in extreme cases it can lead to amputation.[109] Cold weather can also increase heart attack risks because the heart works harder to keep warm in cold weather, increasing heart rate and blood pressure.[110]

Based on past reports of extreme heat and cold in Plymouth County, we can predict future probabilities. There were three reports of high heat index values and two reports of extreme cold and wind chill since 2010. According to data from the previous 11 summers, there is roughly a 27% chance of a reportable extreme heat event in the next year. According to data from the previous 12 winters, there is roughly a 17% chance of an extreme cold event occurring in the next year. However, due to climate change causing the Northeast to become more warm and wet, the number of hot days and days with extreme heat are projected to greatly increase while the number of cold days and days with extreme chill are projected to decrease. Figure 3-11 shows the projected increase in days with maximum temperatures above 90 degrees Fahrenheit. Figure 3-12 shows the projected decrease in days with minimum temperatures below 32 degrees Fahrenheit in Plymouth County. It is clear that hot days and days with extreme heat will become more frequent with time. The probability of extreme temperatures occurring in Carver is high. Days with high heat are increasing while days with extreme cool are decreasing. The severity of extreme temperature events is relatively minor given that the main consequences are human health and the potential to lose power. The area of occurrence of these extreme temperatures would be widespread and the area of occurrence would naturally be statewide.

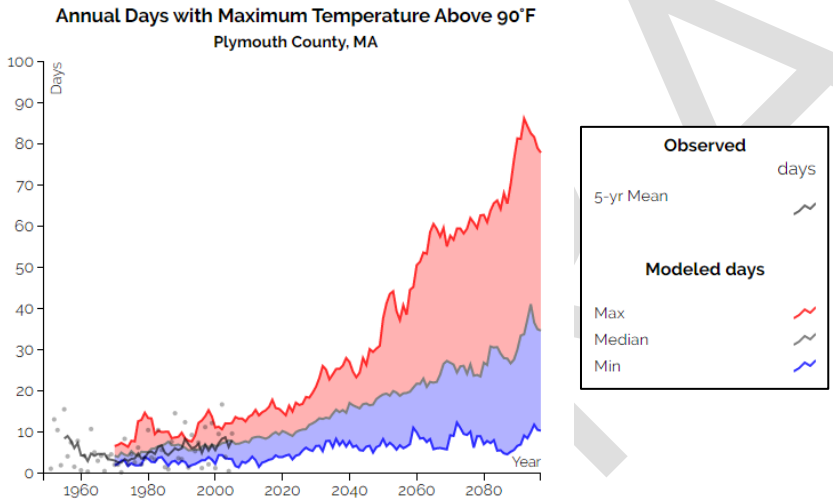


Figure 3-11. Projected Increase in Hot Days in Plymouth County, MA
Source: Resilient MA[111]

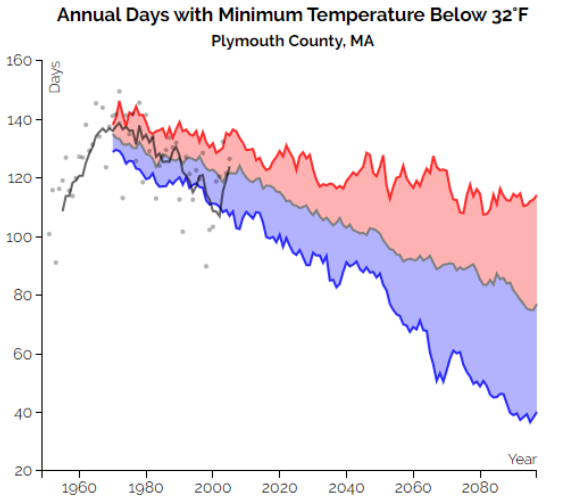


Figure 3-12. Projected Decrease in Cold Days in Plymouth County, MA
Source: Resilient MA[112]

[109] https://www.cdc.gov/disasters/winter/pdf/extreme-cold-guide.pdf
[110] https://www.healthline.com/health-news/how-extremely-cold-weather-can-affect-your-health#Less-obvious-effects
[111] https://resilientma.org/datagrapher/?c=Temp/county/tx90/ANN/25023/
[112] https://resilientma.org/datagrapher/?c=Temp/county/tn32/ANN/25023/

Wildfire

Wildfires are unplanned fires caused by lightning or other natural causes, by accidental or arson-caused human ignitions, or by escaped prescribed fires. These fires can be highly destructive and can be very uncontrollable. They occur in forested, semi-forested, or less developed areas.[113] Wildfires are a natural part of the southeastern Massachusetts ecosystem. Fires keep the forest floor clean of debris, encourage the growth of grasses that serve as wildlife feed, and ensure that trees have plenty of room to grow. Natural fires, recurring in a cyclical manner, can recycle nutrients and create a diversity of natural habitats. In these ways, wildfires that occur in isolated areas can be a positive force. Increasingly, however, development is encroaching into forested areas and wildfires present a danger to human life and man-made facilities. Forest fires that used to be in remote areas are now forest fires in people's backyards. The dual issues of human suppression of forest fires and human encroachment into forest areas, has increased the risks associated with wildfire. The dispersion of growth into rural and undeveloped areas is a widespread issue. As development (particularly low-density residential development) pushes into flammable vegetated areas, the threats of wildfires increase. Carver does have low-density development sited within forested landscapes.

The state of Massachusetts is likely to experience at least one larger fire each year with significant damages. Barnstable and Plymouth Counties are the most vulnerable to wildfires due to their vegetation, sandy soils, and wind conditions.[114] Portions of southeastern Massachusetts, including the Myles Standish State Forest, are classified as "pine-barrens." Carver's 2010-2015 Open Space and Recreation Plan states that this ecosystem is considered a unique habitat according to the Natural Heritage and Endangered Species Program.[115] Pine barrens are habitats comprised of sandy, nutrient-poor soils, with a poor water-retaining capacity that are prone to drought, acidic water and soil, and fire adapted plant communities.[116] This ecosystem is characterized by Pitch pine (*Pinus rigida*) in the overstory and an understory comprised of dense thickets of Scrub oak (*Quercus ilicifolia*) and other low-growing shrubs like Lowbush blueberry (*Vaccinium augustifolia*) and Black huckleberry (*Gaylussacia baccata*). Pitch pine and Scrub oak vegetation are resinous and waxy, characteristics that make it the most highly flammable vegetation in the region. The ecosystem of the Pine-Barrens relies on periodic fire for maintenance and regeneration. [117] Fires allow the cones to release stored seeds to perpetuate the barren community. They also boost diversity, removing leaf litter and opening the overstory, allowing more species to establish themselves here. Table 3-13 details the vegetated coverage of the southeastern Massachusetts region; this table can be used to assess flammability.

[113] https://www.nps.gov/orgs/1965/wildfires-prescribed-fires-fuels.htm
[114] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[115] https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/openspaceplan-2010.pdf
[116] https://pinelandsalliance.org/learn-about-the-pinelands/ecosystem/pine-barrens-vs-pinelands/
[117] https://extension.unh.edu/goodforestry/html/7-4.htm

Table 3-13. Vegetated Coverage in Southeastern MA

Vegetation Type	Acres	Percent of Total
Pitch pine/Scrub oak	120,332.00	23 %
Northern hardwood	41,423.49	8 %
Red Maple dominant	19,191.91	4 %
Oak/Maple Birch	3,908.96	1 %
Open meadow	7,283.46	1 %
Forested wetlands	56,101.70	11 %
Mixed hardwood pine	42,023.78	8 %
Suburban forest	92,233.93	18 %
Waterbodies/Beaches/No vegetation	132,883.69	26 %

The map in Figure 3-13 shows the very flammable Pitch Pine (Pinus rigida)/Scrub Oak (*Quercus ilicifolia*) communities in and around Carver and the Myles Standish State Forest. The Myles Standish State Forest Pitch pine-scrub oak forests have some of the highest fuel loads of any other forest along the Northern Atlantic Coast.[118]

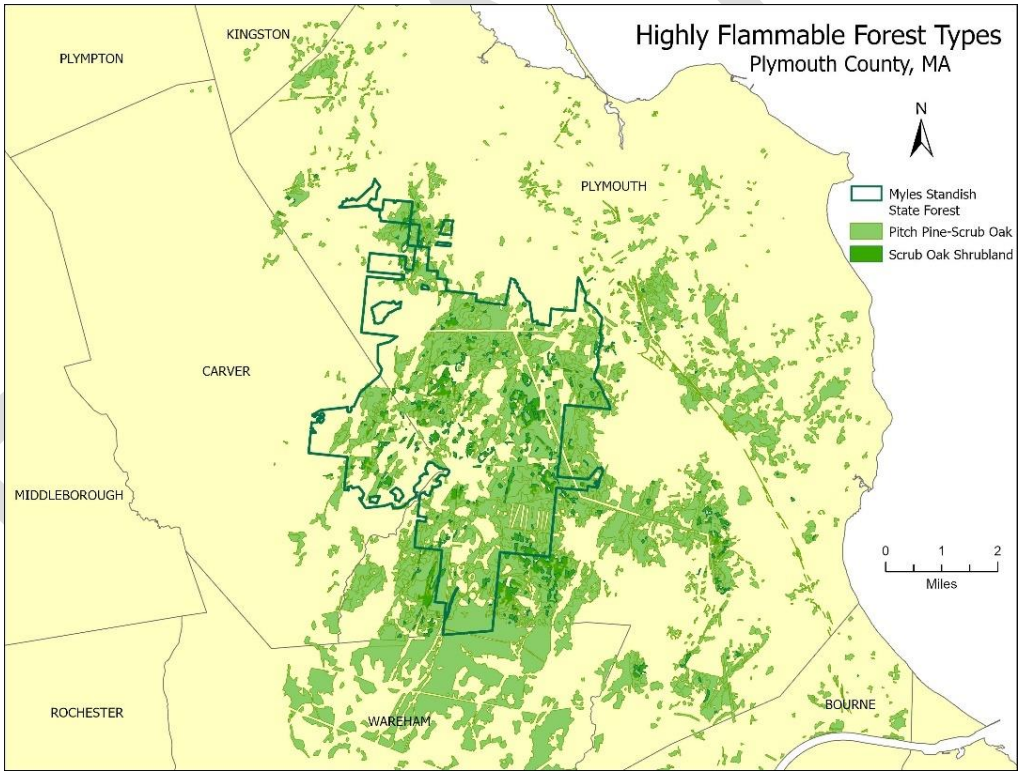


Figure 3-13. Highly Flammable Pitch Pine and Scrub Oak
Data Source: MassGIS[119]

[118] https://www.fws.gov/uploadedFiles/02w_Chapter_2_Affected_Environment(4969KB).pdf
[119] https://www.mass.gov/info-details/massgis-data-priority-natural-vegetation-communities

Carver has a long history of wildfires and several risk factors including the lack of a public water supply for firefighting; rapid population growth; concentrations of mobile homes and elderly residents; development encroaching on forested areas; and significant risk areas including 1,900 acres of state forest. Fighting fires relies on having modern wildfire apparatus, immediate and adequate access to the area, early detection, and sufficient water. Since there is no public water supply, Carver relies on two tanker trucks and fire ponds for fighting wildfire and structural fires. It is crucial that there are ample water resources for the fire department to use in the case of fires. Increasing drought frequencies (see the Drought section) pose a threat to the ability of the Carver Fire Department to keep the people of Carver safe. Moving forward, increases in seasonal droughts and warmer temperatures will increase Carver's wildfire risk.[120]

In addition, the increasing encroachment of developments on these very flammable habitats is increasing the risk of widespread fire damage to property. Mobile home communities are of particular risk of wildfires due to the high density of people living in close proximity. Fire load is highest in areas with pitch pines, which are most prevalent in South Carver. Some solutions include zoning regulations to avoid development any closer to public lands, ensuring homeowners living near these communities are maintaining their properties according to fire safety standards, and prescribed fires.[121]

The Carver Fire Department was a responder to the 1957 major crown fire that burned from Carver to the Atlantic Ocean destroying a total of 14,000 acres. In 1964, the "White Island" fire began on Federal Road in Carver and burned 800 acres towards Charge Pond in the state forest and this triggered the burning of an additional 5,500 acres with 28 structures in neighboring Wareham. Several of these large historic fires are mapped in Figure 3-14. During the last 30 years there have been numerous fires of 100 acres or less associated with the Myles Standish State Forest. Some fires reached more than 1,000 acres.

Since 2005 there have been no large wildfires. There have, however, been 99 reported brush fires according to the Carver Fire since 2017. This means there are roughly 20 brush fires each year. In any given year there is a 100% chance a brush fire will occur. Large wildfires are much less common but still pose a great risk to Carver given the vegetation. Plymouth County has experienced 13 large wildfires since 1957. Based on the historical wildfire record, there is roughly a 20% chance that Plymouth County experiences a large wildfire in any given year.

[120] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[121] https://www.fws.gov/uploadedFiles/02w_Chapter_2_Affected_Environment(4969KB).pdf

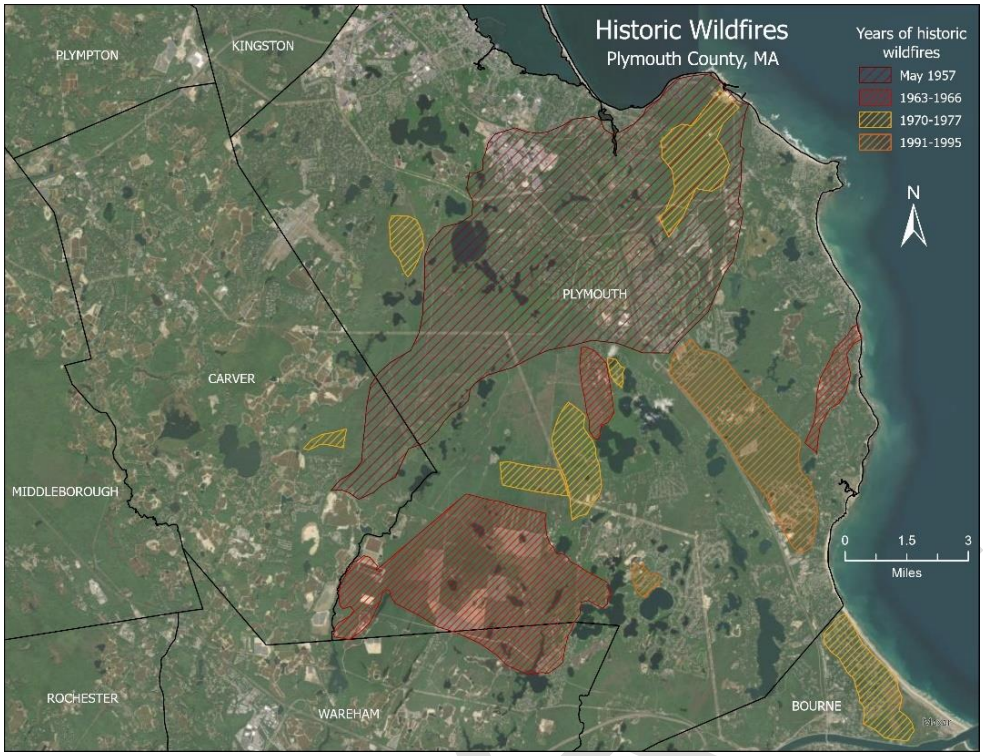


Figure 3-14. Historic Wildfires in Plymouth County
Data Source: Town of Plymouth Open Space and Recreation Plan[122]

The types of injuries that wildfire can cause include loss of life, loss of property, and environmental damage. Wildfires can impact human health, drinking water, and agriculture. The smoke produced can impact the health of both humans and animals and cause both eye and respiratory illness, especially among children and the elderly. Fires burning in residential areas can also melt plastic water pipes, contaminating water sources with carcinogens.[123] Crops can catch fire, greatly impacting those working in agriculture. Wildfires produce greenhouse gasses, aerosols, ash, and debris and some of the larger particles can settle in reservoirs. Lastly, water treatment plants could close due to damage or power outages caused by wildfires.[124] Although the frequency of wildfire in Carver is considered medium, the severity would be extensive. Although the area of impact would probably be relatively localized, the area of occurrence is certainly regional**.**

Currently, Carver Fire Department has two tanker trucks and utilizes four large brushbreakers and two Forestry apparatus's outfitted with specialized equipment for fighting brush fires. The Carver Fire Department continues to apply for grants for additional tanker trucks and to add Global Positioning System units on all fire trucks in order to better prepare for wildfires. The Fire Department also focuses heavily on public education and fire prevention demonstrations to aid in the prevention of fires. In addition, the state continues a program of thinning out the Myles Standish State Forest in an effort to prevent wildfires and brushfires through good forest management.

[122] Town of Plymouth Open Space and Recreation Plan, Major Historic Forest Fires, p.107, 2017 https://www.plymouth-ma.gov/sites/g/files/vyhlif3691/f/uploads/2017_plan_draft_-_final_2018.pdf
[123] https://www.c2es.org/content/wildfires-and-climate-change/
[124] https://www.drought.gov/sectors/wildfire-management

Invasive Species

Invasive species are "non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems."[125] Climate change is causing stress to native ecosystems, making it easier for invasive species to spread and dominate. Massachusetts has warmed by more than two degrees Fahrenheit in the last century, causing heavier and more frequent precipitation and storm events, and hotter and drier summers, among other impacts.[126] In combination with the increased disturbance due to greater development and urbanization, and a shift in nutrient availability, invasive species are rapidly spreading and out-competing native plants.[127]

Invasive plants are spread through underground root systems and dispersed by the birds and mammals that eat the seeds and carried via wind and water.[128] For this reason, invasive species have a wide range of impact, affecting the entire state of Massachusetts and the country. Those that are most common in Carver are commonly found all over New England. The entire Town of Carver has minor issues with three invasive species listed on the Massachusetts Invasive Plant List: Common reed (*Phragmites australis*), Japanese knotweed (*Polygonum cuspidatum),* and Oriental bittersweet (*Celastrus orbiculatus*).[129] These three species can be found scattered around the whole town. Common reed can be problematic because it grows quickly, forming large, dense stands, and excludes other species by creating shade. Phragmites flourishes in disturbed areas but can also be found in pristine areas. It is primarily found in wetland areas with full sun and can tolerate both freshwater and salt water. This species is a big issue because it can alter wetland hydrology, increases the potential for fire, and degrades wetland wildlife habitat.[130]

Japanese knotweed spreads rapidly, forming dense thickets that can crowd and shade out native vegetation and reduce habitat for native animals.[131] Knotweed thrives in disturbed areas that are not stabilized with other vegetation and can tolerate a variety of adverse conditions including full shade, high temperatures, high salinity, and drought.[132] It can be found along streams and rivers, in low-lying areas, rights-of-way, waste places, and around old homes and farmsteads.[133] Knotweed poses a significant threat to riparian areas where it can survive floods, rapidly colonize scoured areas, and outcompete native species.

Oriental bittersweet is a climbing woody vine that spreads easily and quickly. It can overwhelm and kill other vegetation by choking them or by producing dense shade, preventing other plants from getting sunlight. It can also cause uprooting and blow-over during high winds and heavy snowfall.[134] Bittersweet can be found along the edges of roadways and forests, open woodlands, coastal areas, salt marshes, and disturbed lands. It is

[125] Massachusetts Invasive Plant Advisory Group (MIPAG) https://www.massnrc.org/mipag/index.htm
[126] What Climate Change Means for Massachusetts, US EPA, August 2016 https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ma.pdf
[127] Szyniszewska, Anna, University of Florida's Department of Geography, Invasive Species & Climate Change, Climate Institute https://climate.org/archive/topics/ecosystems/invasivespecies.html
[128] https://www.fws.gov/gomcp/pdfs/phragmitesqa_factsheet.pdf
[129] The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts (with annotated list), Massachusetts Invasive Plant Advisory Group (MIPAG) https://www.mass.gov/doc/invasive-plant-list/download
[130] https://www.invasive.org/alien/pubs/midatlantic/phau.htm
[131] Japanese Knotweed, New York Invasive Species (IS) Information http://nyis.info/invasive_species/japanese-knotweed/
[132] https://www.invasive.org/alien/fact/pdf/faja1.pdf
[133] http://nyis.info/invasive_species/japanese-knotweed/
[134] Asiatic Bittersweet (*Celastrus orbiculatus*), Town of Concord Massachusetts https://concordma.gov/774/Asiatic-Bittersweet-Celastrus-Orbiculatus

often found in sunny, open areas but is tolerant of shade and therefore can invade inner forested areas as well.[135]

Carver's Open Space and Recreation Plan identifies two non-native species, Norway maple (*Acer platanoides*) and Norway spruce (*Picea abies*). Norway maple is an invasive tree species that can be found in isolated stands along Main Street in Carver,[136] and has been found in every county in Massachusetts.[137] This species can be problematic because it produces large numbers of seeds and develops dense stands that can outcompete native plants.[138]

Norway spruce is a non-native species that can also be found along Main Street in Carver, and in every county in Massachusetts. However, Norway spruce is not considered an invasive, likely invasive, or potentially invasive species by the Massachusetts Invasive Plants Advisory Group (MIPAG).[139] Despite their potential impacts, neither of these species are of great concern to the Town of Carver.

Carver's Open Space and Recreation Plan states that much of Carver has a water table at or near the ground surface nine months out of the year. Of the roughly 25,000 acres in Carver, sand-muck soils make up roughly 3,500 acres or 14% of the area in town while marsh muck and peat make up roughly 3,100 acres or 13% of the area in town. Roughly 15% is open water and 5% is adjacent shorelines. This means that nearly 50% of Carver is wetlands. In 2015, cranberry (*Vaccinium macrocarpon*) production comprised roughly 4,000 acres or 16% of land area in Carver. Coupled with the necessary and related uplands adjacent to bogs, this number increases to roughly 6,900 acres and 28% of land area in town. Today, due to increases in cranberry production, land used directly for the production of cranberries, is closer to 20-25% of land area in town.

The main invasive species concern for cranberry bogs is locally referred to as "Foxtail" but is also known as Carolina fanwort (*Cabomba caroliniana*). This species is also on the Massachusetts Invasive Plant List. It is a thick spreading plant that can form very dense stands, clogging waterways and irrigation systems, as well as choking out native plant species, heating water temperatures, and limiting fish species. It can be spread through seeds or rhizomes, or by attaching itself to boats and waterfowl. It can also survive the harsh winters under layers of ice.[140] For smaller areas, like those found in Carver's cranberry bogs, this species is controlled by using rakes and excavators to remove the plant and surrounding peat. According to GoBotany, this species is found in nearly every county in Massachusetts and in other regions of southern New England as well.

Carolina fanwort is troublesome primarily for private cranberry growers and impacts their ability to grow cranberries efficiently. They spend time removing this invasive species, taking away from time they could be spending on their crops. Cranberries are native to Massachusetts and invasive species threaten the ability for native species to thrive and succeed. The cranberry industry is significant in Carver and invasive species pose a big threat to the local economy and residents who rely on this industry for their livelihood. The probability that Carver faces issues with invasive species in the future is 100% because invasives are already present in town.

[135] https://www.invasive.org/alien/pubs/midatlantic/ceor.htm
[136] Town of Carver 2010-2015 Open Space & Recreation Plan https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/openspaceplan-2010.pdf
[137] Acer platanoides (Norway maple) Native Plant Trust Go Botany https://gobotany.nativeplanttrust.org/species/acer/platanoides/
[138] Norway maple, Mass Audobon https://www.massaudubon.org/learn/nature-wildlife/invasive-plants/norway-maple
[139] Species Reviewed Alphabetical List, Massachusetts Invasive Plants Advisory Group (MIPAG), (Last updated 06/2021) https://www.massnrc.org/mipag/speciesreviewed_alpha.htm
[140] Fanwort (*Cabomba caroliniana*), Town of Concord Massachusetts https://concordma.gov/768/Fanwort-Cabomba-Caroliniana

They will likely continue to grow and spread due to increasing temperatures and precipitation coupled with development that creates new disturbed areas for these invasives to colonize.

Carver contains several areas that are particularly vulnerable to invasive species. According to MassWildlife's Natural Heritage & Endangered Species Program (NHESP), Carver has certified vernal pools, priority habitats of rare species, natural communities, and estimated habitats of rare wildlife. All of these locations, indicated in Figure 3-15, contain rare or threatened species that would be greatly impacted by further spread of invasive species. These areas, highlighted on the map below, along with Carver's cranberry bogs, are the most vulnerable areas in Carver. Invasive species can be found everywhere but they usually occur in specific locations, especially in disturbed areas. In contrast to other hazards, they cause inconveniences rather than massive consequences affecting the entire town.

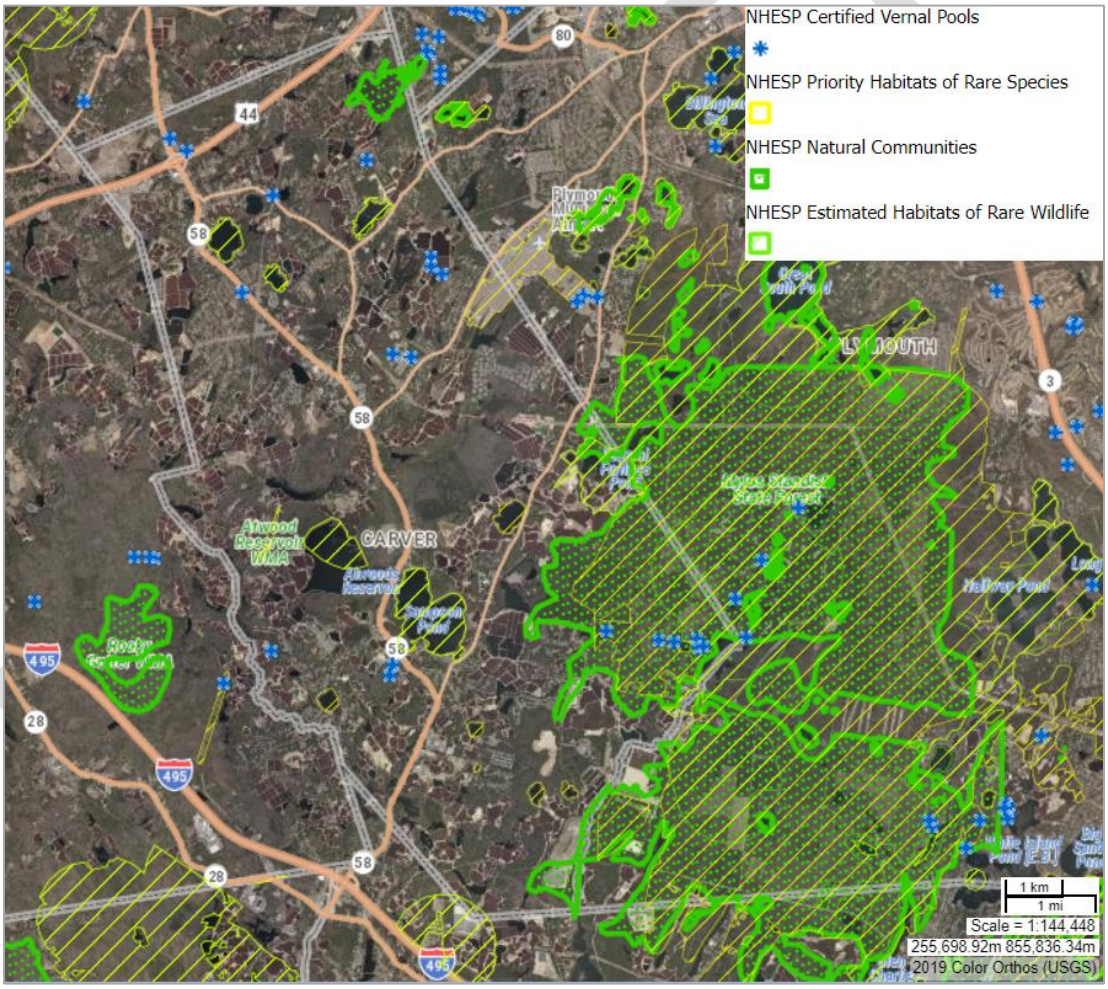


Figure 3-15. Natural Heritage & Endangered Species Program (NHESP) Vulnerable Areas in Carver, MA Source: MassGIS[141]

[141] https://www.mass.gov/service-details/natural-heritage-gis-resources

Drought

Drought is a prolonged period characterized by abnormally dry, moisture-deficient conditions largely due to a reduction in precipitation or an increase in evapotranspiration due to heat stress. Drought can affect both natural and anthropogenic systems and is most commonly associated with wildfires. Combined with air temperature, humidity, wind speed, soil moisture, and the availability of fuel, or vegetation, drought can greatly impact the frequency, intensity, and severity of wildfires. A lack of rain and low humidity dries out vegetation making it more flammable.[142] Healthy vegetation provides many services including slowing the flow and reducing the volume of stormwater runoff. However, under drought conditions, vegetation struggles to survive, exacerbating the impacts of flood events. The plants that were formerly helping to contain and stabilize the soil die and leave the soil looser and more easily disturbed. Both the reduction in water intake and the increased soil erosion can cause the weakening of tree root systems and could lead to trees falling more easily during high wind events.[143]

Productivity and biodiversity are at risk when drought conditions are present. Native plants are not getting enough water, and are struggling and dying, making it easier for invasive colonizers, both plants and insects, to arrive and start outcompeting native species. The diminishing vegetation causes a decline in viable wildlife habitat. In addition, livestock and wildlife have fewer water resources and vegetation required for survival during droughts.[144]

Water quality and quantity is also diminished as a direct result of drought. This can cause a reduction in streamflow, groundwater, and surface water, that can affect aquatic organisms and their habitat; it can reduce groundwater recharge, posing issues for individuals with private wells; it can have a significant economic impact on large water users such as golf courses, industrial operations, and cranberry farms; and can lead to increased demand, and diminished supply and pressure for firefighting. This is particularly concerning in Carver because there is no public water supply and the majority of water to extinguish fires comes from ponds.[145]

Carver is a largely agricultural town that has many cranberry bogs, reservoirs, wetlands, and waterways, many of which are interconnected. Cranberry growing alone– wetland and necessary and related upland areas– accounts for at least 28% of Carver's land area.[146] Since there is no town-wide municipal water, the Fire Department fills its tanker trucks from the town's ponds, rivers, private reservoirs, and other private wetlands for its fire suppressing water supply. If these water supplies were to become low or depleted and, since residents mostly depend on private well water, prolonged periods of drought could have serious consequences in terms of residential health and safety, fire suppression, and impairment of the natural environment.

Carver has worries about water supply both for drinking water and firefighting. The extended drought during summer 2016 emphasized the need to increase the public water supply to ensure adequate access during longer droughts, as the two Town wells were drawn down during that summer and several private wells dried up. During the drought, freshwater springs in Sampson's Pond dried up and the water level dropped eighteen

[142] https://www.drought.gov/topics/fire
[143] https://resilientma.org/changes/changes-in-precipitation
[144] http://threeissues.sdsu.edu/three_issues_droughtfacts02.html
[145] https://www.mass.gov/doc/massachusetts-drought-management-plan/download?_ga=2.268357966.1958624045.1638388103-960195772.1620831883
[146] Town of Carver 2010-2015 Open Space & Recreation Plan https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/openspaceplan-2010.pdf

inches. If water levels drop enough, Carver might have to consider expanding reservoirs and digging them deeper in order to meet their water needs. Drought conditions also exacerbate problems with algal blooms in several of the Town's ponds, including Sampson's Pond.[147] Another concern is if bog or reservoir properties are sold to non-cranberry growers. The conveyance of water between cranberry bogs is crucial to the success of bogs downstream. It is important that owners of these properties understand their role and responsibilities owning properties upstream of other cranberry bogs.

Massachusetts generally has enough precipitation to support the demands residents and businesses place on water. However, the state has suffered several major statewide droughts. The most severe, state-wide droughts occurred in 1879-1883, 1908-1912, 1929-1932, 1939-1944, 1961-1969, 1980-1983, and 2016-2017. Several droughts that were not as severe occurred in 1999, 2001, 2002, 2007, 2008, 2010, and 2014.[148]

The Southeast Region of Massachusetts, which includes Plymouth, Bristol, and Norfolk counties, has experienced a drought during four of the past six years between 2016 and 2021. The worst drought in the past 6 years occurred during the summer and early fall of 2020. It is clear that the frequency of droughts in this region is increasing. Table 3-14 shows the dates and status of droughts that occurred between 2016 and 2021 in the Southeast Region of Massachusetts and Table 3-15 details the specifics of each drought level. It is important to note that the names of the status categories changed between 2017 and 2020, so what we now call "Mild" was formerly called "Advisory," "Significant" was formerly called "Watch," and "Critical" was formerly called "Warning." According to this data, there have been ten instances over the past 6 summers where the drought status in the Southeast Region has ranged from Mild (formerly Advisory) to Critical (formerly Warning). This means there is a very high likelihood, nearly a 100% chance, that Carver will experience at least one drought in the next several summers. Based on this data, we can expect at least 15 droughts in this range between 2022 and 2030. Over these six years, there were four that had at least one drought so in any given year, there is roughly a 66% chance that Carver will experience a drought. However, this likelihood will increase with time because climate change is causing hotter and drier summers.

[147] Carver MVP Plan, 2018 https://srpedd.s3.amazonaws.com/wp-content/uploads/2020/08/13213206/Carver-MVP-Plan-050118.pdf
[148] https://www.mass.gov/doc/massachusetts-drought-management-plan/download?_ga=2.268357966.1958624045.1638388103-960195772.1620831883

Table 3-14. Recorded Droughts 2016 – 2021
Source: Mass.gov Drought Status[149]

Year	Begin Date	End Date	Southeast Status
2016	7/1/2016	7/31/2016	Advisory
2016	8/1/2016	8/31/2016	Watch
2016-2017	9/1/2016	2/28/2017	Warning
2017	3/1/2017	3/31/2017	Watch
2017	4/1/2017	5/31/2017	Advisory
2020	7/1/2020	8/31/2020	Significant
2020	9/1/2020	9/30/2020	Critical
2020	10/1/2020	10/31/2020	Significant
2020	11/1/2020	11/30/2020	Mild
2021	3/1/2021	6/30/2021	Mild

Table 3-15. Drought Indices
Source: Massachusetts Drought Management Plan[150]

Drought Level	Precipitation	Groundwater	Streamflow	Reservoir
Normal	1 month below normal	2 consecutive months below normal**	1 month below normal**	Reservoir levels at or near normal for time of year
Mild	2 month cumulative total below 65% of normal	3 consecutive months below normal**	At least 2 out of 3 consecutive months below normal**	Small index reservoirs below normal
Significant	1 of the following: 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
Critical	1 of the following: 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	Same Warning **and** previous month was Warning or Emergency	>8 months below normal**	>7 months below normal**	Continuation of previous month's conditions

[149] https://www.mass.gov/info-details/drought-status#past-drought-declarations-maps-and-history-
[150] https://www.mass.gov/doc/massachusetts-drought-management-plan/download?_ga=2.268357966.1958624045.1638388103-960195772.1620831883

Climate change is projected to cause a small decrease in summer rainfall in Massachusetts. Combined with higher temperatures, the frequency of droughts is expected to increase.[151] Though average precipitation is likely to increase during winter and spring, it is not projected to change significantly during summer and fall. Most of the expected precipitation will fall during extreme precipitation events. Unlike several smaller storms, extreme precipitation events do not significantly recharge groundwater or replenish streams with steady flows. Rather, these extreme events will increase stormwater runoff, especially in areas with high impervious cover.[152]

Rising temperatures will melt snow earlier in spring and increase evaporation, and thereby dry the soil during summer and fall. Flooding is likely to be worse during winter and spring, and droughts worse during summer and fall.[153] According to the Massachusetts State Hazard Mitigation Plan, the chance of a Watch Level drought occurring in Massachusetts in any given month is 8%.[154]

Droughts occur with a high frequency in Carver and their severity is usually minor. Droughts usually have a widespread area of impact and can occur statewide**.** The most vulnerable areas in Carver are the ponds used for firefighting, the cranberry bogs, and the groundwater used to supply wells and the limited areas that have a public water supply. This probability, severity, and length of future droughts could increase dramatically with potential warming climate trends.

[151] https://resilientma.org/changes/changes-in-precipitation
[152] Runkle, J., K. Kunkel, R. Frankson, D. Easterling, A.T. DeGaetano, B. Stewart, and W. Sweet, 2017: Massachusetts State Climate Summary. *NOAA Technical Report NESDIS 149-MA*, 4 pp. https://statesummaries.ncics.org/chapter/ma/
[153] What Climate Change Means for Massachusetts, US EPA, August 2016 https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ma.pdf
[154] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Tornado

A tornado is defined as "a narrow violently-rotating column of air that extends from the base of a thunderstorm to the ground."[155] Tornados were ranked using the Fujita Scale, or the F-Scale (Table 3-16) between the 1970s and 2007. The Fujita Scale rates tornado intensity, based on a wind speed estimate and on the damage tornadoes inflict on infrastructure and vegetation. On February 1, 2007, the Enhanced F-scale (Table 3-17) was implemented, slightly affecting the ranking of tornadoes occurring after the system was implemented. Both the F-Scale and Enhanced F-scale wind speeds are estimates based on damage.

Table 3-16. Fujita Scale
Source: NOAA Storm Prediction Center[156]

SCALE	WIND ESTIMATE (MPH)*	TYPICAL DAMAGE
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	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.
F3	158-206	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.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

[155] https://www.nssl.noaa.gov/education/svrwx101/tornadoes/#:~:text=A%20tornado%20is%20a%20narrow,a%20thunderstorm%20to%20the%20ground.
[156] https://www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3-17. Enhanced F-Scale
Source: NOAA Storm Prediction Center[157]

FUJITA SCALE			DERIVED EF SCALE		**OPERATIONAL EF SCALE**	
F Number	Fastest 1/4-mile (mph) *	3 Second Gust (mph) *	EF Number	3 Second Gust (mph) [1]	**EF Number**	**3 Second Gust (mph)** *
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

The state of Massachusetts experiences mild tornadoes from time to time. On average, Massachusetts experiences 1.7 tornadoes per year, with central Massachusetts being the most tornado prone region.[158] Massachusetts ranked nationally as 35th in occurrences of tornadoes for the period 1950 – 1995, but 16th in fatalities and 12th in property damages based on these same events.[159] These tornadoes, however, are generally very weak and short-lived, only making landfall for a minute or two. According to NOAA's Storm Events Database, Plymouth County has experienced 8 tornadoes since 1950, when collection of this data began (Table 3-18). Based on the data collected during the period of 71 years, there is roughly an 11% chance that Plymouth County will experience a tornado in any given year. According to these records, however, no tornadoes have made landfall in Carver to date (Figure 3-16).[160]

[157] https://www.spc.noaa.gov/faq/tornado/ef-scale.html
[158] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[159] https://www.disastercenter.com/mass/tornado.html
[160] https://www.ncdc.noaa.gov/stormevents

Table 3-18. Plymouth County Tornados 1950-2021
Source: NOAA Storm Prediction Center[161]

Date	Magnitude	Scale Used	3 Second Gust (mph)*	Direct Deaths	Direct Injuries	Damage Estimate	Tornado Length	Tornado Width
9/7/1958	F0	Fujita	45-78	1	1	$ 2,500.00	0	33
7/4/1964	F1	Fujita	79-117	0	0	$ 250,000.00	2.3	33
6/9/1965	F0	Fujita	45-78	0	0	$ 30.00	0.1	33
11/18/1967	F2	Fujita	118-161	0	0	$ 250.00	0.1	17
9/16/1986	F1	Fujita	79-117	0	0	$ 250,000.00	0.1	50
7/10/1989	F1	Fujita	79-117	0	1	$ 25,000.00	0.1	23
7/10/1989	F0	Fujita	45-78	0	0	$ 25,000.00	0.1	23
8/20/1997	F0	Fujita	45-78	0	0	$ -	0.1	5
7/24/2012	EF0	Enhanced Fujita	65-85	0	0	$ 3,000.00	0.03	15

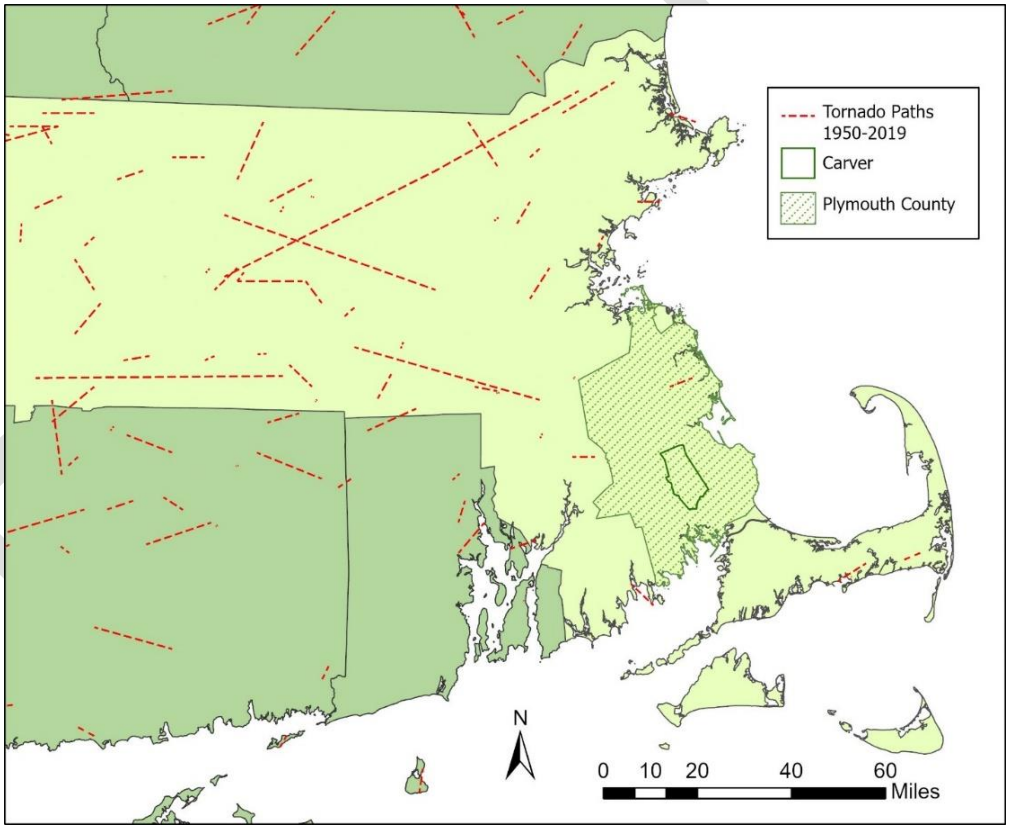


Figure 3-16. Tornado Paths in Southern New England 1950-2019
Data Source: NOAA Storm Prediction Center[162]

[161] https://www.spc.noaa.gov/gis/svrgis/
[162] https://www.spc.noaa.gov/gis/svrgis/

Many of the tornadoes that have made landfall in Plymouth County have minimal and localized impacts. The 1986 tornado in Plymouth County caused damage in a shipyard and to nearby houses. Three walls of a boat storage building were blown out, a chimney toppled, a porch was thrown from a house, and some boats, piers, and floats were damaged. The 1989 tornado was reported in two towns in Plymouth County. This tornado caused localized damage to some homes and a grove of pine trees were severely damaged. The 1997 tornado consisted of three waterspouts that lasted between 15 and 55 seconds, several funnel clouds were spotted, and no property damage or injuries were reported. The most recent tornado that made landfall close to Carver occurred at White Horse Beach, in Plymouth MA, on July 24th, 2012. Three waterspouts formed offshore, moved quickly onshore, and caused minimal damage, including a window that was ripped off its hinges and shattered and damage to a beach umbrella and several awnings. Wind speeds were likely less than 65 miles per hour and records of showers, thunderstorms, hail were noted. Though tornados do occur from time to time near Carver, they are very small and not likely to cause significant damage.

Within this region, tornadoes tend to be more likely in the months of May through September and between the hours of 3 and 6pm. The National Weather Service reports that the warning window for a tornado fluctuates between 8 and 11 minutes.[163] Tornado watch areas can include numerous counties and even states.[164] Tornadoes and other natural hazards that bring high winds can affect the entire southeastern Massachusetts region. Residents of mobile home communities are more vulnerable to tornadoes than the general population – 38% of tornado fatalities are in mobile homes.[165] The higher fatalities do not reflect the fact that mobile home communities are more likely to be hit by a tornado, but rather that, if hit, mobile homes are more vulnerable to damage. According to the 2010 census Carver has 1,118 mobile homes. If hit with a tornado, these communities could be greatly impacted. Tornadoes impact a very specific area and depending on the size, could easily damage some areas of town but not others. The impacts of a tornado in Carver would be very localized.

Due to the fact that Carver has not experienced a tornado and because the tornados that do make landfall nearby are relatively small, weak, and short-lived, the Town of Carver does not consider tornados to be a significant hazard. If a tornado were to hit Carver, based on past data, it would likely be relatively insignificant. However, climate change will very likely increase the frequency and intensity of thunderstorms which may increase the risk of tornadoes as well.[166]

[163] https://www.usatoday.com/in-depth/news/nation/2021/06/16/tornado-warning-system-has-come-long-way-but-could-better/5152104001/
[164] https://www.weather.gov/safety/tornado-ww
[165] www.nebraskaweather.unl.edu/severe/UStormfacts.htm
[166] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Floods

Floods are simply defined as the overflow of water onto normally dry land. Flooding is caused by rising water in an existing waterway or the ponding of water at or near the point where the rain fell and can last days or weeks.[167] Flooding can occur both inland and by the coast.

According to NOAA's National Severe Storms Laboratory, inland flooding occurs when "moderate precipitation accumulates over several days, intense precipitation falls over a short period, snowpack melts, or a river overflows because of an ice or debris jam or dam or levee failure."[168] Flash floods are also a potential consequence of increasing frequency and intensity of precipitation in the Northeast. Flash floods occur when fast-moving water tears through riverbeds, urban streets, or mountain canyons. They can be caused by excessive precipitation in a short amount of time but can also occur due to sudden releases of water from dam failures or ice jams.[169] Across the country, inland flooding causes more damage per year than any other severe weather event. In Massachusetts, between 2007 and 2014, the average annual cost of flood damages exceeded $9.1 million.[170] Massachusetts experiences a disastrous flood event approximately every three years, but it is important to note that floods of a lesser magnitude occur much more frequently.

Precipitation is the strongest driver of flooding in the state of Massachusetts.[171] Excessive precipitation from storms is the primary cause of inland flooding in Carver. Several other natural hazards can cause flooding, including hurricanes and tropical storms, Nor'easters, and thunderstorms. Winter flooding is also common, particularly when the ground is frozen, and the water has nowhere to infiltrate. The failures of dams, culverts, and flumes, or agricultural water control structures, though less frequent, are also a notable concern for inland flooding. Areas that are highly developed with a large proportion of impervious cover or areas that are within the floodplain are the most vulnerable.[172]

Common impacts of inland flooding include exposure to contaminated floodwater, with potential pathogens or chemicals, that could contaminate food, soil, drinking water, or flooded buildings; interruption of septic, sewage, and wastewater treatment systems, electrical grids, transportation services, and communication systems; damage to property and the overwhelming of stormwater infrastructure. Additional impacts include long-term health impacts like food and water-borne illnesses and respiratory illnesses due to mold exposure. Older populations, people living with disabilities and other preexisting conditions, like asthma, children, those living near floodplains, and those living in older homes or homes that are not structurally sound, are most at risk to inland flooding due to their health and the likelihood that they would need help during a flood.

The 100-year flood has a one percent chance of occurring each year. A total of 7.47 square miles or roughly 19% of Carver lies within the 100-year floodplain, in high-risk areas, zones A and AE. FEMA flood zone A and AE are very similar in that both designate areas subject to a 1% annual chance of flooding, however, the main difference is that FEMA has provided the BFE or base flood elevation for AE zones. The base flood elevation is

[167] https://www.weather.gov/mrx/flood_and_flash
[168] https://www.nssl.noaa.gov/education/svrwx101/floods/types/
[169] https://www.weather.gov/mrx/flood_and_flash
[170] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[171] https://resilientma.org/changes/changes-in-precipitation#more_frequent_downpours
[172] https://www.mass.gov/info-details/inland-flooding

the elevation to the tenth of a foot that has a 1% chance of flooding each year.[173] These elevations have been determined using historical weather data, local topography, and the best available science.[174] A subcategory of the AE flood zone is the regulatory floodway, which is defined by FEMA as "the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height." [175] A very small portion of Carver is in the moderate to low-risk FEMA flood zone X, in the 500-year floodplain, with a 0.2% annual chance of flooding. Figure 3-17 shows a map of the FEMA flood zones and wetlands in Carver. [176] Table 3-19 details the area and percent of Carver in each FEMA flood zone.

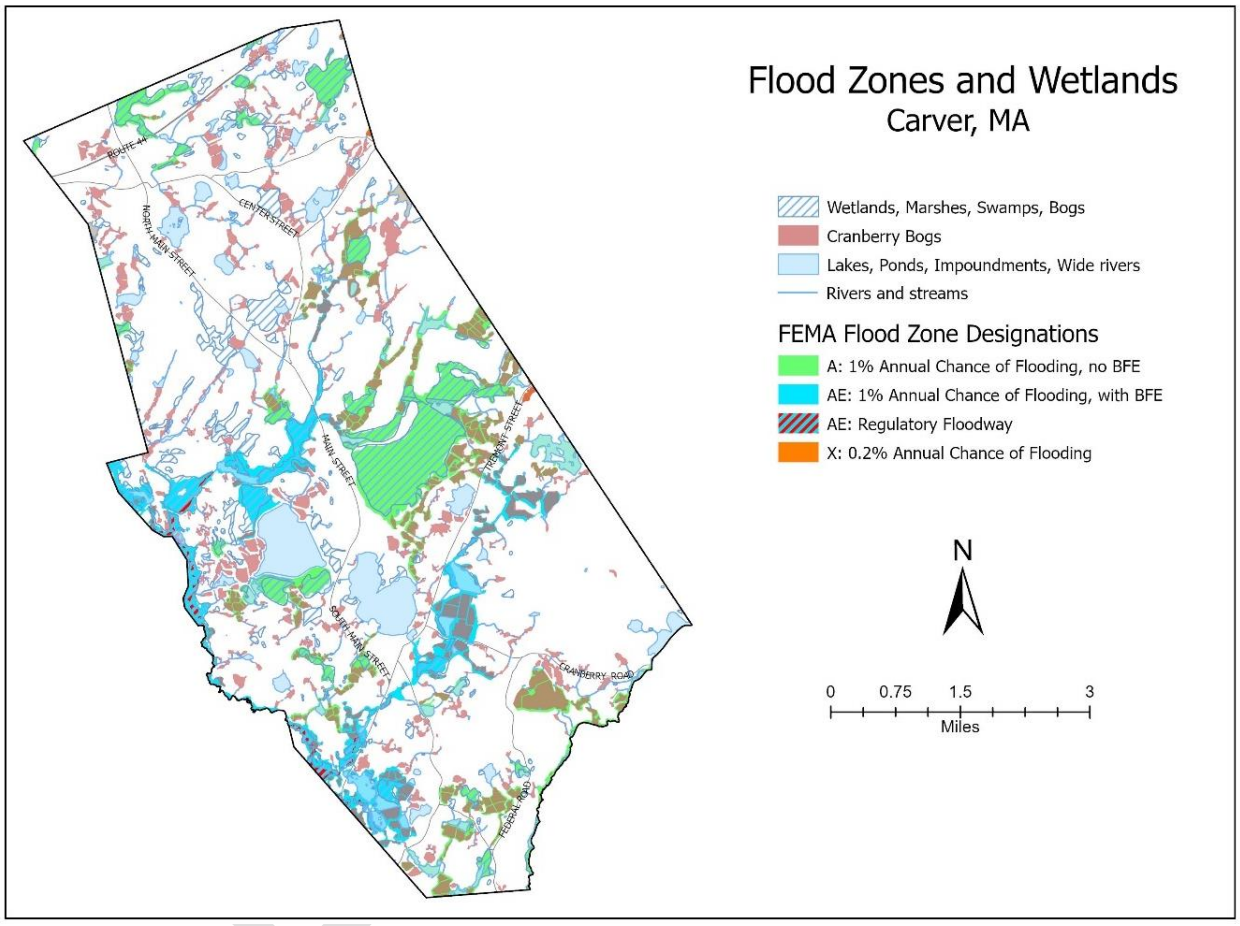


Figure 3-17. Flood Zones and Wetlands in Carver, MA
Data Source: MassGIS

[173] https://floodtraining.vermont.gov/protection-tools/zone-a
[174] https://www.massivecert.com/blog/where-does-base-flood-elevation-come-from
[175] https://www.fema.gov/glossary/floodway
[176] Some of the smaller wetlands are not visible on this map. A more detailed map of Carver's wetlands can be found at MassDEP's Wetland and Wetland Change Areas Map at http://maps.massgis.state.ma.us/images/dep/omv/wetviewer.htm

Table 3-19. Area of Carver within each FEMA Flood Zone
Source: MassGIS[177]

FEMA Flood Zone	Definition	Area in Carver (square miles)	Percent of Carver
A	1% annual chance of flooding, no BFE	4.87	12.3%
AE	1% annual chance of flooding, with BFE	2.60	6.5%
AE	Regulatory floodway	0.18	0.5%
X	0.2% annual chance of flooding	0.076	0.2%
	Total	7.73	19.5%

A federal or statewide disaster declaration related to flooding has occurred in Plymouth County seven times between 2005 and 2021.[178] Based on this historical data, the chance of a flood of this magnitude affecting Plymouth County is roughly once every other year or roughly a 47% chance each year. These disastrous flooding events have been caused by severe storms that impact a wide area. Though dam, culvert, and flume failures also pose a flood threat, the affected area would be much more localized, and the damage would likely be much less severe.

Carver does not experience frequent flooding problems within the hundred-year floodplain although flooding after hurricanes or significant storm events has occasionally been severe. According to Carver's Open Space and Recreation Plan, much of Carver has a water table near or at the ground surface nine months of the year.[179] There is not much groundwater storage for stormwater so during heavy precipitation events, groundwater reaches the surface relatively quickly, causing groundwater flooding. Homes built in areas of high groundwater or too close to wetlands have, and will continue to have, losses due to basement flooding or private water well flooding. Building houses where there is already high groundwater is a special recipe for disaster. We saw this in the spring of 2010 when, after two 100-year storms hit Carver, basements, private water wells, and public drainage areas remained flooded for weeks in a neighborhood built on filled wetlands, and therefore sitting on extremely high groundwater.[180]

Some of this neighborhood—the Great Meadow area in northeast Carver—had—prior to being filled 40 years ago—originally been home to many isolated wetlands as well the riverfront area to a brook. During these consecutive storms, water sitting on the surface in this neighborhood reached up to around one foot deep. Much of this flooding could have been prevented years ago had attention been paid to the functions of wetlands and the elevations of groundwater, and had the neighborhood been built somewhere more suitable. Due to the Carver Wetlands Protection Bylaw instituted in 1998 and to zoning laws certified in 2012, consistent with National Flood Insurance Program (NFIP) regulations, today Carver regulates development to ensure that issues like these are avoided in the future.

[177] https://www.mass.gov/info-details/massgis-data-fema-national-flood-hazard-layer
[178] https://www.fema.gov/disaster/declarations?field_dv2_state_territory_tribal_value=MA&field_year_value=All&field_dv2_declaration_type_value=All&field_dv2_incident_type_target_id_selective=All
[179] Town of Carver 2010-2015 Open Space & Recreation Plan https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/openspaceplan-2010.pdf
[180] Carver Master Plan, 2018 https://srpedd.s3.amazonaws.com/wp-content/uploads/2020/08/13213206/Carver-MVP-Plan-050118.pdf

Several other areas that were significantly affected by the 2010 floods can be seen on the map in Figure 3-18. The map also shows FEMA Flood Zones for reference and it is clear that many of these flooded areas are in the path of regulatory floodways. These flooded areas include Holmes Street, the intersection of Holmes Street and Meadow Street, Pope's Point Road, France Street, and the entire Great Meadow area. In addition, bridges, culverts, and flumes along Beaver Dam Road, Holmes Street, Pope's Point Road, Cross Street, and France Street are at some risk of flooding or failing. In fact, during the two 100-year storm events in the spring of 2010, the France Street Bridge did collapse, although there were no injuries. South Meadow Brook Reservoir is adjacent to Holmes Street and has a tendency to flood. The bridge at Holmes Street also serves as a dam. The town is applying for grants to repair this structure due to some undermining issues. Photos were taken during these floods along some of the roads mentioned above and they can be seen in Figure 3-19. Since that time, the Carver Department of Public Works rebuilt the France Street Bridge and installed two new headers on the Pope's Point Road Bridge in 2011 to mitigate flooding from the South Meadow Brook and Beaver Dam Brook. Flooding can cause significant damage to infrastructure in Carver that is expensive to repair. Generally flooding in Carver does not occur to the extent that cars cannot pass but given the increased chance of heavy precipitation events as a result of climate change, it is likely that flooding will become a larger hazard with time.

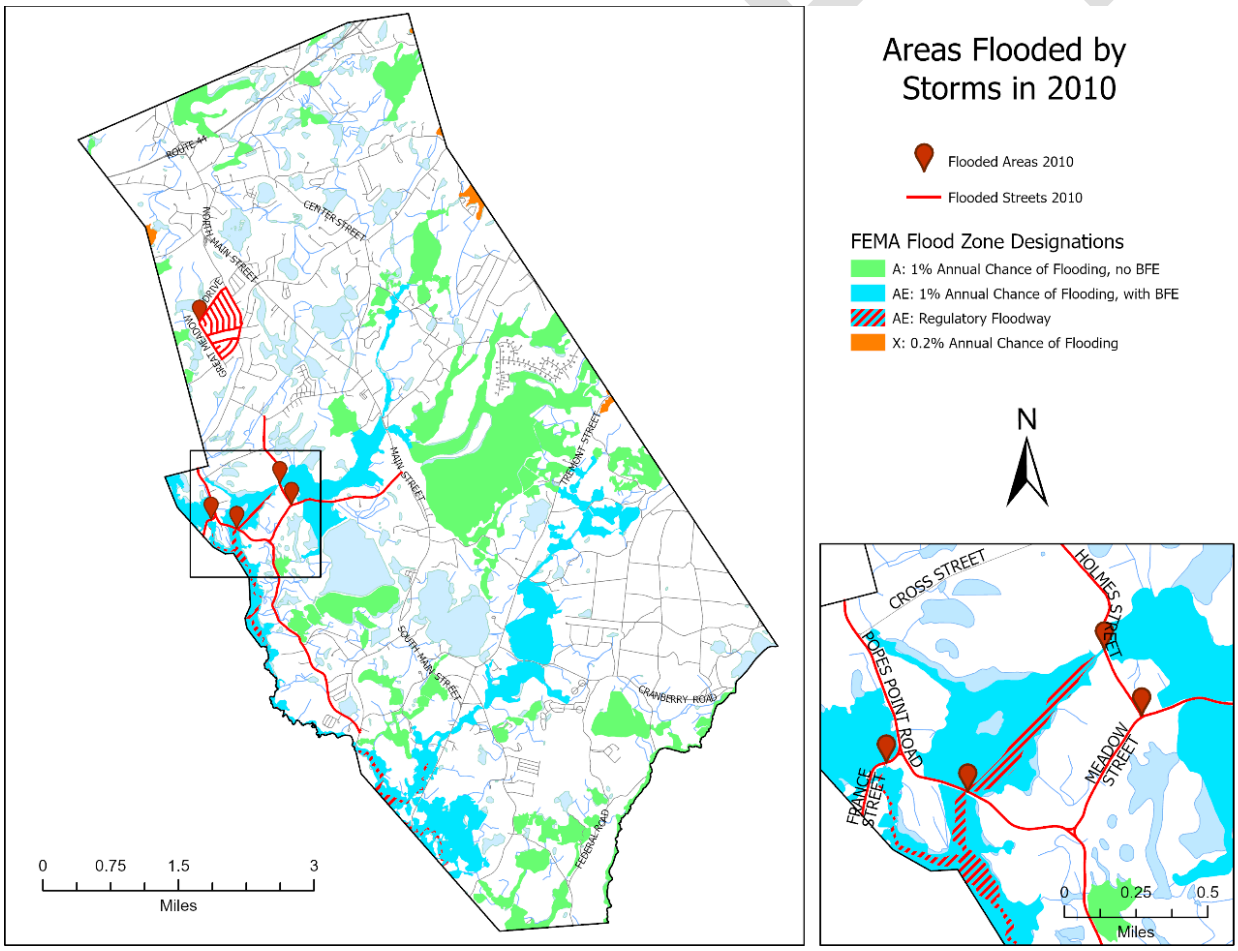


Figure 3-18 Areas Flooded by Storms in 2010 & FEMA Flood Zones
Data Source: MassGIS & pers. com. Sarah Hewins

Holmes St.

Holmes & Meadow St.

Pope's Point Road

France Street Bridge

Figure 3-19. Flooding in Carver in 2010
Source: Sarah Hewins

In addition to climate change causing more frequent and intense precipitation events, the growth and development of Carver also creates a greater risk of inland flooding. More development means a shift from pervious land to impervious land: areas such as open fields and forested areas, that allow water to infiltrate, are converted into impervious land, such as paved parking lots and buildings, which do not absorb water. This shift increases the amount of stormwater and road runoff from precipitation events. According to MassGIS, the total area developed between 1971 and 1999 was 2,760 acres or an increase of 10.8%. Town-wide, however, the total impervious surface area is still listed in 2013 at only 3%.[181]

As indicated in Figure 3-18, the 100-year floodplain areas in Carver are primarily located along riverine corridors. Land area within the 100-year floodplain that, as of 2010, was undeveloped and not preserved in

[181] http://maps.massgis.state.ma.us/dcr/forestry/forestry23.html

perpetuity is approximately 3,795.29 acres or 14.9% of the total land area. In order to decrease future flooding damage to infrastructure and to preserve areas that hold floodwaters, Carver should consider the mitigation value of conserving these lands**.** Further evaluation should be undertaken to assess whether this land area is the rear portion of developed lots, wetland areas, or in any other way restricted from development. Much of this area may be associated with bogs.

Carver has three major rivers and many tributary brooks. Riverine flooding does not pose as great a threat to Carver as it might in other communities due to the abundance of wetlands and open space. About 600 acres of land in Carver is protected open space—one-half of 1% of the existing open space in town. About 12,000 acres of land in Carver remains unprotected open space. Wetlands and open space provide, among other things, groundwater recharge, infiltration, water storage, and flood control by holding or delaying riverine flood waters' release, by evaporating the flood waters, and by reducing peak flows. Wetlands cover nearly 50% of the Town and with the proper care and protection of these resources, Carver has its own built-in riverine flood protection. Wetlands and open space also contribute to air and water purification, the creation of topsoil and agricultural land, and climate control. Eliminating wetlands or open space will reduce or diminish these services altogether.

The protection of wetlands and open space also saves public funds by preventing development of hazardous areas and of areas that provide natural flood protection. Though the protection of wetlands and open space does not appear to be a very dramatic hazard mitigation measure, it is perhaps one of the most important for a town like Carver given the natural abundance of wetlands and open space here. The Town of Carver has incorporated flood mitigation in our local conservation planning. The Town will continue—during the Open Space and Recreation Plan's normal up-date cycle—to implement the measures suggested in the 2010-2015 Open Space and Recreation Plan: to protect its wetlands and open space by selective town acquisition when that land is available; and when acquisition is possible, by helping landowners obtain conservation restrictions on their land, and by continuing to regulate wetlands and floodplain protection as required by law.

Overall, the Town of Carver has sustained little structural damage during floods because of sparse development along the streams. There is a relatively large area of swamps and bogs that are well regulated with many flumes, or drop structures, used in cranberry cultivation flow control. Inland floodwaters have made their way to the wetlands and swamps in town, but this is not always the case and does not always happen without consequence. Inland flooding has caused damage to agriculture, namely cranberry crops, because these crops are only flooded at a specific time of the year when they are ready to be harvested. Otherwise, the cranberries might experience a large amount of stress and the harvest may be greatly impacted if they are flooded at the wrong time or in excess. To date, inland flooding has not caused damage to any of the flumes, or water control structures. The large natural system of lakes, ponds, swamps, cranberry bogs, and other wetlands in Carver is an effective flood protection measure, protecting infrastructure from flood damage. The flat terrain and creation of storage areas by the bogs slow the flow of floods.[182]

Another type of flooding is coastal flooding, defined as the "inundation of land areas along the coast [..] caused by higher-than-average high tide and worsened by heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean)." [183] Coastal flooding could coastal erosion, cause road closures, damage to critical infrastructure, reduced stormwater drainage capacity, and the intrusion of saltwater to drinking water, among

[182] https://www.mass.gov/doc/integrated-management-plan/download
[183] https://www.nssl.noaa.gov/education/svrwx101/floods/types/

several other impacts.[184] In Massachusetts, over the last decade an average of six coastal flooding events per year have occurred. Though coastal flooding is a significant concern for Eastern Plymouth County, it is not a concern for Carver.[185] Carver is not a coastal town and thus does not experience coastal flooding – the Cape Cod Bay is roughly 5.5 miles from the northeastern portion of town, and the farthest point in Carver to the coast, is just over 19 miles. Carver's Wankinco River, which marks the southeastern boundary of town, drains to several ponds before draining to the Wareham River and ultimately to Buzzard's Bay. Carver is roughly 2.5 miles from the beginning of the Wareham River. Despite low likelihoods, it is important to note that the southern followed by the eastern portion of Carver would be most vulnerable. Even with a category 4 hurricane, as displayed in Figure 3-20, coastal flooding is still not expected to reach Carver. However, sea level rise will increase the frequency and severity of routine tidal flooding and storm related coastal flooding.

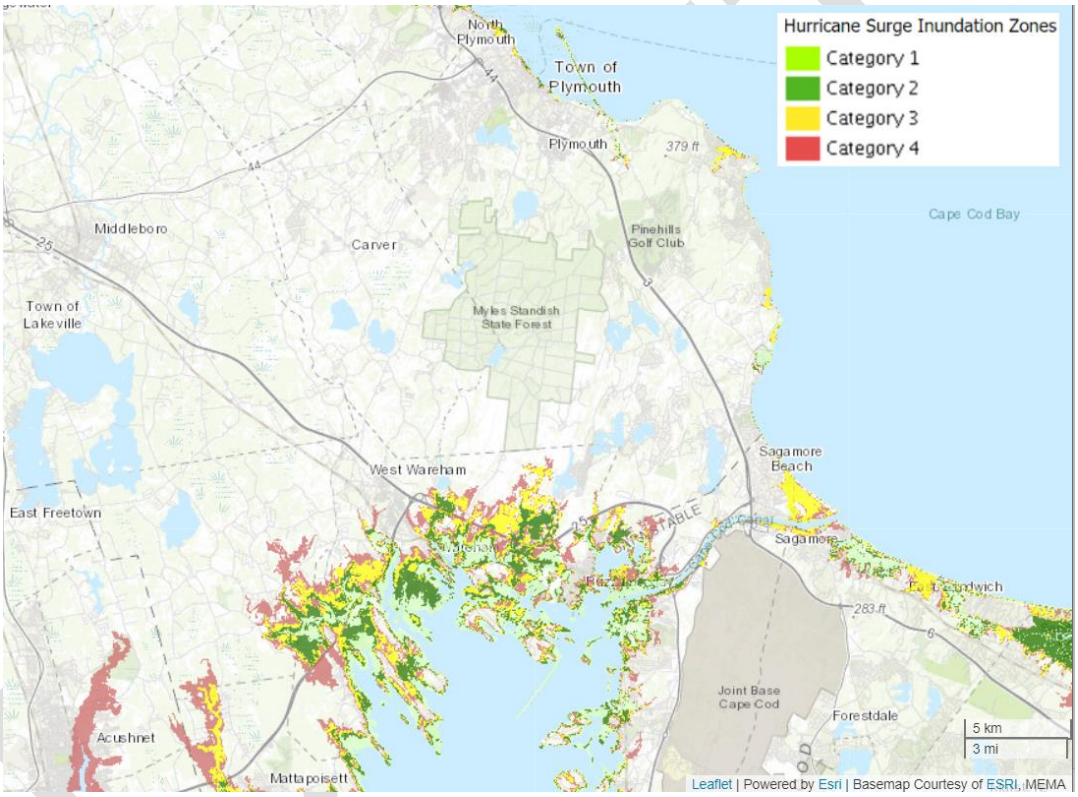


Figure 3-20. Hurricane Inundation Zones based on Hurricane Category
Source: Mass.gov Hurricane Inundation Maps[186]

Climate projections, developed by the University of Massachusetts, suggest that the frequency and intensity of rainfall events in Massachusetts will trend upward, resulting in an increased risk of flooding across the state (see Excessive Precipitation section for more information).[187] According to climate scientists, Massachusetts can

[184] https://www.neefusa.org/nature/land/increases-coastal-flooding#:~:text=Impacts%20of%20coastal%20flooding%20may,of%20saltwater%20to%20drinking%20water.
[185] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[186] https://memamaps.maps.arcgis.com/home/webmap/templates/OnePane/basicviewer/embed.html?webmap=45e2419bf23e40eca0b
[187] https://resilientma.org/changes/changes-in-precipitation

expect more intense and frequent downpours that will result in more frequent flooding and a greater area exposed to inland flooding.[188] These heavier precipitation events will not allow for significant groundwater replenishment or steady stream flows. Rather, the volume of stormwater will likely overwhelm natural systems, especially in areas with high impervious cover, likely causing inundation in low-lying areas and potentially even causing flash floods.[189]

As mentioned above, there is a 47% chance of a federal or statewide disaster declaration related to flooding in Plymouth County in any given year. The frequency of inland flooding in Carver is high and the severity of the flooding could be serious and cause a significant amount of damage. The areas of impact from flooding in Carver tend to be localized. The main areas impacted by inland flooding would be those along rivers, especially areas in flood zones. In terms of just Carver, specific areas of town would be impacted more than others but if there is a storm with heavy precipitation, it is very likely that several other towns in Massachusetts will also be affected by inland flooding, so the area of occurrence could be statewide.

Tsunamis

Tsunamis are devastating surges of water that come onshore in a string of waves caused by the displacement of a large volume of water. This displacement can be caused by earthquakes, volcanic activity, landslides, glacier calving, and meteorite impacts. The frequency of tsunamis depends on the frequency of the events that cause them.[190]

Between 1668 and 2017, a total of 52 potential tsunami events have been identified as possibly impacting the east coast of the US. Nine of these are considered definite or probable tsunamis. The likelihood of a tsunami occurring on the east coast is once every 39 years. No tsunamis have hit the coast of Massachusetts since 1950.[191] Figure 3-21 shows the total number of tsunami events, total number of events causing runup heights from 0.01m to >3.0m, and total deaths due to tsunamis for US states and territories in the Atlantic Ocean starting with the first confirmed US East Coast tsunami in 1886. According to this source, there have been two confirmed tsunamis in Massachusetts, one where the runup distance was undetermined and another where the runups were between 0.01m and 0.3m. Regardless of the source, tsunamis are clearly extremely infrequent in Massachusetts and when they do occur, they have minimal impacts.

[188] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf
[189] https://www.mass.gov/doc/massachusetts-drought-management-plan/download
[190] https://www.ngdc.noaa.gov/hazard/data/publications/tsunami-hazard-assessment-2015.pdf
[191] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

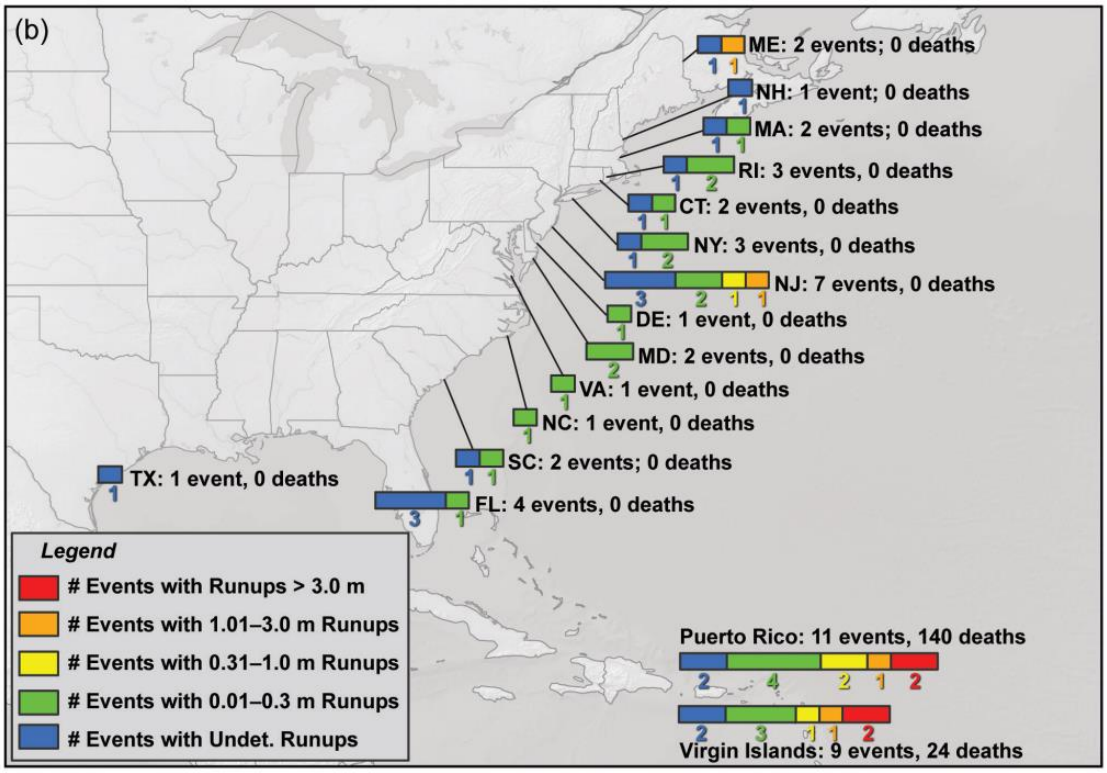


Figure 3-21. Atlantic Ocean Tsunamis
Source: United States and Territories National Tsunami Hazard Assessment[192]

The eastern portion of Carver, closest to the Atlantic coast, is the area of town that is most vulnerable to a tsunami. However, historical data combined with the low frequency of activities causing tsunamis indicate that the probability of future tsunami events in the state of Massachusetts is very low. As mentioned above in the flooding section, Carver is not a coastal town and is several miles from both Buzzards Bay and the Cape Cod Bay. The likelihood of a tsunami surge travelling several miles into the Town of Carver is extremely low. Sea level rise could cause a tsunami surge to travel farther inland, however, affecting a greater area. Though the probability of a tsunami impacting the Town of Carver is extremely low, the potential impacts could be serious.

[192] https://www.ngdc.noaa.gov/hazard/data/publications/tsunami-hazard-assessment-2015.pdf

Dam, Culvert, and Flume Failure

"A 'dam' is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water."[193] There are 56 dams in Carver, the majority of which are privately owned (Figure 3-22). Most dams in the Town of Carver are defined as "flumes," or agricultural water-control structures that consist of metal pipes connecting a cranberry bog, brook, or other wetland or waterway to another, through which the flow of water is controlled by inserting or removing wooden boards. Flume failure has not been officially reported in Carver though it has likely occurred in the past. The potential risks of flume failure are limited and likely only include minimal flooding of cranberry bogs or adjacent land. This could have adverse impacts on cranberry bogs if they are flooded at the wrong time. Routine flume maintenance is necessary to control the growth of trees, remove invasive species, and keep the area clear to ensure that the flumes are not blocked and so that structural defects can be detected early.

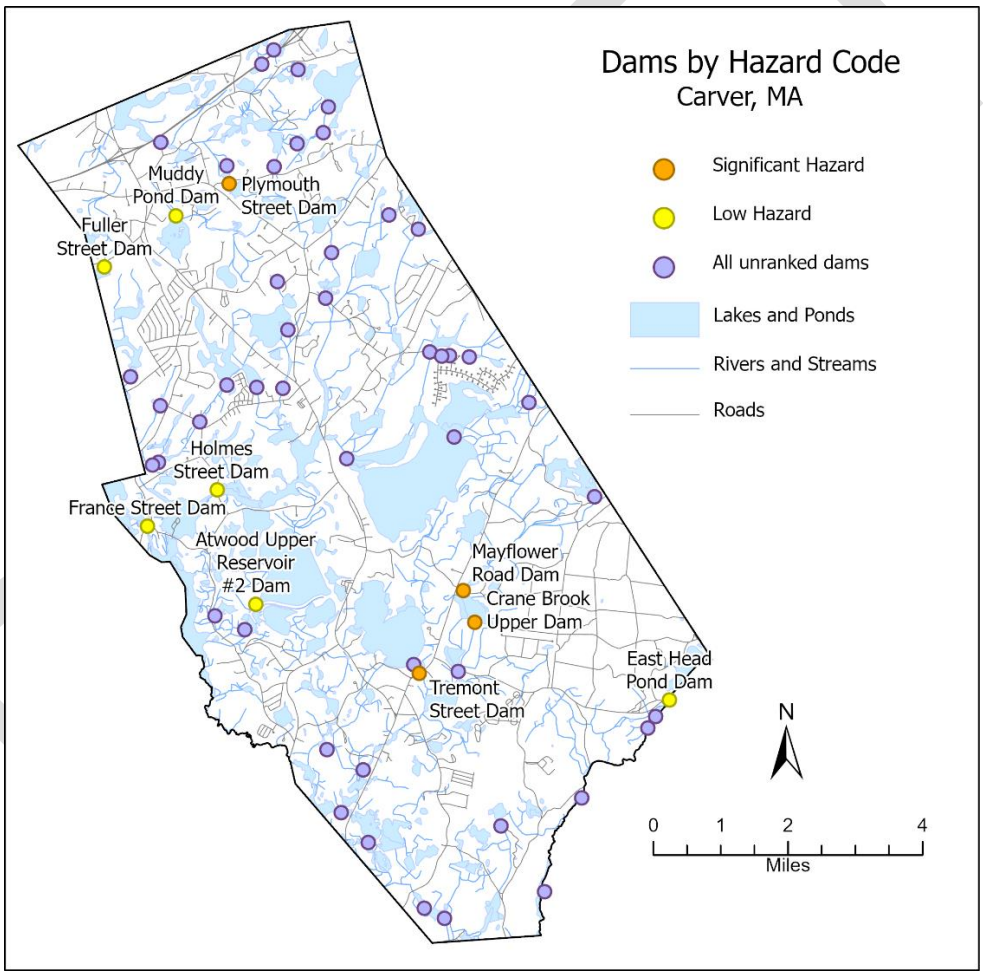


Figure 3-22. Carver Dams and their Hazard Codes
Data Source: MassGIS[194]

[193] https://damsafety.org/sites/default/files/FEMA%20Federal%20Guidelines%20Glossary%20148_04.pdf
[194] https://www.mass.gov/info-details/massgis-data-dams#maintenance-

Table 3-20. Carver Dams, Hazard Codes, and Owner Information
Source: MassGIS[195]

Dams	Hazard Code	Dam Owner
Muddy Pond Dam	Low Hazard	Private
Fuller Street Dam	Low Hazard	Private
Holmes Street Dam	Low Hazard	Private
France Street Dam	Low Hazard	Town of Carver
Atwood Upper Reservoir #2 Dam	Low Hazard	Private
East Head Pond Dam	Low Hazard	Private
Plymouth Street Dam	Significant Hazard	Private
Mayflower Road Dam	Significant Hazard	Private
Crane Brook Upper Dam	Significant Hazard	Private
Tremont Street Dam	Significant Hazard	Town of Carver

Carver also has ten dams with a Massachusetts DCR Office of Dam Safety hazard classification: 4 dams are identified as a Significant Hazard and 6 dams are identified as a Low Hazard. The Significant Hazard dams are located on Crane Brook Bog Pond (2 dams), Sampson Pond, and North Center Street Pond.[196] These dams, their hazard code, and their owner can be seen in Table 3-20. Significant hazard potential dams are typically defined as a dam whose failure or mis-operation will cause significant property destruction. Low hazard potential dams are typically defined as a dam whose failure or mis-operation will cause minimal property destruction.[197]

In 2003, a dam in a north shore community "overtopped" after heavy precipitation. When this happens, the dams can fail quickly as the earthen structures are subject to erosion pressures. Carver's 2016 Hazard Mitigation Plan referred to an incident over 20 years ago, now, where a car was lost when a dam under a roadway in town failed. Prior to this event, in the 1990s, a dam in the Myles Standish State Forest collapsed and was repaired, but cars are still not allowed to pass to this day. There have been several dam failure scares in Carver, but no significant dam failures during the past 20 years or so. In the past, the Muddy Pond Brook backed up behind the Muddy Pond Dam causing concern, though the dam remained stable. At one time, the town evacuated people living near the Plymouth Street Dam due to a failure scare. The biggest near disaster was when the France Street bridge, which is also a dam, collapsed in 2010 after Carver was hit with two 100-year storms. This event is described in more detail and there are several photos in the flooding section. Several homes immediately downstream of the France Street Dam were evacuated and the town was very worried about downstream impacts. The floodwaters ended up travelling under Rochester Road, avoiding even more damage. Based on this information, it seems as though there is one significant issue with a dam in town roughly every 10-20 years. That means there is roughly a 2-20% chance of a dam failure in Carver each year.

The Massachusetts Office of Dam Safety reports that the region's dams, like the other parts of New England infrastructure, are aging and expensive to repair. In addition to aging, the region's dams are often doing work beyond their original design. The increase in development and impervious surfaces leads to increased runoff and therefore higher flows in some streams and rivers and thus greater demands are placed on the dams. The

[195] https://www.mass.gov/info-details/massgis-data-dams#maintenance-
[196] https://www.mass.gov/doc/integrated-management-plan/download
[197] https://damsafety.org/sites/default/files/MA_PerfomanceReport_v2.pdf

confluence of high groundwater and extreme rain events can cause damage to local bridges and to water control structures. Both inland flooding and heavy rainfall can contribute to dam, culvert, or flume failure.

Dam failures are most likely to happen from overtopping, foundation defects, cracking, inadequate maintenance and upkeep, and seepage. Overtopping of dams is by far the most common issue with dam safety and is responsible for roughly 34% of all US dam failures.[198] The Riverways Program, within the Massachusetts Division of Ecological Restoration (DER) within the Department of Fish and Game, has been studying the larger environmental costs of both operational dams and dam failures. Dam failures may cause loss of life and property downstream, but they may also degrade the environment. Many dams act as a holding area for contaminated sediments and nutrients. With a dam failure, these sediments and nutrients are released and can negatively impact wildlife and the ecology of the river system. An associated cost of dam failures is the potential for such destruction to affect fish ladders or culverts for directing water.

According to the Southeastern Regional Planning and Economic Development District (SRPEDD), Carver has 175 culverts.[199] In 2010, certain culverts in Carver washed out due to the two large storms. During the improvement projects along Route 58 and Montello Street, a culvert was blocked and flooded, knocking out the wells for the Silo Marketplace.

Many culverts in town were designed to accommodate historic patterns of precipitation and runoff, which are rapidly transforming as a result of climate change. Undersized culverts are expected to pose a greater threat of failure and flooding as precipitation events become more intense and less predictable. The Carver Department of Public Works checks culverts annually and applies for funding to replace those ranked as a high priority for repairs or replacement. However, the combination of a lack of maintenance funds and Carver's aging stormwater infrastructure exacerbates the risk of serious flood damage during heavy rains.[200]

As mentioned above Carver experiences a significant issue with a dam in town roughly every 10-20 years. Each year there is roughly a 2-20% chance of Carver experiencing a dam failure. The frequency of dam, culvert, and flume failure noted above is medium. This hazard is considered serious, but the area of impact is isolated because this hazard causes the most damage to properties and infrastructure in a small radius. Though, at present, most of the dams in Carver are relatively small, evidence shows that climate change will cause more extreme weather events and these events may result in increased stresses to aging dams. Dams can be found all over New England, so communities all over the state could experience this hazard.

[198] https://damsafety.org/dam-failures
[199] https://srpedd.org/community/carver/
[200] Carver MVP Plan 2018 https://srpedd.s3.amazonaws.com/wp-content/uploads/2020/08/13213206/Carver-MVP-Plan-050118.pdf

Earthquake

"An earthquake is the vibration, sometimes violent, of the earth's surface that follows a release of energy in the earth's crust due to fault fracture and movement."[201] The magnitude of earthquakes is measured using the Richter Scale, detailed in Table 3-21, which ranks the amount of energy an earthquake releases. Most earthquakes are less than a magnitude 3 on the Richter Scale many of these smaller tremors are not even felt by humans.[202]

Table 3-21. Richter Scale
Source: GNS Science[203]

Richter magnitude	Description	Earthquake effect
< 2.0	Micro	Micro earthquakes, not felt.
2.0-2.9	Minor	Generally not felt, but recorded.
3.0-3.9		Often felt, but rarely causes damage.
4.0-4.9	Light	Noticeable shaking of indoor items, rattling noises. Significant damage unlikely.
5.0-5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings.
6.0-6.9	Strong	Can be destructive in areas up to about 160 kilometres (100 mi) across in populated areas.
7.0-7.9	Major	Can cause serious damage over larger areas.
8.0-8.9	Great	Can cause serious damage in areas several hundred miles across.
9.0-9.9		Devastating in areas several thousand miles across.
10.0+	Epic	Never recorded

The United States Geological Service (USGS) categorizes this region as one of low risk for earthquakes, although small-scale earthquakes (under 3 on the Richter scale) are common in the region. Figure 3-23 shows a map of the northeast with recorded earthquakes between 1975 and 2016. According to the Weston MA Observatory of Boston College, which tracks earthquake activity throughout New England, 11 earthquakes have been reported in Plymouth County between 1638-2014. The average magnitude of these 11 earthquakes is 2.5 and none of these earthquakes occurred in Carver.[204] Earthquakes do, however, impact a wide area so an earthquake with an epicenter elsewhere could impact Carver. Figure 3-24 shows earthquakes with a magnitude greater than 2.5 in Southern New England between 1638-2014. The probability of a magnitude 5.0 or greater earthquake centered in New England is about 10–15% in a 10-year period.[205] That means each year there is roughly a 1-1.5% chance of an earthquake of this magnitude in New England.

[201] https://pubs.usgs.gov/gip/earthq1/how.html
[202] https://science.howstuffworks.com/nature/natural-disasters/earthquake6.htm
[203] https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Monitoring-Earthquakes/Other-earthquake-questions/What-is-the-Richter-Magnitude-Scale
[204] https://www.bc.edu/bc-web/schools/mcas/sites/weston-observatory/research/earthquake-maps-and-catalogs.html
[205] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

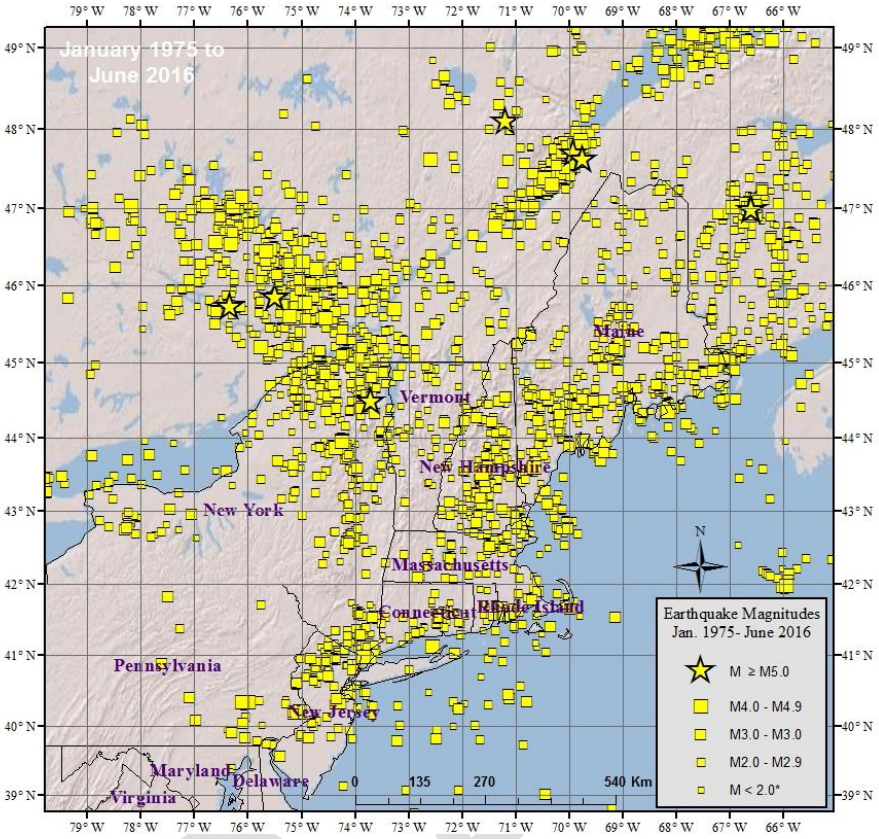


Figure 3-23. All reported earthquakes in the Northeast between January 1975 – June 2016
Source: Boston College Weston Observatory Earthquake Maps and Catalogs[206]

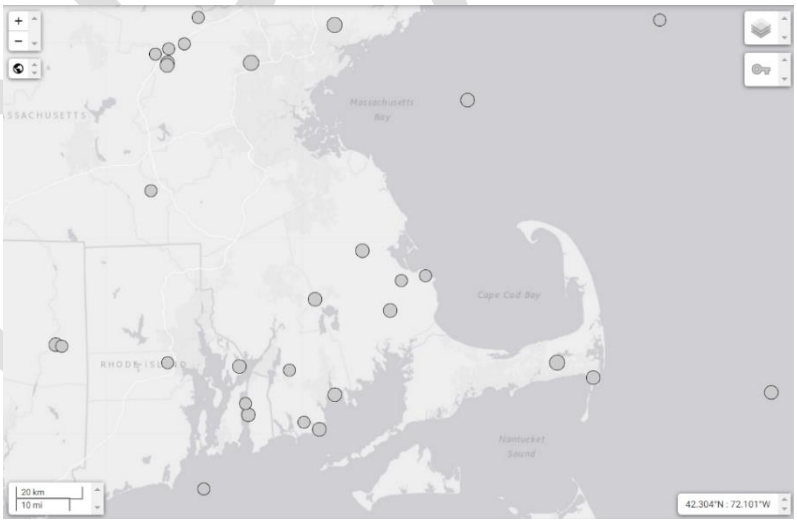


Figure 3-24. Earthquakes > Magnitude 2.5 in Southern New England 1638-2014
Source: USGS Earthquake Catalog[207]

[206] https://www.bc.edu/bc-web/schools/mcas/sites/weston-observatory/research/earthquake-maps-and-catalogs.html
[207] https://earthquake.usgs.gov/earthquakes/search/

Carver is classified within the 1-3% Peak Ground Acceleration (PGA) zone, labeled as light shaking, no damage. PGA is a measurement that compares the shaking of the ground with the force of gravity. Figure 3-25 shows a National Seismic Hazard Map (NSHM) for the US that is derived from seismic hazard curves calculated on a grid of the US. It describes the annual frequency of exceeding a set of ground motions. In this map there is a 2% probability of the PGA being exceeded within 50 years. The PGA is a good way to compare earthquake risks between regions of the US and compared to other areas in the United States, Carver's earthquake hazard is low.

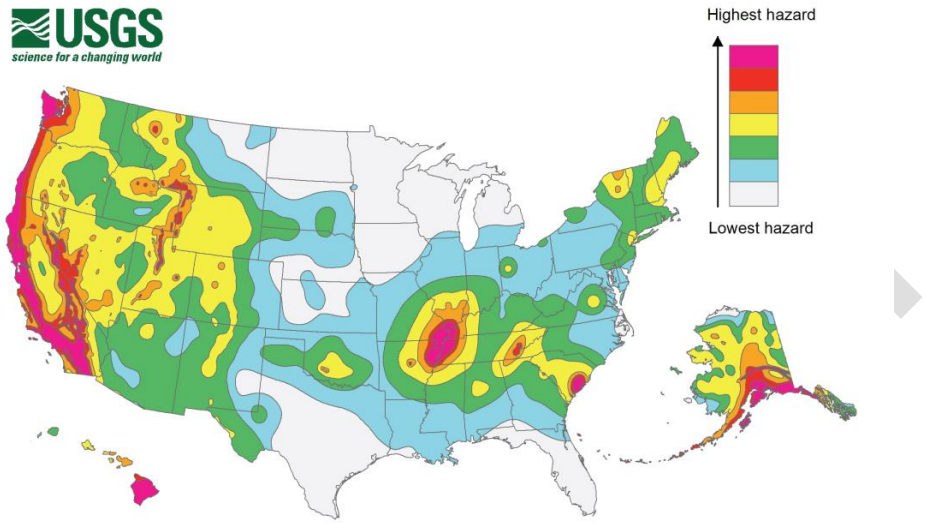


Figure 3-25. USGS National Seismic Hazard Map for the US
Source: USGS[208]

While the likelihood of a powerful earthquake in the region is extremely low, the actual risk is higher because of how old the buildings are and because few structures have been built to withstand earthquakes. Critical infrastructure such as bridges and dams would be vulnerable to an earthquake. Earthquake impacts at the local level can vary based on types of construction, building height, building density, population density, and soil type, among other factors. Earthquakes also cannot be predicted; this makes them a particularly difficult hazard to prepare for. However, given the size of the past earthquakes in this region, it is much more likely that Carver will experience a minor earthquake with minimal impacts.

The likelihood of a geological hazard in the region is possible but the impacts would be minor, and the severity limited, because earthquakes in the area are typically very small. The area of impact of a minor earthquake would be local. Areas closer to the epicenter will experience stronger tremors. The entire town of Carver would be vulnerable to the impacts of an earthquake but older infrastructure in Carver, as well as power, water, and wastewater treatment systems would be particularly vulnerable. The entire state could experience earthquakes, so the area of occurrence is statewide. Earthquakes can be triggered by changes in the amount of stress on a fault. Surface water in the form of rain and snow are two climate variables that can affect stress loads.[209] With increasing rainfall predicted to impact the Northeast as a result of climate change, it is possible that the probability of an earthquake might increase.

[208] https://www.usgs.gov/media/images/2018-long-term-national-seismic-hazard-map
[209] https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/

Mosquito-borne Illness

There are two mosquito-borne diseases that are particularly concerning for the state of Massachusetts: Eastern Equine Encephalitis (EEE) and West Nile Virus (WNV). Though EEE is rare, it is a serious disease that can affect the nervous system, causing meningitis or encephalitis, both of which are an inflammation of the brain.[210] Roughly one third of patients who develop EEE die and many who survive have mild to severe brain damage. Individuals under the age of 15 and over 50 are at the greatest risk for developing severe diseases when infected with EEE.[211]

Historically, EEE outbreaks have occurred in Massachusetts every 10-20 years and last about 2-3 years. Based on historical data, in any given year, there is roughly a 10-30% chance of experiencing a EEE outbreak in any given year. The last few outbreaks occurred in 2004-2006, 2010-2012, and the most recent outbreak began in 2019.[212] As evident in the two maps below, 2019 and 2020 Plymouth County, and namely the Town of Carver, were hit particularly hard with EEE. Based on recent data, if there have been 8 years with EEE outbreaks in the past 16 summers, the chance of an EEE outbreak happening in any given year is 50%.

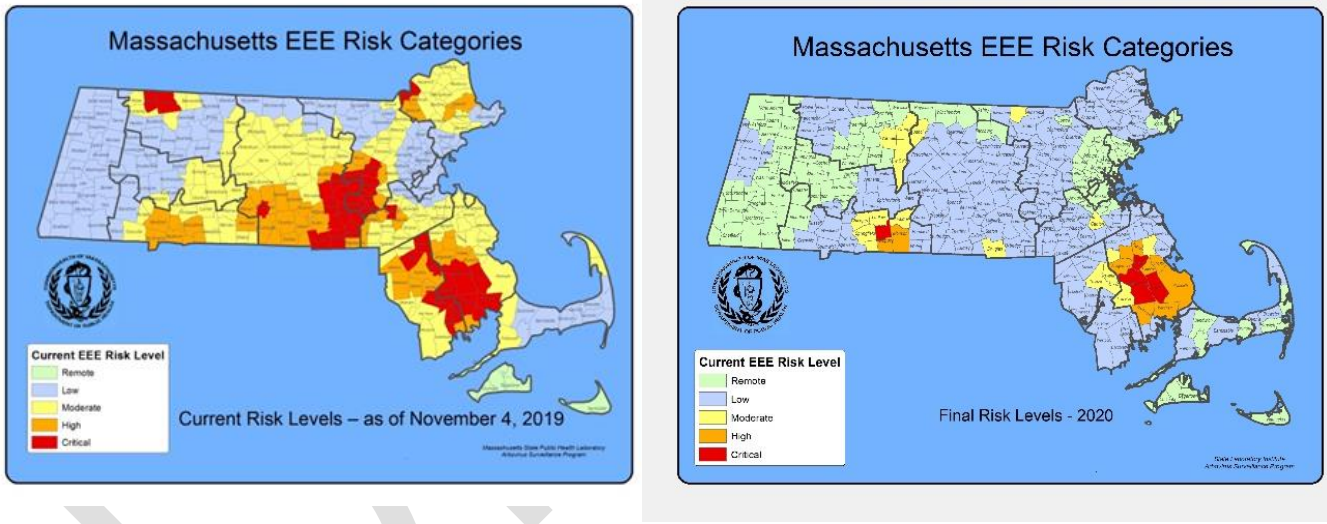


Figure 3-26. Massachusetts EEE Risk Categories 2019 & 2020
Source: Arbovirus Surveillance in Massachusetts, 2021 MA Department of Public Health[213]

The number of people that have been infected with EEE is very high in Plymouth County compared to other counties in Massachusetts. Between 2000 and 2020, there have been 15 cases of human EEE reported in Plymouth County. This number is at least double those reported in other counties across the state.

[210] Arbovirus Surveillance in Massachusetts, 2020 Massachusetts Department of Public Health (DPH) https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data
[211] https://www.health.ny.gov/diseases/communicable/eastern_equine_encephalitis/fact_sheet.htm
[212] https://www.cambridgepublichealth.org/services/environmental-health/mosquito-borne-diseases/eastern_equine_encephalitis.php
[213] Arbovirus Surveillance in Massachusetts, 2020 Massachusetts Department of Public Health (DPH) https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data

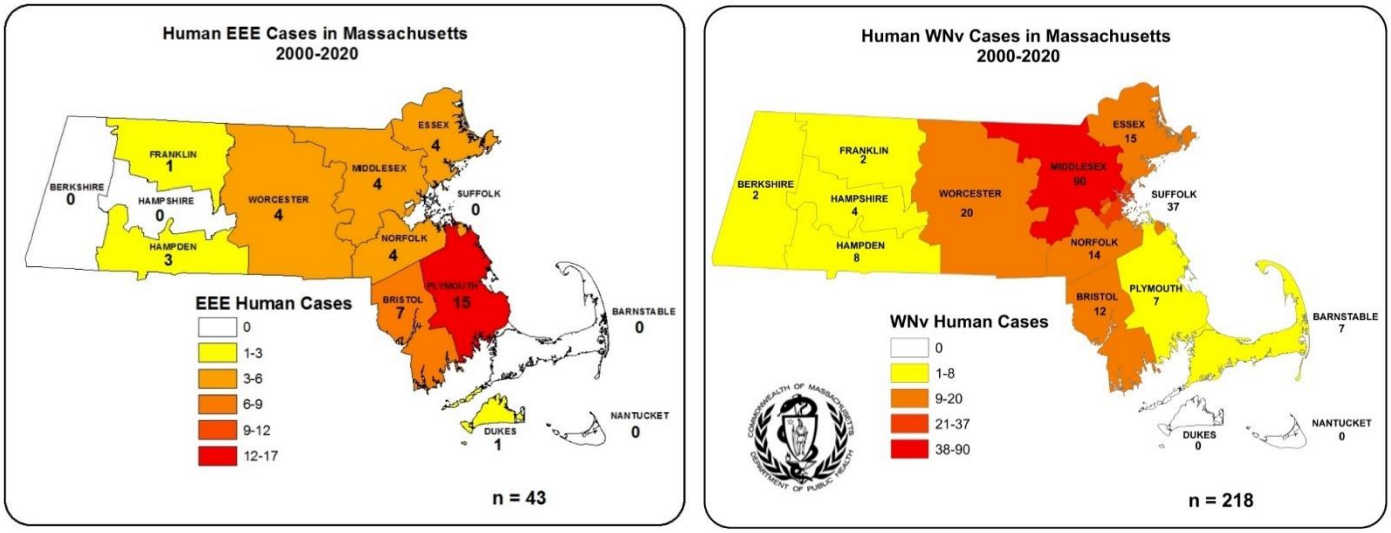


Figure 3-27. Number of Human EEE & WNV Cases in Massachusetts 2000-2020
Source: Arbovirus Surveillance in Massachusetts, 2021 MA Department of Public Health[214]

West Nile Virus is more common than EEE, but typically less severe. It can cause fevers, aches, nausea, rashes, and other mild symptoms, in roughly 20% of people.[215] Less than 1% of infected people can develop a serious, sometimes fatal, illness such as meningitis or encephalitis.[216] Individuals over the age of 50 have a higher risk of developing a severe illness as a result of West Nile Virus infection.[217] Between 2000 and 2020, there have been 7 human WNV cases reported in Plymouth County.

EEE and WNV outbreaks are caused by mosquitos that feed on both birds and mammals. A combination of large mosquito populations, bird populations that have little to no immunity to the virus, and favorable weather conditions, including significant precipitation events and long periods of high temperatures, along with a large number of freshwater swamps, open water, and other wetlands in Carver create the perfect environment for EEE to spread. Warmer temperatures shorten the time it takes for a mosquito to develop and the time it takes a mosquito to transmit a pathogen after ingesting an infected blood meal. [218] With climate change causing more intense and frequent precipitation events and an overall warming trend, the environment conducive to the spread of EEE is projected to grow (see Average/Extreme Temperature and Excess Precipitation sections).[219] The risk of mosquito-borne illnesses is only increasing as climate change brings warmer, wetter summer weather providing the perfect breeding grounds for mosquitos carrying these diseases.

[214] Arbovirus Surveillance in Massachusetts, 2020 Massachusetts Department of Public Health (DPH) https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data
[215] https://www.cdc.gov/westnile/index.html
[216] https://www.mayoclinic.org/diseases-conditions/west-nile-virus/symptoms-causes/syc-20350320
[217] https://www.mass.gov/service-details/west-nile-virus-wnv
[218] Arbovirus Surveillance in Massachusetts, 2020 Massachusetts Department of Public Health (DPH) https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data
[219] https://resilientma.org/changes/changes-in-precipitation

Mosquitos breed in standing water in ponds, swamps, marshes, and other wetland habitats.[220] Mosquitos generally do not fly far from their breeding grounds, but they can fly up to several miles.[221] This means that neighborhoods, buildings, parks, farms, and place where people gather that are within several miles of wetlands, especially those with stagnant water, are at greater risk of encountering mosquitos carrying diseases. Due to Carver's abundance of wetlands and cranberry bogs, the entire town is vulnerable to mosquitos and the diseases they carry.

Currently, there are no vaccines to prevent human infection. Personal protection measures, including wearing insect repellent, long sleeves, and long pants are the main recommendations from the CDC. To prevent being bitten by an infected mosquito, the state of Massachusetts also suggests removing stagnant water around your home, adjusting outdoor activity to avoid peak mosquito hours between dusk and dawn, and steering clear of outdoor camping, especially near freshwater swamps where EEE activity is most likely. The State of Massachusetts was responsible for dropping mosquito larvicide tablets in catch basins to help prevent the spread of mosquitos that carry these diseases. Signs are also posted at entrances to conservation lands warning people about the danger of EEE. In order to protect residents during late summer of 2020, Carver banned all outdoor activities at all town playgrounds, beaches, and the athletic fields at Carver Elementary School, Carver Middle High School, and Shurtleff Park between dusk and dawn.[222] The Plymouth County Mosquito Control Project is a state agency that sprays pesticides at resident requests to eliminate mosquitos locally and tests certain sites for the presence of disease.[223]

[220] https://www.orkin.com/pests/mosquitoes/mosquito-habitats
[221] https://mosquitonix.com/blogs/news/how-far-can-mosquitoes-fly
[222] https://www.boston25news.com/news/local/plymouth-county/mosquito-borne-virus-prompts-carver-ban-outdoor-activities-between-dusk-dawn/JDUZUSQVRNABVGUTNZ3SZVERLE/
[223] https://www.plymouthmosquito.org/home.html

Landslides

Landslides are defined as the movement of mass, rock, debris, or earth down a slope. A slope moves when the forces acting down-slope, primarily due to gravity, are greater than the materials that compose the slope. Common causes that increase the effects of down-slope forces and factors that reduce strength, include slopes that are already on the verge of movement by rain, snow, changes in water level or groundwater, stream erosion, earthquakes, volcanic activity, disturbance by human activities, or any combination of those factors.[224]

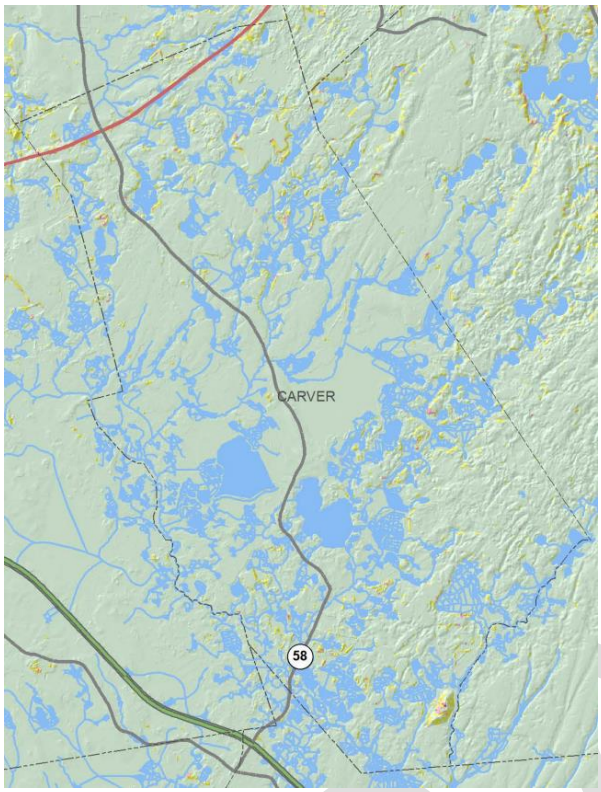
Landslides are not an issue in Carver since the topography is mostly flat with wetlands making up roughly 50% of the land area in town. Carver's Open Space and Recreation Plan states that only 5% of the town has a slope greater than 15%. The Natural Resource Conservation Service estimates that around 40% of Carver has severe limitations for development due to wetness or steep slopes.[225]

In 2013, the Massachusetts Geological Survey and University of Massachusetts Amherst published a Slope Stability Map of Massachusetts, mapped at a 1:125,000 scale, that is shown in Figure 3-28. This map shows where landslides are likely to occur after periods of high-intensity rainfall based on topography, soil characteristics, hydrology, and more. The vast majority of the Town of Carver is considered stable but there are some very small areas that are considered moderately or nominally stable and there are even smaller areas considered to be at the lower threshold of instability.

Massachusetts as a whole has a relatively low landslide risk. Between 1996 and 2012, there were eight events that triggered one or more landslides in the state. However, many landslides are minor and occur in remote areas where they may not be recorded, so it is estimated that closer to 30 or more landslides occurred during this time.[226] It is important to note that the highest concentration of unstable slopes is found in the western portion of the state, therefore a landslide is more likely to occur in Western Massachusetts than in Eastern Massachusetts. Roughly one to three landslides occur in the state of Massachusetts annually. [227] No landslides have been recorded in Carver, MA according to the USGS US Landslide Inventory.[228] However, two landslides have occurred nearby, in Walpole in 2010, caused by three days of heavy rains, and in Attleboro in 2014, caused by erosion.

Slope saturation by water is the primary cause of landslides in Massachusetts. Landslides can cause property damage and can impact transportation, significantly affecting communities. Climate change will cause warmer, wetter, winters and more frequent and intense storms that, in turn, will likely lead to more frequent soil saturation. It will also cause more droughts and wildfires that will reduce vegetative cover that can help to stabilize soils. There is a chance that the likelihood of landslides will increase due to the impacts of climate change. However, the likelihood is still relatively low due to the largely stable slopes in Carver. The probability of Carver experiencing a landslide in any given year is low, between 1-5% given the stable slopes and lack of history with landslides.

[224] https://www.usgs.gov/faqs/what-a-landslide-and-what-causes-one?qt-news_science_products=0#qt-news_science_products
[225] Town of Carver 2010-2015 Open Space & Recreation Plan https://www.carverma.gov/sites/g/files/vyhlif4221/f/uploads/openspaceplan-2010.pdf
[226] Nabil Hourani, Mass Highway Department, written communication, December 18, 2006 – STATE PLAN
[227] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, p. 4-59 – 4-75, September 2018 https://www.mass.gov/files/documents/2018/810/26/SHMCAP-September2018-Full-Plan-web.pdf
[228] https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=ae120962f459434b8c904b456c82669d



Map Color Code	Predicted Stability Zone	Relative Slide Ranking[1]	Stability Index Range[2]	Factor of Safety (FS)[3]	Probability of Instability[4]	Predicted Stability With Parameter Ranges Used in Analysis	Possible Influence of Stabilizing or Destabilizing Factors[5]
	Unstable	High	0	Maximum FS<1	100%	Range cannot model stability	Stabilizing factors required for stability
	Upper Threshold of Instability		0 - 0.5	>50% of FS1	>50%	Optimistic half of range required for stability	Stabilizing factors may be responsible for stability
	Lower Threshold of Instability	Moderate	0.5 - 1	≥50% of FS>1	<50%	Pessimistic half of range required for instability	Destabilizing factors are not required for instability
	Nominally Stable	Low	1 - 1.25	Minimum FS=1	_	Cannot model instability with most conservative parameters specified	Minor destabilizing factors could lead to instability
	Moderately Stable		1.25 - 1.5	Minimum FS=1.25	_	Cannot model instability with most conservative parameters specified	Moderate destabilizing factors are required for instability
	Stable	Very Low	>1.5	Minimum FS=1.5	_	Cannot model instability with most conservative parameters specified	Significant destabilizing factors are required for instability

[1]**Relative Slide Ranking** - This column designates the relative hazard ranking for the initiation of shallow slides on unmodified slopes.

[2]**Stability Index Range** - The stability index is a numerical representation of the relative hazard for shallow translational slope movement initiation based on the factors of safety computed at each point on a 9 meter (~30 foot) digital elevation model grid derived from the National Elevation Dataset. The stability index is a dimensionless number based on factors of safety generated by SINMAP that indicates the probability that a location is stable considering the most and least favorable parameters for stability input into the model. The breaks in the ranges of values for the stabilty index categories are the default values recommended by the program developers.

[3]**Factors of Safety** - The factor of safety is a dimensionless number computed by SINMAP using a modified version of the infinite slope equation that represents the ratio of the stabilizing forces that resist slope movement to destabilizing forces that drive slope movement (Pack et al., 2001). A FS>1 indicates a stable slope, a FS<1 indicates an unstable slope, and a FS=1 indicates the mariginally stable situation where the resisting forces and driving forces are in balance.

[4]**Probability of Instability** - This column shows the likelihood that the factor of safety computed within this map unit is less than one (FS<1, i.e., unstable) given the range of parameters used in the analysis. For example, a <50% probability of instability means that a location is more likely to be stable than unstable given the range of parameters used in the analysis.

[5]**Possible Influence of Stabilizing and Destabilizing Factors** - Stabilizing factors include increased soil strength, root strength, or improved drainage. Destabilizing factors include increased wetness or loading, or loss of root strength.

Pack, R. T., Tarboton, D. G. and Goodwin, C. N., 2001, Assessing terrain stability in a GIS using SINMAP, in 15th annual GIS conference, GIS 2001, Vancouver, British Columbia, February 19-22.

Figure 3-28. Slope Stability Map of Massachusetts
Source: Massachusetts Geological Survey & University of Massachusetts Amherst[229]

Coastal Erosion

Coastal erosion is the process where rising sea levels, strong wave action, and coastal flooding wear away at the rocks, soils, and sands along the coast. This is an issue daily as sea levels rise but is made worse when storms cause strong winds and storm surge.[230] Both continued development along the coast and rising sea levels will contribute to increased coastal erosion in the future. The highest coastal erosion rates in the state of Massachusetts occur along the coast of Cape Cod.[231] As mentioned previously in both the flooding and tsunami hazard sections, Carver is not a coastal town and therefore does not experience coastal erosion. Therefore, we did not choose to examine this hazard.

229 http://www.geo.umass.edu/stategeologist/Products/Landslide_Map/SSIM_Sheet3v2_print.pdf?_gl=1*ne7odi*_ga*OTQ4NTIyMjI1LjE2MjgxNjQzOTU.*_ga_21RLS0L7EB*MTYzMzQ1MDIyOS4xLjAuMTYzMzQ1MDIzMS4w&_ga=2.111752322.705078911.1633450230-948522225.1628164395v

230 https://toolkit.climate.gov/topics/coastal-flood-risk/coastal-erosion

231 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018 https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

4 Vulnerability Assessment

Quantitative and Qualitative Vulnerability Assessment

According to FEMA, typical critical facilities include hospitals, fire and police stations, critical record storage areas, and similar facilities. They are identified in the hazard mitigation planning process because they require special consideration when identifying hazards and determining mitigation actions. It is important to ensure that these critical facilities can continue to provide these important services during an emergency. [232]

The 2016 Hazard Mitigation Plan identified 31 critical facilities listed in Carver's Comprehensive Emergency Management Plan (2014). In 2021, the Hazard Mitigation Committee reviewed the previous list of critical facilities and added several new facilities. The facilities were also grouped based on category and tier. The first tier represents facilities directly related to emergency response and densely populated, largely 55+, living communities that could require more assistance in an emergency. The second tier represents other facilities that would require special attention during an emergency.

After identifying critical facilities, the Hazard Mitigation Committee conducted both a quantitative and a qualitative vulnerability assessment. For the qualitative vulnerability assessment, we mapped all critical facilities overlain by the FEMA flood maps (Figure 4-1). This allowed us to determine which critical facilities were in flood zones. The Vulnerability Assessment chart detailing each critical facility and the flood zone and type it is in, if applicable, can be found in Appendix C.

Flood zones with A designations indicate that they are susceptible to the 100-year flood, or a 1% annual chance of flooding. We determined that six of the *parcels* containing Carver's critical facilities are in FEMA flood zones with A designations: the Meadowbrook Apartments/Elderly Housing, South Meadow Village, Cranberry Village, Meadow Woods and well site, the North Carver Water District Pumps, and the Carver Municipal Well. However, the exact location of the wells at South Meadow Village and Cranberry Village, the Carver Municipal Well, and the North Water District Pumps are not located in flood zones—just certain areas of the parcels overlap with the flood zones.

The Meadow Woods well site, however, is located directly adjacent to two FEMA flood zones, zone A, and a regulatory floodway, along the Weweantic River. According to FEMA, regulatory floodways are defined as "the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height." [233] This could pose a problem if the well floods. There is a possibility that pollutants from the river can contaminate well water and if that happens, the well will need to be decontaminated. One solution would be to have a watertight sanitary well seal and a steel sleeve to protect the well from contamination.[234]

[232] https://www.fema.gov/glossary/critical-facility
[233] https://www.fema.gov/glossary/floodway
[234] https://agrilifeextension.tamu.edu/library/water/water-wells-in-floodplains-what-you-need-to-know/

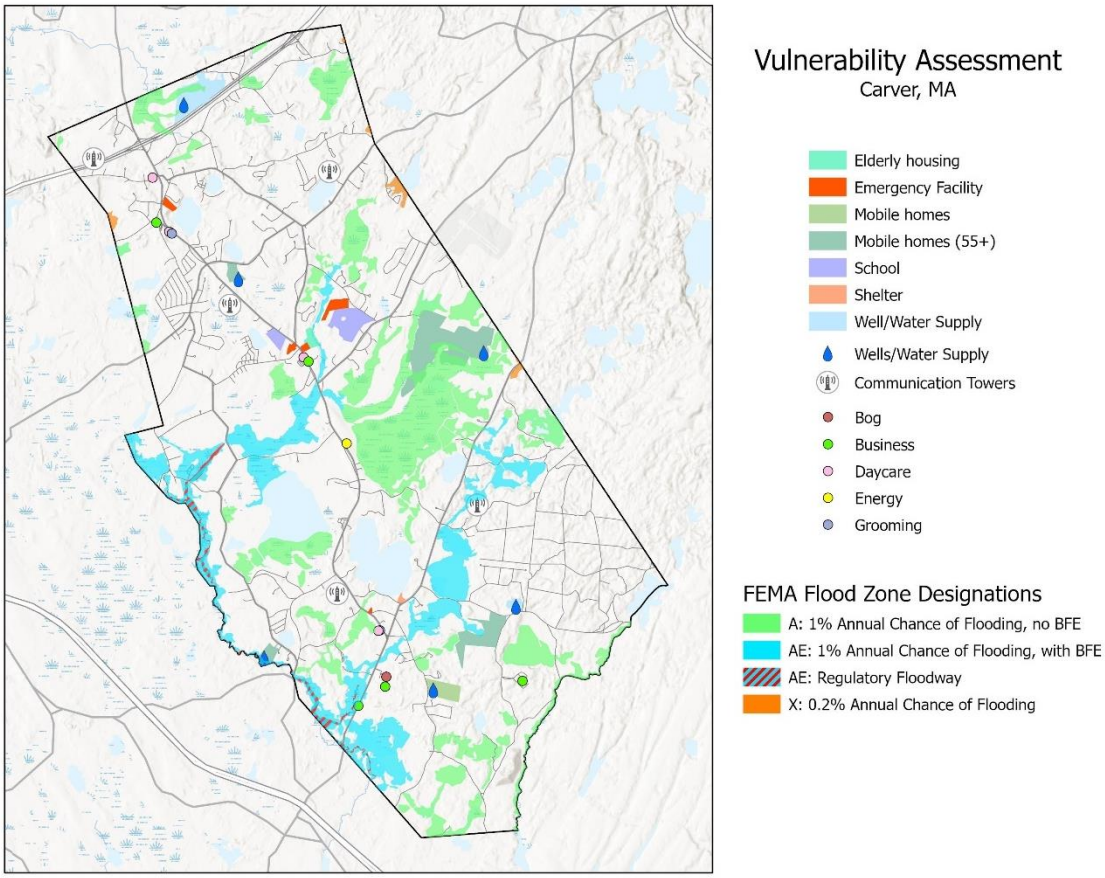


Figure 4-1. Vulnerability Assessment Map
Data Source: MassGIS[235]

Four of Carver's critical facilities in flood zones are home to a high concentration of 55+ residents and elderly people that may require additional assistance during and after a flood. These facilities should be "given special consideration when formulating regulatory alternatives and floodplain management plans." Critical facilities should not be located in a floodplain but if they are, they should be given a higher level of protection so that they can continue to function and provide services after the flood. Emergency plans will help facilities like these continue to provide these services during the flood. [236]

Most hazards Carver experiences are not mappable, or they are mappable but the previous location where the hazard occurred has little bearing on the exact location the hazard might occur in the future. Therefore, we only mapped the overlap between critical facilities and FEMA flood zones and conducted a qualitative vulnerability assessment to extract additional town knowledge that could be useful in determining impacts of hazards we did not map. The results of the qualitative vulnerability assessment can be found in a list in the Hazard Mitigation Committee minutes from Working Meeting No. 3 and intertwined in the hazard sections in Chapter 3.

[235] https://www.mass.gov/info-details/massgis-data-fema-national-flood-hazard-layer
[236] https://www.fema.gov/glossary/critical-facility

5 Mitigation Measures

A hazard mitigation strategy for reducing the community's vulnerability to natural hazard events has been prepared. The following chapter includes descriptions of the Town's mitigation goals, the status of mitigation actions identified in previous plans, on-going mitigation actions, descriptions of proposed mitigation actions to be implemented, and how these actions have been prioritized.

The Town of Carver identifies the following mitigation goals that are relevant to the hazard-mitigation actions of the Town of Carver.

1. Reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster.

2. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from riverine flooding.

3. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from non-flooding hazards such as wildfires, tornadoes, hurricanes, etc.

4. Improve pre-disaster planning, communication, and coordination among federal, state, county, community, private, and non-profit entities so that they can plan for and mitigate natural hazards in a clear and comprehensive manner.

5. Increase the awareness of the public and communities to the risks presented by the multiple natural hazards that affect the region as well as to the mitigation activities and grant opportunities available to minimize the impacts of these hazards.

6. Improve existing policies and programs to reduce further or eliminate the impacts of natural hazards.

The mitigation actions that were proposed in the 2016 Hazard Mitigation Plan were reviewed and assessed by the hazard mitigation committee. A comprehensive list of the former actions, responsible parties, resources required, and status can be found in Appendix C. These previous mitigation actions included:

1. Developing wildfire prevention education in Elementary Schools, and public awareness at town-wide events.

2. Updating the local process based on new state buildings codes and incorporate into local codes.

3. Updating all new home plans to guarantee hazard mitigation features of code are being met.

4. Comprehensive Master Plan coordination and utilization.

5. Updating of Hazard Mitigation Plan.

6. Updating CEM's Hurricane and Disaster Information Package and conveying information to mobile home communities.

7. Open Space Plan coordination and utilization.

8. Formalizing and appointing members to a regional aquifer advisory committee.

Most of the actions proposed in 2016 have been completed or are on-going efforts by the Town. Updating the Comprehensive Master Plan as well as updating the Open Space & Recreation Plan is still in progress but will be completed in 2022. Efforts to reestablish the regional watershed council have not resulted in creating an active council yet. However, the Town will continue this effort moving forward.

In addition to working on these on-going actions, the Town of Carver also works on maintenance projects, structural improvements, enforces zoning, floodplain, and soil conservation regulations, utilizes warning systems, and works to educate the public to ensure they will be better prepared for hazards (Table 5-1).

Table 5-1. Existing Protection Matrix

Category of Protection Measure	Description	Area Covered	Effectiveness and/or Enforcement	Improvements or Changes Needed
Capital Improvement Planning/ Structural Improvements	Capital Improvement Planning (CIP) Committee in place. Prepares CIP on an annual basis covering a 5-year cycle.	Town-wide	Funding on as-possible basis.	The town struggles to fund CIP items and maintain a sufficient operating budget.
	Use of Chapter 90 funds to improve drainage networks and roads	Route 58	Very effective in ensuring cleaner stormwater discharge, protecting wetlands, and flood prevention	None
Regulations/ Bylaws/ Codes	Local Wetlands (including Floodplain) Protection Bylaw	Town-wide	Very Effective	None
	Local roadways sufficient width for fire response equipment	Town-wide	Effective – Planning Board and Fire Department work together to ensure site plans and regulations are adequate for emergency response purposes.	None
	Zoning upland requirements for residential lots- a minimum of 70% of lot must be upland (residential lot minimum is 60,000 sq. ft.). Local Floodplain Zoning Bylaw	Town-wide	Each residential lot must have adequate upland area – protects floodplain areas by giving the resident enough useable land area for building and landscaping, i.e. prevents encroachment in floodplain/wetland areas.	None

Category of Protection Measure	Description	Area Covered	Effectiveness and/or Enforcement	Improvements or Changes Needed
Regulations/ Bylaws/ Codes	Subdivision Regulations- underground utilities required	Town-wide	Enforced	None
	Soil Conservation Regulations- could impact sedimentation build up in waterways run-off from sand and gravel operations	Town-wide	Adequate	None
Operations, Administration, and Enforcement	Tree Maintenance	DPW; Town-wide within public street ROW	As funding permits within Tree Warden workload	More funds
	Inter-department Emergency Coordination through Local Emergency Planning Committee	Emergency Management; Town-wide	Meets on as-needed basis.	None
	Disaster Warning System	Emergency Management; Town-wide	Cable TV; siren system	None
	Maintenance of Drainage Facilities	DPW; Town-wide	On an as needed basis, routine annual program followed as permitted within the Highway Department workload.	None
	Winter Road Clean-up	DPW	Snow removal, tree removal as needed in response to storms.	None
	Clear-cutting by State for fire road maintenance	State; Town-wide	As needed basis by state	None
	Fire Dept. review of new site plans for vegetation clearance	Fire Dept.; Town-wide	As new construction plans are submitted	None
	Fire Dept. patrols	Fire Dept.	Periodic and as needed	None
Planning	Comprehensive Plan / Master Plan-2017	Town-wide	No mention of disaster mitigation	On-Going
Conservation	Open Space and Recreation Plan –2010-2015	Town-wide	No mention of disaster mitigation--except for recommended building outside of wetland buffer zones and floodplain areas.	On-Going
Education & Training	Regular Training run on nuclear evacuation; hazardous materials, etc.	Town-wide	Effective	None
	Wide range of materials available at town hall on preparedness.	Town-wide	Adequate	Widen distribution – consider mailing with tax or utility bill

The hazard mitigation committee has prepared a list of proposed hazard mitigation actions that can be found in Appendix C. These actions address hazard risks identified in the Vulnerability Assessment (Chapter 4) and are aligned with the hazard mitigation goals. The current proposed mitigation actions include:

1. Wildfire prevention awareness.
2. Updating and enforcing regulations/Bylaws/Codes for mobile homes.
3. Updating and enforcing regulations/Bylaws/Codes for single-family homes.
4. Hurricane hazard awareness.
5. Updating and incorporation of Comprehensive Master Plan Goals and Objectives.
6. Following Open Spaces & Recreation Plan Goals and Objectives.
7. Re-establishing Plymouth-Carver Aquifer Advisory Committee.
8. Culvert inspections and replacement.
9. Remote water level sensors.

The hazard mitigation committee used a prioritization method to identify, evaluate, and rank specific mitigation actions. The full table used for this prioritization can be found in Appendix C. The prioritization focused on the following aspects:

1. Benefits – Determine whether the proposed mitigation action will improve property protection, natural resource protection, technical capacity, public awareness, or post-hazard emergency response.
2. Feasibility – Determine whether the proposed mitigation measure is feasible in terms of Town staffing, public and Town supports, and technically feasible.
3. Economic – Evaluate each mitigation measure in terms of estimated cost and potential funding sources.
4. Regulatory – Evaluate each mitigation measure for consistency with local, state, and federal permitting requirements and guidance.

Each proposed mitigation action was organized in accordance with the mitigation goal(s). Then each action was ranked on a scale of 1-3 for thirteen categories assessing the benefits, feasibility, economic impact, and regulatory restrictions. The rankings corresponded to:

- 3 – best/most benefit/least cost/easy or no permitting
- 2 – some benefit, moderate cost, some potential permitting complications
- 1 – little to no benefit, expensive, complicated permitting required

The ranking scores for each category was totaled for each mitigation action, resulting in a total score that was used to prioritize each action. In general, the actions are prioritized as follows:

- High = total score greater than 33
- Medium = total score between 32 and 31
- Low = total score less than 30

Some of these actions will require grant funding; others will require the cooperation of other agencies. The Town of Carver will make a good-faith effort to implement these actions within the constraints of the local budget, staff resources, and new demands from state and federal agencies.

6 Monitoring, Evaluation, and Update of Plan

This section is written to provide a framework for gauging progress and adjusting to new conditions, such as new policies, Federal requirements, and new initiatives, as they may arise.

Monitoring

Monitoring of the Hazard Mitigation Plan will be the responsibility of Carver Emergency Management. If need be, site visits or additional follow up will occur for actions outlined in the previous section. Monitoring will include site visits to appropriate locations where these measures have been implemented and will coincide with the annual review of the town's Comprehensive Emergency Management Plan (CEMP). Mitigation measures that have not been implemented will be reviewed to determine if they will still minimize natural hazards or if they are no longer a viable option. Additionally, any new options to include an update of the plan will be considered. A questionnaire will be developed and distributed to all appropriate department heads / departments in Carver's municipal government—i.e., "responsible parties" to the implementation of all protective measures in this document. This questionnaire will be used in the monitoring review process to ensure that all updates are sensible, timely, and are being completed by the various parties responsible. The Emergency Management Director will be responsible for the Plan's Monitoring as well as its Update and Evaluation.

Evaluation

Evaluation of the Hazard Mitigation Plan in its entirety will be done on a 5-year basis in accordance with the Disaster Mitigation Act of 2000 or after any significant natural hazard disaster. At that time, the Select Board will appoint a Hazard Mitigation Committee when requested to do so by the Emergency Management Director. Any new problems that arise will be reviewed be the hazard mitigation team and incorporated into the Hazard Mitigation Plan. The plan will be updated with possible new goals, mitigation measures, and plans of action as determined from the evaluation. This allows for up-dates to be made as the Town of Carver grows and changes.

The evaluation will include a review of the goals and actions and whether each still addresses current and expected conditions. The identification and magnitude of hazards will be reviewed. Local fiscal issues, administrative challenges, or major regulation changes will be discussed during this evaluations process. The evaluation will also consider local development and land use changes.

Update

The Emergency Management Department will oversee the hazard mitigation review and updating process.

The official update process will commence 4 years from this plan's approval date as shown on the Certificate of Adoption (Appendix D) not to begin more than 18 months from the expiration date of this plan. A Mitigation Team to be appointed at that time will be responsible for conducting this review and update. The update will be in conformance with federal requirements and will evaluate the effectiveness of whether the previously approved plan's method and schedule for monitoring, evaluating, and updating the plan worked, and what

elements or processes, if any, need to be changed or modified to provide a more successful outcome in future plans.

Integration of the Hazard Mitigation Plan into Other Planning Initiatives

Although many of the recommended mitigation measures from the Town of Carver, Massachusetts, 2016 Hazard Mitigation Plan have been implemented since the plan was adopted, continued ongoing local processes to guide implementation of the Plan and integration with Carver's others plans and programs is required. Such a process will be implemented over the next five years as described below.

Upon approval of the 2021 Hazard Mitigation Plan by FEMA, the Local Hazard Mitigation Implementation Team will provide all interested parties and implementing departments with a copy of the Plan and will initiate a discussion regarding how the Plan can be integrated into that department's on-going work. At a minimum, the Plan will be reviewed and discussed with the following departments: Building, Conservation, Department of Operations & Maintenance, Emergency Management, Fire, Health, Planning & Community Development, Police, and Recreation.

The Town will incorporate and consider elements from this Hazard Mitigation Plan and its process during other community planning projects as they are updated and renewed during their normal update cycles—the Town's Capital Improvement Plan, Comprehensive Emergency Management Plan, Master Plan, Open Space & Recreation Plan[237], the regional Plymouth/Carver Aquifer Action Plan[238], the Plymouth/Carver Sole Source Aquifer Regional Open Space Plan,[239] and any local Land Use and Management Plans[240] that are available.

Continued Public Involvement and Review by Regional Agencies

The public and important stakeholders will have opportunities to submit feedback and solicit comments from the Town of Carver regarding the plan and projects. The residents and businesses shall be notified when hazard mitigation issues are brought to the Select Board. This may be done using the local newspaper (*The Carver Reporter)*, the Town of Carver's Town Clerk's bulletin board, The Carver Council on Aging newsletter, Annual Town Meeting, the Annual Old Home Day event, and through the Southeastern Regional Planning and Economic Development District (SRPEDD). The plan will also be posted on the town's website, at www.carverma.gov, and on the town's School Department website, at www.carver.org, with the caveat that the local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. Reviews and comments can be found in Appendix D.

[237] Town of Carver 2010-2015 Open Space and Recreation Plan, Carver Open Space and Recreation Planning Committee, March 2010. See also www.carverma.gov/conservation-commission/pages/open-space-and-recreation-plan for an online copy of this Plan.
[238] See the Plymouth/Carver Aquifer Plan, 2007, at https://www.kingstonmass.org/vertical/sites/%7B14403534-636B-4C7F-A416-D66D8321CF44%7D/uploads/PCAAC_Plan_2007.pdf
[239] See the Plymouth/Carver Sole Source Aquifer Regional Open Space Plan, 2008, at https://scholarworks.umb.edu/uhi_pubs/9/
[240] Town of Carver Land Use and Management Plan for the Cole Property, 2007, prepared by Sarah G. Hewins, available at the Conservation Department at the Carver Town Hall, 108 Main Street, Carver, MA, 02330.

Appendix A

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.*

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.

ELEMENT	REQUIREMENTS
A4. Does the Plan document the review and incorporation of existing plans, studies, reports, and technical information? ***44 CFR 201.6(b)(3)*** ***Intent****: To identify existing data and information, shared objectives, and past and ongoing activities that can help inform the mitigation plan. It also helps identify the existing capabilities and planning mechanisms to implement the mitigation strategy.*	a. The plan **must** document *what* existing plans, studies, reports, and technical information were reviewed. Examples of the types of existing sources reviewed include, but are not limited to, the state hazard mitigation plan, local comprehensive plans, hazard specific reports, and flood insurance studies. b. The plan **must** document *how* relevant information was incorporated into the mitigation plan. ***Incorporate*** *means to reference or include information from other existing sources to form the content of the mitigation plan*.
A5. Is there discussion on how the community(ies) will continue public participation in the plan maintenance process? ***44 CFR 201.6(c)(4)(iii)*** ***Intent****: To identify how the public will continue to have an opportunity to participate in the plan's maintenance and implementation over time.*	a. The plan **must** describe how the jurisdiction(s) will continue to seek public participation after the plan has been approved and during the plan's implementation, monitoring and evaluation. ***Participation*** *means engaged and given the chance to provide feedback.* Examples include, but are not limited to, periodic presentations on the plan's progress to elected officials, schools or other community groups, annual questionnaires or surveys, public meetings, postings on social media and interactive websites.
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? ***44 CFR 201.6(c)(4)(i)*** ***Intent****: To establish a process for jurisdictions to track the progress of the plan's implementation. This also serves as the basis of the next plan update.*	*a.* The plan **must** identify how, when, and by whom the plan will be monitored. ***Monitoring*** *means tracking the implementation of the plan over time. For example, monitoring may include a system for tracking the status of the identified hazard mitigation actions.* *b.* The plan **must** identify how, when, and by whom the plan will be evaluated. ***Evaluating*** *means assessing the effectiveness of the plan at achieving its stated purpose and goals.* *c.* The plan **must** identify how, when, and by whom the plan will be updated. ***Updating*** *means reviewing and revising the plan at least once every five years.* d. The plan **must** include the title of the individual or name of the department/ agency responsible for leading each of these efforts.

4.2 ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT

Requirement §201.6(c)(2)(i)	[The risk assessment shall include a] description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
§201.6(c)(2)(ii)	[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
§201.6(c)(2)(ii)(A)	(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
§201.6(c)(2)(ii)(B)	(B) An estimate of the potential dollar losses to vulnerable structures identified in … this section and a description of the methodology used to prepare the estimate.
§201.6(c)(2)(ii)(C)	(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.
§201.6(c)(2)(iii)	For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Overall Intent. The risk assessment provides the factual basis for activities proposed in the strategy that will reduce losses from identified hazards. A quality risk assessments makes a clear connection between the community's vulnerability and the hazard mitigation actions. In other words, it provides sufficient information to enable the jurisdiction(s) to identify and prioritize appropriate hazard mitigation actions.

Local risk assessments do not need to be based on the most sophisticated technology, but do need to be accurate, current, and relevant. During a plan update, local jurisdictions assess current and expected future vulnerability to all hazards and integrate new hazard data such as recent hazard events and new flood studies. In the mitigation plan review, FEMA looks at the quality of the information in the risk assessment, not the quantity of information in the risk assessment.

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.

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.

4.4 ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION *(Plan Updates Only)*

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."

APPENDIX A:
LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction:	**Title of Plan:**	**Date of Plan:**
Local Point of Contact:	**Address:**	
Title:		
Agency:		
Phone Number:	**E-Mail:**	

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan (section and/or page number)**	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))			
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? (Requirement §201.6(b)(2))			
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))			
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))			
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))			
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))			
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))			
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))			
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? (Requirement §201.6(c)(2)(ii))			
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))			
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
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? (Requirement §201.6(c)(3))			
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))			
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))			
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? (Requirement §201.6(c)(3)(ii))			
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? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))			
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? (Requirement §201.6(c)(4)(ii))			
ELEMENT C: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))			
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))			
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))			
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))			
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS d			

Appendix B

Town of Carver
Hazard Mitigation Plan
Kick-off Meeting Notes

Meeting No. 1
July 1, 2021
9:00 – 10:30 AM
Carver Town Hall – Room 4

Attendees:

- Andy Glines, Fuss & O'Neill (F&O)
  Senior Civil Engineer | Project Manager
  401-861-3070 Ext 4540
  317 Iron Horse Way, Suite 204
  Providence, RI 02908
- ~~Alex Duryea, Fuss & O'Neill~~
  Environmental Scientist
  401-861-3070 Ext 4548
  317 Iron Horse Way, Suite 204
  Providence, RI 02908
- Elise Leduc, Woods Hole Group (WHG)
  Coastal Scientist, PWS
  508-495-6234
  107 Waterhouse Road
  Bourne, MA 02532
  www.woodsholegroup.com
- Tom Walsh, Emergency Management Director
- Sarah Hewins, 2016 HMP team member and former Conservation Agent
- Jim Walsh, Planning and Economic Development Director
- ~~Craig Weston, Fire Chief~~
- Brook Monroe, Conservation Agency
- ~~John Woods, Deputy Director of Operations & Maintenance~~
- ~~Bill Napolitano, SRPEDD~~
- Mike Paduch, Assessors Board
- Kevin Tracey, North Carver Water District Water Commissioner

Meeting Notes:

1. Welcome and team introductions

2. F&O and WHG provided overview of the HMP Process
   - What is a Hazard Mitigation Plan and why should Carver have one
     - Introduction to the HMP process
     - Current Plan from 2016
     - FEMA requires HMP to be updated every 5 years
     - Updating this plan rather than starting from scratch
   - F&O and WHG partnering with Town for update
     - F&O providing background and experience with Town
     - WHG providing additional experience with HMPs and coordination with permitting agencies
   - Discussion of Public Outreach Strategy
     - Tom will continue to advertise monthly coordination meetings as public, working meetings
     - Conduct two presentations throughout process
     - Conduct surveys of targeted neighborhoods
       - Mobile home parks
       - Abutting National Forest
       - Areas that have experienced flooding
     - Post something online
     - Provide hard copies at public buildings
       - Town Hall
       - Library
       - Senior Center
       - Fire Station
       - Mobile home parks
         - Typically drop pamphlets off anyway, can drop off piles of surveys there
   - Reviewed state hazard list
     - Natural hazards only
     - Note that hazards have been added in 2018 by FEMA
     - See Enclosed list of required hazards that are required to be included
       - No additional hazards identified (yet)

- We will focus on
  - Inland Flooding
    - Carver doesn't have traditional flooding issues
    - Carver has lots of wetlands and very sandy soil
    - Failure of water control structures is a concern – flumes, culverts, dams
      - "flumes" = water control structures
      - "planks" = not batter boards
      - Rt. 58 Montello St. improvement projects – culvert was blocked and flooded, knocked out wells for Silo Marketplace
    - Need to coordinate with MVP, this will tie into MVP report
    - Neighborhoods: Never flooded to the extent that you can't drive through them (just a few inches); these are back roads
      - Great Meadow – there is a river underneath that has since been filled
      - Holmes Street – nearby reservoir that floods
      - Meadow Street
      - Popes Point Road and Cross St – subject to flooding
        - Popes Point Road & Beaver Dam Road were resolved
  - Severe Winter Storm
    - Two back-to-back nor'easters March 1st – 3rd & 6th – 8th, 2018, major wind damage, 58mph winds in Carver during the first storm, >90% of residents without power
  - Drought
    - Conveyance of water between cranberry bogs
    - Long term management of bog/reservoir properties: if sold to non-growers, they may not be managed well to support downstream growers
      - Controversial Pine Street plan
  - Wildfires
    - 2nd fire tanker recently added to fleet, now there's one in South Carver (delivered last week)
    - Heavy concentration of "pitch pine"
    - Forest Management
      - Town does not do much in the way of forest management; the state manages their forests (Myles Standish State Forest)

- Invasive Species
  - Fox Tail tends to clog waterways
    - It would be good to confirm what species this is: *Myriophyllum heterophyllum*? *Myriophyllum spicatum*? (both are on the MA invasive plant list)
- Hurricanes/Tropical Storms
  - 1,000+ mobile homes in Town
  - Approximately 800 mobile homes are 55+
  - Tie-downs

3. Data Requirements
   - Carver data:
     - Recent hazard records/photos (storms, flooding, major repairs, wildfire incidents, etc.) will be useful
       - Sarah provided some photos of storm events
       - Map of local flooding areas – Sarah
       - Wildfire records – Fire Department
       - Culvert/water control structures – John Woods
     - Selection of critical facilities
       - Does not need to be a Town-owned facility – solar arrays are a good example of this, dual use arrays are much higher and could be more affected by the wind
       - Hazardous material sites
       - Buildings that require evacuation assistance
       - Old police station is vacant, but still critical because it's where power to EMS station comes through.
       - Addresses may need to be added/changed.
       - Start with existing list from 2006 plan
     - Need to know what mitigation measures completed since 2016
       - When and what was completed?
       - Will need to update to-do list
   - Relevant Town plans/reports to be compiled by F&O
     - 2016 HMP
     - MVP
     - GIS: Current assessor's parcel database (MassGIS Jan. 2021)
     - FEMA
     - Repetitive loss properties
       - None anticipated, but Town will confirm
       - Long lead time to receive data
     - Wild fire logs for the last 5 years
     - Invasive species

        - See 2015 Open Space & Recreation Plan which should be found in Planning & Community Development page on the website (or Sarah has a copy)
        - 2019 MVP Plan
    - Land Use categories
        - should be listed in Master Plan
        - Bill SRPEDD did the Master Plan, we will use the same categories
        - 2017 master plan - in planning and community development website - or on SRPEDD website
    - Photos

4. Timeline for HMP Update Completion
    - Schedule
        - Setting recurring meeting schedule is preferred
            - 1st Thursday of the month at 9 AM
        - Submission to permitting agencies by end of calendar year
        - Meeting approach (i.e. virtual or in-person moving forward) to be discussed with Tom
            - Prefer in-person meetings but will need to evaluate budget
            - Working meetings, invite the public

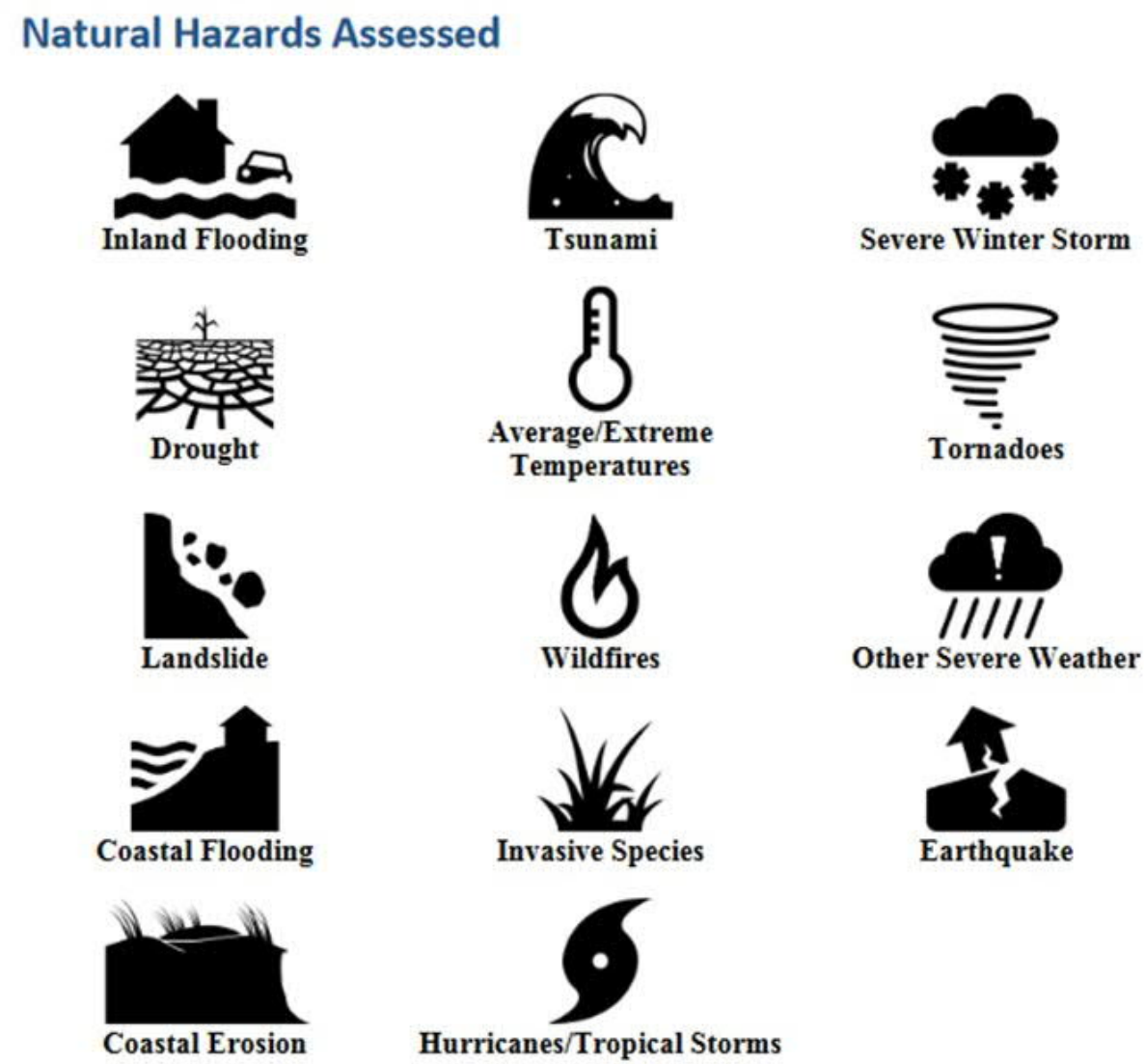
Action Items:

- ~~F&O will reach out to John to request data on problem culverts in Town.~~
    - ~~John provided list~~
- ~~F&O will reach out to Craig to request data on wildfires and hazardous sites.~~
    - F&O will reach out to Matt Barrington at 508-866-3440
- F&O will review and compile relevant Town plans/reports, then send links for use as reference documents.
- F&O will follow-up with how to ask for Repetitive Loss Properties in Carver.
    - Then, Tom will reach out to FEMA to request list of repetitive loss properties.
- F&O will send draft survey as word file for review/comment.
- F&O will distribute draft schedule.
- Tom will review 2016 list of Critical Facilities.
- Bill to provide list of Land Use categories used in Town.
- F&O will send appointment for next meeting
    - Tentatively scheduled for Thursday (8/5) at 9 AM
- F&O will provide estimate to Tom for cost of attending in-person meetings

Next Meeting:

- August 5, 2021, at 9 AM
    - Location TBD based on discussion with Tom

From the Massachusetts State Hazard Mitigation and Climate Adaptation Plan – September 2018.



Town of Carver
Hazard Mitigation Plan
Working Meeting No. 1

Meeting No. 2
August 5, 2021
9:30 – 11:00 AM
Carver Town Hall – Room 4

Invitees:

- Andy Glines, Fuss & O'Neill
- Alex Duryea, Fuss & O'Neill
- Elise Leduc, Woods Hole Group
- Tom Walsh, Emergency Management Director
- Sarah Hewins, Vice Chair of Select Board
- ~~Jim Walsh, Planning and Economic Development Director~~
- Craig Weston, Fire Chief
- Brook Monroe, Conservation Agency
- John Woods, Deputy Director of Operations & Maintenance
- ~~Bill Napolitano, SRPEDD~~
- ~~Mike Paduch, Assessors Board~~
- Kevin Tracey, North Carver Water District Water Commissioner

New Action Items:

- F&O to send out final survey for review, then send out final survey PDF
- F&O will create online survey (via Survey Monkey) and distribute it with a blurb
- F&O will coordinate with Tom and select a new date for Public Presentation #1
- Sarah will post survey to Facebook, town website, select board office (gov't official page and personal page)
- Craig will put survey on Carver Fire Department website
- Tom will print and deliver surveys and dropboxes to Town Hall, Library, South Meadow Village, & Cranberry Village
- Either Tom or Craig will print several survey copies to put in the Fire Station lobby
- Tom will post on Emergency Management Facebook page(s)
- Those who are distributing the surveys online, post another blurb every few days reminding people to take the survey by the 8/23 deadline

Outstanding Action Items:

- John Walsh is working on updating the Carver Master Plan on the town website
- Bill is looking over Land Use categories and grouping criteria used in Master Plan
- We need to find out what mitigation measures have been completed since 2016 and when? This will help us update the to-do list.

Agenda Items:

1. **Welcome and team introductions**

2. **To-do during this meeting:** Refine critical facilities, confirm hazard selection and data sources, make a plan of how to get data that is not readily available, and finalize public survey questions

3. **Completed Tasks Since Last Meeting**
   - John provided problem culvert list to F&O
   - F&O contacted Matt Barrington with Carver Fire to request hazardous material report and records of wildfires over the last 5 years
     - Waiting on scans of reports
   - Tom contacted FEMA to request list of repetitive loss properties
     - FEMA has started processing the request but is currently in a transitional period so it might take several months
   - Brooke provided F&O with information on invasive species in Carver
     - Not a huge concern, minor issues with *Phragmites australis* and Japanese knotweed (*Polygonum cuspidatum*), Oriental bittersweet (*Celastrus orbiculatus*)
     - Carver does not have a tree warden, had an invasive species committee in the past that no longer exists
     - Wanted to know how other towns take care of invasive species – it's very expensive
   - Mike said that the main invasive species concern for bogs is "Foxtail" (*Cobamba caroliniana?*)
     - Always a problem, thick spreading plant that clogs waterways and irrigation systems
     - Only practical control, to his knowledge, is raking it up
   - Tom reviewed 2016 list of Critical Facilities and updated it for 2021

4. **Finalize public survey questions**
   - Review of Survey
     - Comments/edits incorporated to make survey more clear and to remove jargon
       - Question 1 removed
       - Introductory paragraph – jargon removed, much more clear
       - Q5: (h) "Town House" to "Town Hall" & (k) clarification "Public" water distribution infrastructure
       - Q6: question rephrased – "Which of the following actions have you taken *to make you or your property* more hazard resistant?"
       - Q8: (i) removed "Perform detailed risk assessments"
       - No question #9
       - Q10: added an answer (h) "I have access/functional needs"
     - No wide-scale mailing – costly/difficult to process all the paper responses
     - Mostly online – using Survey Monkey or similar platform
       - F&O will send the link with a 1-2 sentence blurb

- Town to post in several areas online
  - Sarah's Public Official page and Town Facebook page
  - Shared again to team members' personal pages
  - Tom can post on town website and Emergency Management Page(s)
  - Craig can post on Fire page
- Tom will print and drop off physical copies of survey & put out a drop box in each place and go back and collect filled out surveys on or after 8/23
  Locations include:
  - Town Hall
  - Library
  - Some at Center Fire Station lobby (99 main)
  - South Meadow Village
  - Cranberry Village
- If mailing back, send to P.O. Box 580 Carver Emergency Management, Carver MA 02330
- F&O to incorporate edits and send out survey PDF and link by Friday
- Survey will be open from 08/09 – 08/23, late responses will be accepted

5. Refine Critical Facilities

- Review FEMA Checklist:
  Critical facilities:
  - Emergency operations centers
  - City or town offices
  - Water and wastewater treatment plants
  - Sewage pumping stations
  - Police or fire stations
  - Schools
  - Hospitals
  - Day-care facilities
  - Public works garages
  - Nursing homes/elderly housing
  - Emergency shelters

  Economic Drivers:
  - Large businesses
  - Large employers
  - Historical or Cultural sites
- Repetitive loss structures (working on getting from FEMA)
- Structures that have incurred substantial damage, as defined by FEMA
- Anticipated future land use areas
- Critical facility additions
  - Add Carver Elementary School - 85 Main St, Carver, MA 02330
  - Add well for Pine Tree Village - Wareham St. & David Rd., Carver, MA
    - Village association has been in contact with Sarah re a DEP grant
    - Need to confirm that there is a well here

        - This and other wells listed serve mobile homes – elderly and/or low income, service hundreds of people
    - North Carver Water District Pumps - technically at 80 Pleasant St, but red dot doesn't show up in the right place on the map
    - Include HAZMAT list as a reference?
    - Create a tiered priority list?
        - Add solar arrays with battery storage (or planned battery storage) - tier 2?
        - Add daycares - Tom will send list of the 4 or 5 known locations

6. Confirm Hazard Selection and Data

- Flooding (inland and coastal)
    - List dams/culverts as a separate hazard
    - Include flumes/water control structures under flooding
    - F&O will create a map of local flooding for heavy precipitation hazard
        - based on Sarah's photos and information about problematic locations
        - will recirculate for review
- Wildfires
    - FD to provide maps of past wildfires and response records over the past 5 years
    - can provide a map of significant wildfires that have happened in the past ~50 years
- Invasives
    - Oriental bittersweet is also an issue around town
- Dams – past incidents
    - North Carver dam near post office, muddy pond brook had backed up
    - Myles Standish reservation - just after headquarters - collapsed in the 90s; repaired, but cars still not allowed to pass
    - France Street - ~2010; has been repaired… in the photos Sarah took from Great Meadow Drive. Did have to evacuate a few homes immediately downstream.
- Data source chart – suggestions for better or more local data?

7. Review draft schedule & timeline for HMP completion

- Future meetings 9-10:30am
    - F&O to send outlook invites for the remaining meetings
    - Next meeting 9/2 9-10:30am
- Public meetings – evening presentations 6/7pm
    - Room 1 is often booked Tuesday nights and every other Wednesday night
    - Tom can book Room 1 once we solidify a date/time
    - Elise unavailable 10/14, will choose weeknight between 10/25-10/29
- *Update since the last meeting!*
    - Tom found out that the selectmen will not be meeting in Carver Town Hall Room 1 on Tuesday 10/26, so the room (which is very often booked) will be free then
    - We will host the first public outreach presentation Tuesday evening 10/26 at 6pm in Carver Town Hall Room 1
    - More information and discussions about the public outreach presentation will be coming soon!

Resources:

Agendas
07-01 Agenda – https://docdro.id/jC29oKc
08-05 Agenda – https://docdro.id/RZTti5q

Minutes
07-01 Minutes – https://docdro.id/tdos9CP

Final Survey PDF – https://docdro.id/lOwDmz0
Survey Monkey Link – https://www.surveymonkey.com/r/CarverHMP
Survey blurb: "The Town of Carver is currently working on updating its Hazard Mitigation Plan. Residents of Carver are encouraged to take this short survey to help the town respond to natural hazards. Please complete this survey by August 23rd."

Schedule (updated 8/19/21) – https://docdro.id/rbXupFk

Map of Dams in Carver - https://docdro.id/v1FZwqu

2021 Updated List of Critical Facilities – https://docdro.id/1y4YmTq
2018 MVP Plan – https://docdro.id/z7WkCuh
2016 Carver Hazard Mitigation Plan – https://docdro.id/1kI2aAi
2017Carver Master Plan – https://docdro.id/g31VVHE
2010-2015 Carver Open Space and Recreation Plan – https://docdro.id/OI9KNZJ
MA Interactive Property Map – https://www.mass.gov/service-details/massachusetts-interactive-property-map
Municipal Mapper Carver, MA – http://maps.massgis.state.ma.us/map_ol/carver.php
Carver Tax Assessor's maps – https://www.carverma.gov/assessors-maps
MEMA Website – https://www.mass.gov/orgs/massachusetts-emergency-management-agency
FEMA Website – https://www.fema.gov/

Town of Carver
Hazard Mitigation Plan
Working Meeting No. 2 - Minutes

Meeting No. 3
September 2, 2021
9:00 – 10:30 AM
Carver Town Hall – Room 4

Invitees:

- Andy Glines, Fuss & O'Neill
- ~~Alex Duryea, Fuss & O'Neill~~
- Elise Leduc, Woods Hole Group
- Tom Walsh, Emergency Management Director
- Sarah Hewins, Vice Chair of Select Board
- Jim Walsh, Planning and Economic Development Director
- Craig Weston, Fire Chief
- ~~Brook Monroe, Conservation Agency~~
- John Woods, Deputy Director of Operations & Maintenance
- ~~Bill Napolitano, SRPEDD~~
- Mike Paduch, Assessors Board
- Kevin Tracey, North Carver Water District Water Commissioner

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Minutes
07-01 Minutes – https://docdro.id/tdos9CP
08-05 Minutes – https://docdro.id/bhBJ2E3

Final Survey PDF – https://docdro.id/lOwDmz0
Survey Monkey Link – https://www.surveymonkey.com/r/CarverHMP

Schedule (updated 9/1/21) – https://docdro.id/rbXupFk

Map of Dams in Carver - https://docdro.id/v1FZwqu

2021 List of Critical Facilities (updated 9/1/21) – https://docdro.id/1y4YmTq
2018 MVP Plan – https://docdro.id/z7WkCuh
2016 Carver Hazard Mitigation Plan – https://docdro.id/1kI2aAi
2017Carver Master Plan – https://docdro.id/g31VVHE
2010-2015 Carver Open Space and Recreation Plan – https://docdro.id/OI9KNZJ
MA Interactive Property Map – https://www.mass.gov/service-details/massachusetts-interactive-property-map
Municipal Mapper Carver, MA – http://maps.massgis.state.ma.us/map_ol/carver.php
Carver Tax Assessor's maps – https://www.carverma.gov/assessors-maps
MEMA Website – https://www.mass.gov/orgs/massachusetts-emergency-management-agency
FEMA Website – https://www.fema.gov/

Action Items:

1. F&O to send updated Vulnerability Analysis chart (from 2016 HMP p. 13) to Tom for initial review, then send to HMP Committee
2. F&O will revise Proposed Mitigation Actions table (from 2016 HMP p. 35-37)
    a. Tom will take a first pass at filling it in and will reach out to other departments as necessary
3. F&O to send Tom 2016 HMP goals for initial review and edits
4. F&O to draft email to Tom to send to 9 survey respondents who provided emails
5. F&O to send out clarification on exact locations of remaining critical facilities yet to be mapped
6. F&O to send out agenda Monday 10/4 before next working meeting 10/7
7. F&O will follow up with Health Agent at Board of Health to get more info about past mosquito borne (EEE) incidents, if needed

Meeting Notes:

1. **Agenda:** Review public survey results, finalize critical facilities, update vulnerability assessment chart, review 2016 mitigation actions and goals

2. **Review Public Outreach Efforts & Survey Results**
    - 129 respondents
        - Survey is now closed
        - No hard copies were received
    - 9 people want to be involved
        - Will invite them to presentation and send survey results
    - Survey Results Discussion
        - Mosquito borne illness
            - Outdoor youth sports have been canceled
            - Signs have been posted at conservation lands warning people about EEE
            - Carver is a EEE hotspot
            - <u>Add this as a separate natural hazard</u>
        - Holmes St bridge - some undermining issues. The bridge is also a dam
            - Can mention this location specifically in the dam chapter.
            - Town is applying for grants to repair.
        - Public comment to include historic sites
            - Marcus Atwood House – COA – Is included
            - Other historic sites
                - Two historic districts
                - Union Church
                - Savery Ave - first divided highway in the country
            - <u>Add historic sites/districts discussion/map to intro/community profile section. Do not add as critical facilities.</u>

3. **Finalize Critical Facilities**
   - No solar arrays
   - Daycares will be included in the critical facilities list
     - Tom sending locations
     - Daycares along Rt 58 as 2nd tier critical infrastructure
   - Pine Tree Village – separate well on Wareham St. & David Rd.
     - Location received from Craig
   - Add concentrations of animals - 2 kennels (north carver and south carver), horse stable(s)
     - Tom sending locations

4. **Feedback on Vulnerability Ranking Chart**
   - Compare 2016 chart with our draft
     - Need to keep the bold items – hazards
     - Chart that was shared was updated from 2016 plan; rows were added; made a couple adjustments to X's
     - Removing some subcategories and reorganizing
   - To-do:
     - Make hazard list match the list of hazards being addressed in this report (i.e., collapse/remove subcategories)
     - Add scores and reorder table based on final ranking
     - Keep nor'easter in in the discussion of severe winter weather
       - Add sentence to wind and rain section describing how nor'easters are not always winter storms but may also bring wind/rain in other seasons as well

5. **Confirm Mitigation Actions Completed Since 2015/2016**
   - Discussion from meeting:
     - F&O will revise table, add blank columns (e.g., status - multiple choice; notes - when completed? why not done?)
       - Tom will take a first stab at filling it in and will reach out to other departments as necessary
     - Floodplain zoning - adopted through Town meeting in April 2021 → This will be discussed in the narrative on current/ongoing mitigation actions taken by the Town

6. **Goals from 2016 HMP (p. 35)**
    1. Reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster.
    2. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from riverine flooding.
    3. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from non-flooding hazards such as wildfires, tornadoes, hurricanes, etc.
    4. Improve pre-disaster planning, communication, and coordination among federal, state, county, community, private, and non-profit entities so that they can plan for and mitigate natural hazards in a clear and comprehensive manner.
    5. Increase the awareness of the public and communities to the risks presented by the multiple natural hazards that affect the region as well as to the mitigation activities and grant opportunities available to minimize the impacts of these hazards.
    6. Improve existing policies and programs to reduce further or eliminate the impacts of natural hazards.

- From meeting discussion:
    - Tom: what page on the 2016 plan were these on? Wants to see the context in which they were addressed before (p. 35)
    - Elise described that each goal needs at least one action; and every action needs to be associated with at least one goal.
        - So for now this looks like a really comprehensive list, but we may need to adjust/revisit these goals once we have our actions developed.

7. **Looking Ahead**
    - Next meeting 10/7 9-10:30am
    - Public Presentation 10/26 6pm (Room 1)

Town of Carver
Hazard Mitigation Plan
Working Meeting No. 3

Meeting No. 4
October 7, 2021
9:00 – 10:30 AM
Carver Town Hall – EOC

Invitees:

- Andy Glines, Fuss & O'Neill
- Alex Duryea, Fuss & O'Neill
- Elise Leduc, Woods Hole Group
- Tom Walsh, Emergency Management Director
- ~~Sarah Hewins, Vice Chair of Select Board~~
- Jim Walsh, Planning and Economic Development Director
- Craig Weston, Fire Chief
- ~~Brook Monroe, Conservation Agency~~
- John Woods, Deputy Director of Operations & Maintenance
- ~~Bill Napolitano, SRPEDD~~
- ~~Mike Paduch, Assessors Board~~
- Kevin Tracey, North Carver Water District Water Commissioner

New Action Items:

- Tom to ask FEMA for an update regarding repetitive loss properties
- Tom to email survey respondents summarized survey results and invite them to the public presentation 10/26 6pm Carver Town Hall **Room 4**
- F&O to create a flyer for the for Public Presentation & a blurb to go with it
- F&O to reach out to Carver Board of Health for specific info regarding mosquito-borne illnesses

Agenda Items:

1. **Welcome**

2. **To-do during this meeting:**
   - Review hazard data, maps
   - Quantitative Vulnerability Assessment results
   - Qualitative Vulnerability Assessment
   - Finalize hazard ranking
   - 2016 Goals
   - 2016 Action Status
   - Public presentation

3. **Review Hazard Data & Maps**
   - Maps have been created for mappable hazards, for those that are not mappable, graphics have been found and will be used in the report
     - **Fire**
       - Data for maps is mostly in Plymouth, but it's interesting to look at the expanse of areas that have been affected by wildfires
       - Interesting to show vulnerable habitat, could show where future fire more likely
     - **Drought**
       - Becoming more common. Lots of residents on wells - could impact them. Also impacts agriculture - expanding reservoirs and digging them deeper
       - Craig - have had to change strategies on where they can get water for fire suppression (most taken from bogs, rivers, etc.); plus, fire hazard is higher during drought
       - Might want to bump drought up on hazard ranking table
     - **Hurricanes/Tropical Storms**
       - Data displayed on 2 maps
     - **Dams**
       - 3 dams that are a significant hazard based on Office of Dam Safety classifications; 5 that are a low hazard.
     - **Flooding**
       - Mapped areas where Sarah pointed out where flooding has occurred
       - Vulnerable neighborhoods were built a while ago, but current planning restrictions would likely prohibit future/new development here. There's already been a lot of work to better protect and plan around wetlands
       - FEMA flood maps - utilized this layer for the quantitative vulnerability assessment
     - **Wind**
       - Data: EOEEA wind data, Local weather station, National storm event database
     - **Extreme Temperature**
       - only a few events, but listed as one of the top 4 hazards in MVP
       - May be more due to potential future changes (rather than historical or current conditions) since the MVP program is specifically climate change focused
     - **Mosquito borne illness**
       - Plymouth County Mosquito Control (a state agency) - aerial spraying natural areas; test certain sites for presence of disease. Correlation with cedar swamps? State has dropped mosquito larvicide tablets in catch basins
   - Make sure frequency column in hazard ranking table corresponds to how frequently our data/maps say these things are actually happening.

4. **Review Quantitative Vulnerability Assessment chart**
   - Add column of categories "Hazardous Materials", "Large Day Cares", "Communications", "Emergency Response", etc.
   - Craig will double check the critical facility list - make sure it's not outdated
   - Take off Libbiloo's and Bright Beginnings from list. Add Little Crusaders.
   - Unclear locations: North Carver Water District - at the treatment plant & Agway recently moved (aka Nutrium) on Forest St (at North Main at intersection)

5. **Finalize Hazard Ranking**
   - Adjust mosquito borne illness and drought?
   - We'll assign specific frequencies and make sure they're consistent with the data

6. **Qualitative Vulnerability Assessment - Thought Exercise**
   Run through each hazard and identify specific areas/buildings that have been impacted
   - Fire - Mobile home parks are of particular risk due to congestion; fire load is highest in areas of pitch pines, most prevalent in South Carver; Useful to overlay historical fire map with today's development - homes in place now that weren't there before (i.e., a fire of the same location and magnitude would be much more damaging to homes/structures today)
   - High heat - Mostly a concern with employee's health for those that work outside. Temperature mainly becomes a problem when you lose power
   - Dams - Plymouth street - Town had to pull people out when the dam was in trouble. In general, it all tends to spill into the swamp. France Street - biggest near disaster (2010) town was worried about downstream effects, notified people, ended up going under Rochester Rd
   - Snow - Town Hall has flat roof, schools have flat roofs - someone goes and shovel them off
   - Heavy Rain - Council on Aging had some basement flooding Sept 1 - 4+ inches of rain Heavy rain was also a problem for agriculture: not a good time for cranberries to get flooded

7. **New Mitigation Goals**
   Review Goals from 2016 HMP (p. 35)
   Consensus was that the goals are okay as they are
   - Reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster.
   - Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from riverine flooding.
   - Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from non-flooding hazards such as wildfires, tornadoes, hurricanes, etc.
   - Improve pre-disaster planning, communication, and coordination among federal, state, county, community, private, and non-profit entities so that they can plan for and mitigate natural hazards in a clear and comprehensive manner.
   - Increase the awareness of the public and communities to the risks presented by the multiple natural hazards that affect the region as well as to the mitigation activities and grant opportunities available to minimize the impacts of these hazards.
   - Improve existing policies and programs to reduce further or eliminate the impacts of natural hazards.

8. **New Mitigation Actions**
   - Review whether or not these have been completed
   - Tom will follow up with others to check on the status of different actions and get this chart filled out

9. Public Presentation

- Typically: we'd present what is a hazard mitigation plan, why we want one, overview of hazards, critical facilities, and vulnerability assessment results
- Only halfway through the process, mitigation actions will come later – next presentation
- Ask for public input on local issues, can ask questions from the survey, & highlight results
- 10/26 at 6pm - switched to room 4
- We should directly email folks who provided email in the public survey to invite them to the presentation
- F&O to create "invitation"/flyer/announcement for town to distribute
    - Open Meeting Law - produce an agenda 48 hrs ahead of time (better the week before)
    - Town should advertise: town website, Facebook, etc.
    - Tom to contact TV folks to record presentation
- Attendees: Tom, Sarah, Brook, Craig, Town Administrator? & anyone else who is interested
    - The more town support the better!
- Plan:
    - Tom - intro
    - Alex - speak to the data we've already collected; survey results
    - Also want to solicit information similar to what we asked in the survey

10. Looking Ahead

- Public Presentation 10/26 6pm (Changed to Room 4)
- Next meeting 11/4 9-10:30am (EOC)

Resources:

Agendas
07-01 Agenda – https://docdro.id/jC29oKc
08-05 Agenda – https://docdro.id/RZTti5q
09-02 Agenda – https://docdro.id/Z1pfsXC
10-07 Agenda – https://docdro.id/I7vUqdI

Minutes
07-01 Minutes – https://docdro.id/tdos9CP
08-05 Minutes – https://docdro.id/bhBJ2E3
09-02 Minutes – https://docdro.id/SdH0sWG

Schedule (updated 10/12/21) – https://docdro.id/rbXupFk
Final Survey PDF – https://docdro.id/lOwDmz0

Maps/Graphs/Images of Hazard Data for HMP (updated 10/15/21) - https://docdro.id/cc8IZ6S

2021 List of Critical Facilities (updated 10/15/21) – https://docdro.id/1y4YmTq
2018 MVP Plan – https://docdro.id/z7WkCuh
2016 Carver Hazard Mitigation Plan – https://docdro.id/1kI2aAi
2017 Carver Master Plan – https://docdro.id/g31VVHE
2010-2015 Carver Open Space and Recreation Plan – https://docdro.id/OI9KNZJ
MA Interactive Property Map – https://www.mass.gov/service-details/massachusetts-interactive-property-map
Municipal Mapper Carver, MA – http://maps.massgis.state.ma.us/map_ol/carver.php
Carver Tax Assessor's maps – https://www.carverma.gov/assessors-maps
MEMA Website – https://www.mass.gov/orgs/massachusetts-emergency-management-agency
FEMA Website – https://www.fema.gov/

Town of Carver
Hazard Mitigation Plan
Working Meeting No. 4

Meeting No. 4
November 4, 2021
9:00 – 10:30 AM
Carver Town Hall – EOC

Invitees:

- Andy Glines, Fuss & O'Neill
- Alex Duryea, Fuss & O'Neill
- Melissa Jaffe, Woods Hole Group
- Tom Walsh, Emergency Management Director
- Sarah Hewins, Vice Chair of Select Board
- ~~Jim Walsh, Planning and Economic Development Director~~
- Craig Weston, Fire Chief
- ~~Brook Monroe, Conservation Agent~~
- John Woods, Deputy Director of Operations & Maintenance
- ~~Bill Napolitano, SRPEDD~~
- Mike Paduch, Assessors Board
- Kevin Tracey, North Carver Water District Water Commissioner

Action Items

- F&O will update and distribute mitigation action prioritization chart & proposed mitigation action chart for committee review
- F&O will search for funding opportunities for actions #7-9
- F&O will ensure to cross-reference Master Plan in Hazard Mitigation Plan in accordance with Mitigation Action #5
- Tom/Sarah to put link to Public Presentation and PDF of slides on town website
- Tom will send language for actions #2 and #3 (Update and Enforce Regulations/ Bylaws/ Codes for Mobile Homes AND Single-Family Homes) to Paul, the Building Commissioner

Agenda Items:

1. **Welcome**

2. **To-do during this meeting:**
   - Review goals (briefly)
   - Review status of actions from 2016 plan (briefly)
   - Review draft actions & details, final review
   - Determine action prioritization
   - Timeline

3. **Final review of goals – same goals from 2016 HMP (p.35)**
   Goals approved, no changes made
   - Reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster.
   - Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from riverine flooding.

- Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from non-flooding hazards such as wildfires, tornadoes, hurricanes, etc.
- Improve pre-disaster planning, communication, and coordination among federal, state, county, community, private, and non-profit entities so that they can plan for and mitigate natural hazards in a clear and comprehensive manner.
- Increase the awareness of the public and communities to the risks presented by the multiple natural hazards that affect the region as well as to the mitigation activities and grant opportunities available to minimize the impacts of these hazards.
- Improve existing policies and programs to reduce further or eliminate the impacts of natural hazards.

4. **Review status of actions from 2016 HMP – see spreadsheet**
   - Add a sentence or two to the report explaining why the Watershed Council was disbanded in 2014
   - Most are ongoing tasks that need to be completed annually

5. **Review draft actions & details, finalize – see spreadsheet**
   - Every goal needs an action and every action needs to be tied to a goal
   - Do not need actions for every hazard
   - Several updates made to draft document (see spreadsheet)
   - Draft actions 10 (road markers for snow removal) & 11 (roof snow removal) were removed
     - Town already addresses marking roads during heavy snowfall & very few roofs are flat and need to be shoveled after heavy snowfall so this is not a necessary action

6. **Determine action prioritization**
   - F&O will send out updated document for committee review, send back to F&O with edits

7. **Timeline review**
   - In a few weeks we will have a draft plan ready for your review, we will be sending this in a word document with track changes on via email, so please send it back in a word document
   - You will have 1-2 weeks to review this and provide feedback/comments (we will provide the date to return it to us by in the initial email)
   - Once we incorporate your comments, we will want to give the public two other opportunities to get involved:
     - Reviewing the draft HMP & attending the second public presentation
     - Because this is our last in-person meeting as a group, we need to come up with a plan to publicize the draft of the HMP – post on town website and similar avenues where the survey was posted
     - We also should plan on how to publicize the next public presentation
       - In person or virtual? Potentially reach more people if virtual? If in-person, we should ensure the room is available and book it in advance
       - F&O will create another flyer for electronic distribution
   - Then we plan on incorporating any suggestions/feedback we get from the public before sending it back to the town to submit to MEMA/FEMA

Resources:

Agendas
07-01 Agenda – https://docdro.id/jC29oKc
08-05 Agenda – https://docdro.id/RZTti5q
09-02 Agenda – https://docdro.id/Z1pfsXC
10-07 Agenda – https://docdro.id/I7vUqdI

Minutes
07-01 Minutes – https://docdro.id/tdos9CP
08-05 Minutes – https://docdro.id/bhBJ2E3
09-02 Minutes – https://docdro.id/SdH0sWG
10-07 Minutes – https://docdro.id/8NsVBNQ

Schedule (updated 10/12/21) – https://docdro.id/rbXupFk
Final Survey PDF – https://docdro.id/lOwDmz0
Maps/Graphs/Images of Hazard Data for HMP (updated 10/15/21) - https://docdro.id/cc8IZ6S

2021 List of Critical Facilities (updated 10/15/21) – https://docdro.id/1y4YmTq
2018 MVP Plan – https://docdro.id/z7WkCuh
2016 Carver Hazard Mitigation Plan – https://docdro.id/1kI2aAi
2017 Carver Master Plan – https://docdro.id/g31VVHE
2010-2015 Carver Open Space and Recreation Plan – https://docdro.id/OI9KNZJ
Municipal Mapper Carver, MA – http://maps.massgis.state.ma.us/map_ol/carver.php
Carver Tax Assessor's maps – https://www.carverma.gov/assessors-maps
MEMA Website – https://www.mass.gov/orgs/massachusetts-emergency-management-agency
FEMA Website – https://www.fema.gov/

Town of Carver
Public Presentation Agenda
Hazard Mitigation Plan Update

October 26, 2021
6pm
Carver Town Hall, Room 4

Agenda

1. Introductions
2. What is a hazard mitigation plan?
3. Why does Carver need an update?
4. Natural hazards in Carver
5. Survey results
6. Questions for the public in attendance
    a. What natural hazards have you experienced while in Carver?
    b. What natural hazard are you most concerned about causing damage or disrupting daily life in Carver?
    c. What are your biggest concerns related to natural hazards impacting Carver?
    d. What specific community assets are most important to you?
    e. What actions have you taken to make you or your property more hazard resistant?
7. What is the most effective way to engage you in hazard planning and emergency preparedness activities?
8. What steps can your local government take to reduce its risk from natural hazards and protect the buildings and people of Carver?
9. Critical facilities
10. Vulnerability assessment results
11. Overview of the status of the update at this point
12. Questions/comments?

Carver Hazard Mitigation Public Opinion Survey

This survey aims to gauge public perceptions and opinions regarding natural hazards in the Town of Carver. In addition, we would like to gather your feedback regarding the methods and techniques you prefer for reducing the risks and losses associated with these hazards. The information you provide will be used to help improve how the town of Carver deals with and responds to natural hazards. The survey should take less than 10 minutes to complete. Please complete this survey by **August 23rd, 2021**.

Please return this survey to drop box provided, deliver to Town Clerk's Office at Town Hall (108 Main Street), or mail to P.O. Box 580, Carver, MA, 02330.

If you have any questions regarding this survey or would like to learn more ways you can participate in the development of the Carver Hazard Mitigation Plan, please contact the town Emergency Management Director, Tom Walsh at 508-866-5219 or at thomas.walsh@carverma.gov.

1. Which of the following natural hazards have you experienced while in Carver?
(You can select more than 1 answer)

a. Flooding (Coastal or Inland)
b. Coastal Erosion
c. Hurricane/Tropical Storms
d. Severe Winter Storm (e.g., Nor'easter, Snow, Blizzard, Ice Storm)
e. Wildfire
f. Tornado
g. Drought
h. Extreme Temperature
i. Earthquake
j. Invasive Species
k. Other Severe Weather (Heavy Precipitation, High Wind, Thunder/Lightning)
l. Landslide
m. Tsunami
n. Dam/Culvert Failure
o. None of the above

2. Which of the following natural hazards are you most concerned about causing damage or disrupting daily life in Carver?
(Select 1 answer)

a. Flooding (Coastal or Inland)
b. Coastal Erosion
c. Hurricane/Tropical Storms
d. Severe Winter Storm (e.g., Nor'easter, Snow, Blizzard, Ice Storm)
e. Wildfire
f. Tornado
g. Drought
h. Extreme Temperature
i. Earthquake
j. Invasive Species
k. Other Severe Weather (Heavy Precipitation, High Wind, Thunder/Lightning)
l. Landslide
m. Tsunami
n. Dam/Culvert failure
o. None of the above

3. What are your biggest concerns related to natural hazards impacting Carver?
(You can select more than 1 answer)

a. Damage to your home or property from flooding
b. Damage to your home or property from wind/storm damage
c. Damage to your home or property from wildfire(s)
d. Disruption of water service
e. Disrupted transportation (e.g., flooded roads, trees down, heavy snow, etc.)
f. Disrupted agricultural work (e.g., problems with flumes/water control structures, drought)
g. Power outages due to storms
h. Damage to natural habitats and ecosystems
i. Other (please specify): _____

4. What specific community assets are most important to you?
(You can select more than 1 answer)

a. Schools
b. Police, EMS, & Fire stations
c. Bridges (please specify bridge(s) of importance):_____
d. Historic buildings or sites (please specify site(s) of importance):_____
e. Recreational facilities (please specify site(s) of importance):_____
f. Myles Standish State Forest
g. Cranberry bogs/farms
h. Town Hall
i. Libraries
j. Healthcare facilities
k. Public water distribution infrastructure
l. Other (please specify): _____

5. Which of the following actions have you taken to make you or your property more hazard resistant?
(You can select more than 1 answer)

a. Purchased flood insurance
b. Participated in educational activities and trainings about hazard and emergency preparedness
c. Removed debris and hazardous materials from my property
d. Pruned trees on or near my property
e. Obtained an emergency response kit
f. Acquired a generator
g. None of the above
h. 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)

a. Local newspaper
b. Cable/public television
c. Radio advertising
d. Phone
e. Town website
f. Social media (e.g., Facebook)
g. Email alerts
h. Mail
i. Public workshops and/or meetings
j. School meetings
k. Other (please specify): _____

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

(You can select more than 1 answer)

a. Improve flood resiliency and flood proofing of critical water infrastructure
b. Improve the alert/warning/notification system
c. Develop and implement climate change adaptation plans
d. Continue to improve the emergency shelter(s)
e. Remove debris and hazardous materials, as well as prune trees on town property
f. Improve drainage on area roads
g. Educate the public on evacuation methods
h. Apply for grant funding to reduce Carver's risk to natural hazards
i. Educate the public on the science of natural hazards and emergency preparedness
j. Continue to work with regional partners to prepare for and recover from natural hazards
k. Other (please specify): _____

8. Please tell us about yourself.

(Select all that apply to you)

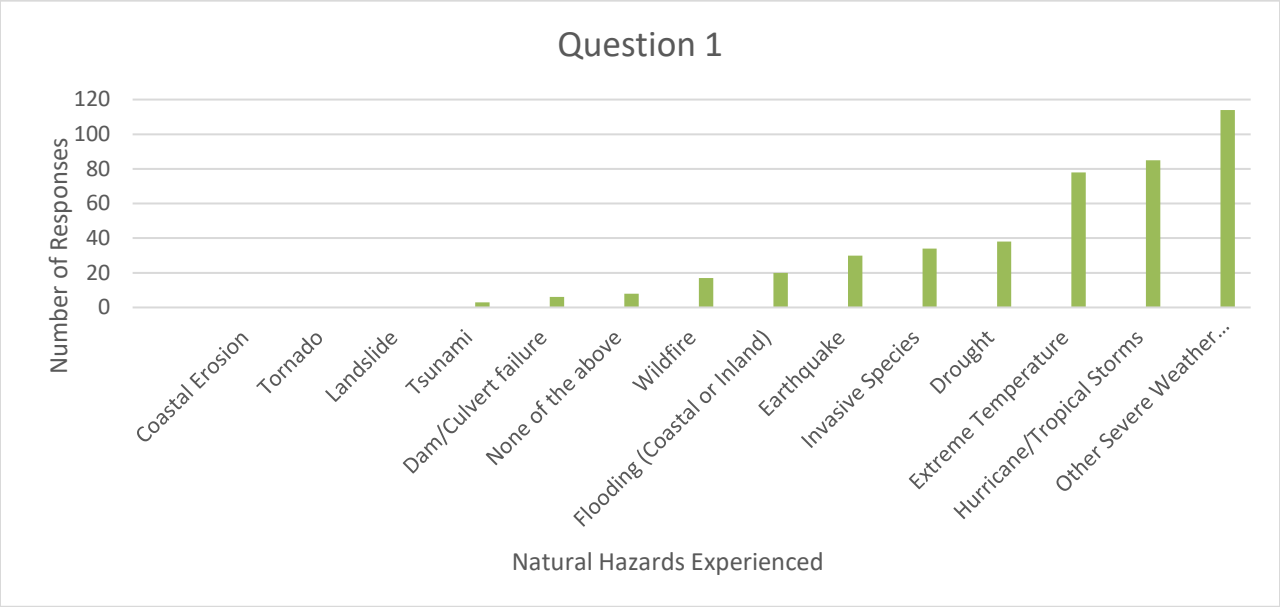
a. Year-round resident
b. Part-time resident
c. I own a home in Carver
d. I rent a home in Carver
e. I work in Carver
f. I am a business owner in Carver
g. I am a frequent visitor to Carver
h. I have access/functional needs
i. Other (please specify): _____

9. If you would like to be more involved in the hazard mitigation planning process, please provide your name, email, and/or alternate contact information.

Carver Hazard Mitigation Public Opinion Survey
Summarized Responses

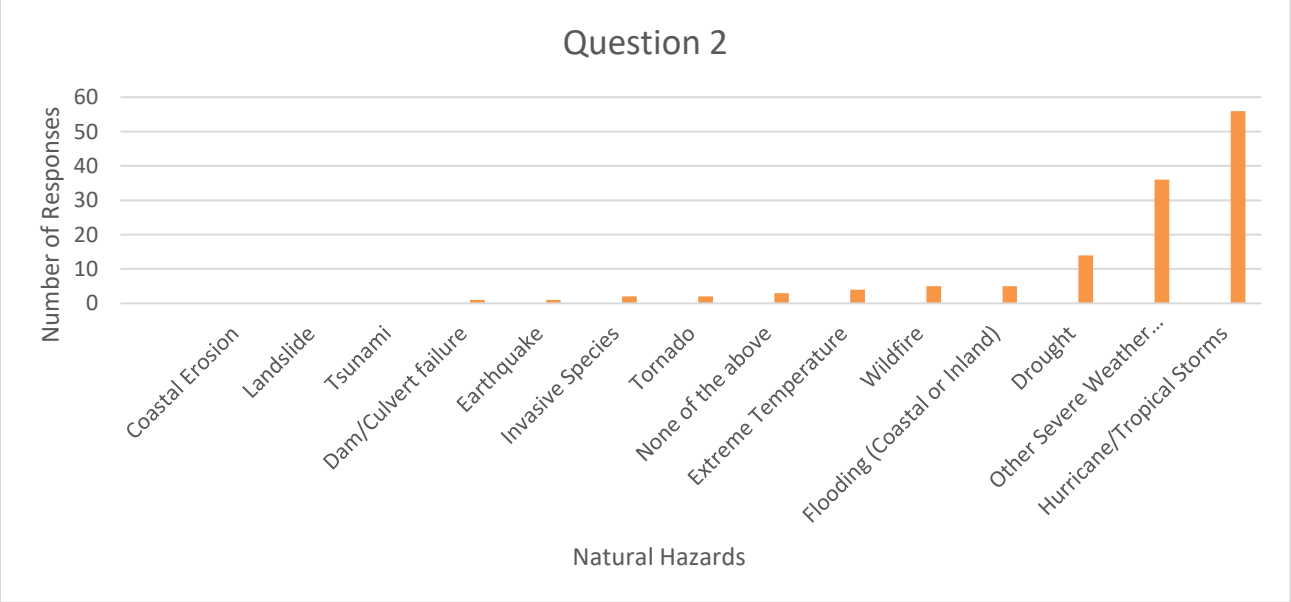
1. Which of the following natural hazards have you experienced while in Carver?
(You can select more than 1 answer)

0	Coastal Erosion
0	Tornado
0	Landslide
0	Tsunami
3	Dam/Culvert failure
6	None of the above
8	Wildfire
17	Flooding (Coastal or Inland)
20	Earthquake
30	Invasive Species
34	Drought
38	Extreme Temperature
78	Hurricane/Tropical Storms
85	Other Severe Weather (Heavy Precipitation, High Wind, Thunder/Lightning)
114	Severe Winter Storm (e.g., Nor'easter, Snow, Blizzard, Ice Storm)



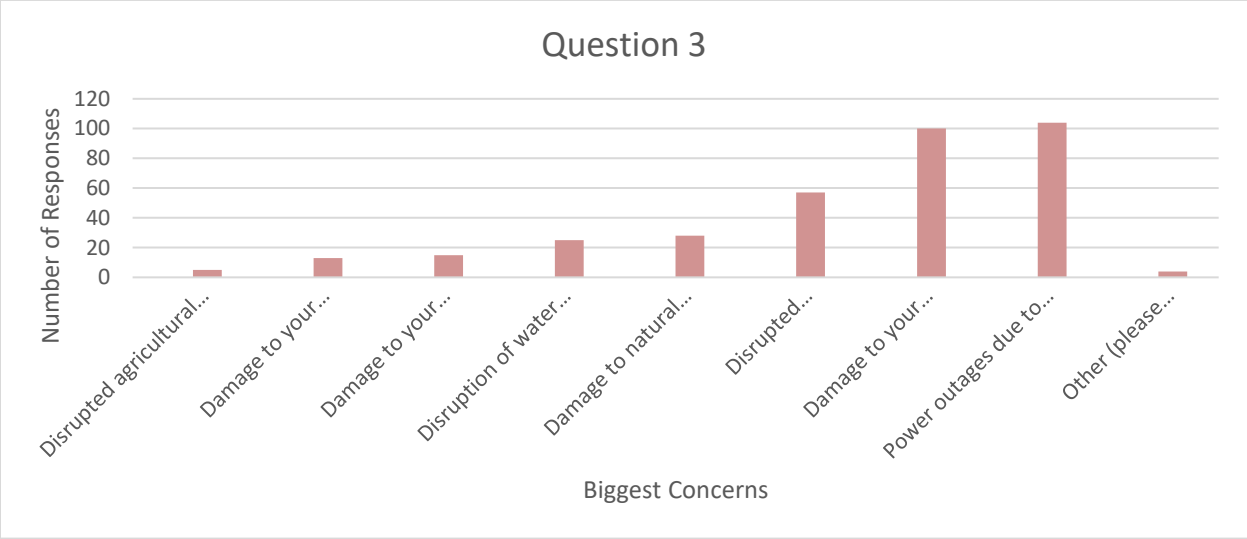
2. Which of the following natural hazards are you most concerned about causing damage or disrupting daily life in Carver?
(Select 1 answer)

0	Coastal Erosion
0	Landslide
0	Tsunami
0	Dam/Culvert failure
1	Earthquake
1	Invasive Species
2	Tornado
2	None of the above
3	Extreme Temperature
4	Wildfire
5	Flooding (Coastal or Inland)
5	Drought
14	Other Severe Weather (Heavy Precipitation, High Wind, Thunder/Lightning)
36	Hurricane/Tropical Storms
56	Severe Winter Storm (e.g., Nor'easter, Snow, Blizzard, Ice Storm)



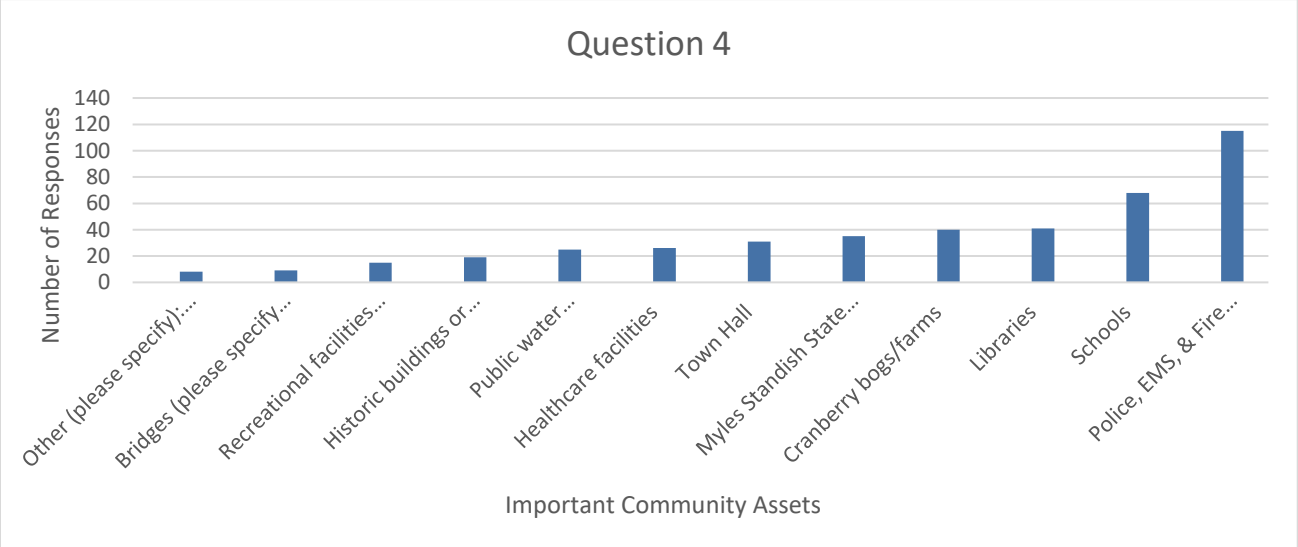
3. What are your biggest concerns related to natural hazards impacting Carver?
(You can select more than 1 answer)

5	Disrupted agricultural work (e.g., problems with flumes/water control structures, drought)
13	Damage to your home or property from wildfire(s)
15	Damage to your home or property from flooding
25	Disruption of water service
28	Damage to natural habitats and ecosystems
57	Disrupted transportation (e.g., flooded roads, trees down, heavy snow, etc.)
100	Damage to your home or property from wind/storm damage
104	Power outages due to storms
4	Other (please specify): _____



4. What specific community assets are most important to you?
(You can select more than 1 answer)

9	Bridges (please specify bridge(s) of importance):_____
15	Recreational facilities (please specify site(s) of importance):_____
19	Historic buildings or sites (please specify site(s) of importance):_____
25	Public water distribution infrastructure
26	Healthcare facilities
31	Town Hall
35	Myles Standish State Forest
40	Cranberry bogs/farms
41	Libraries
68	Schools
115	Police, EMS, & Fire stations
8	Other (please specify): _____

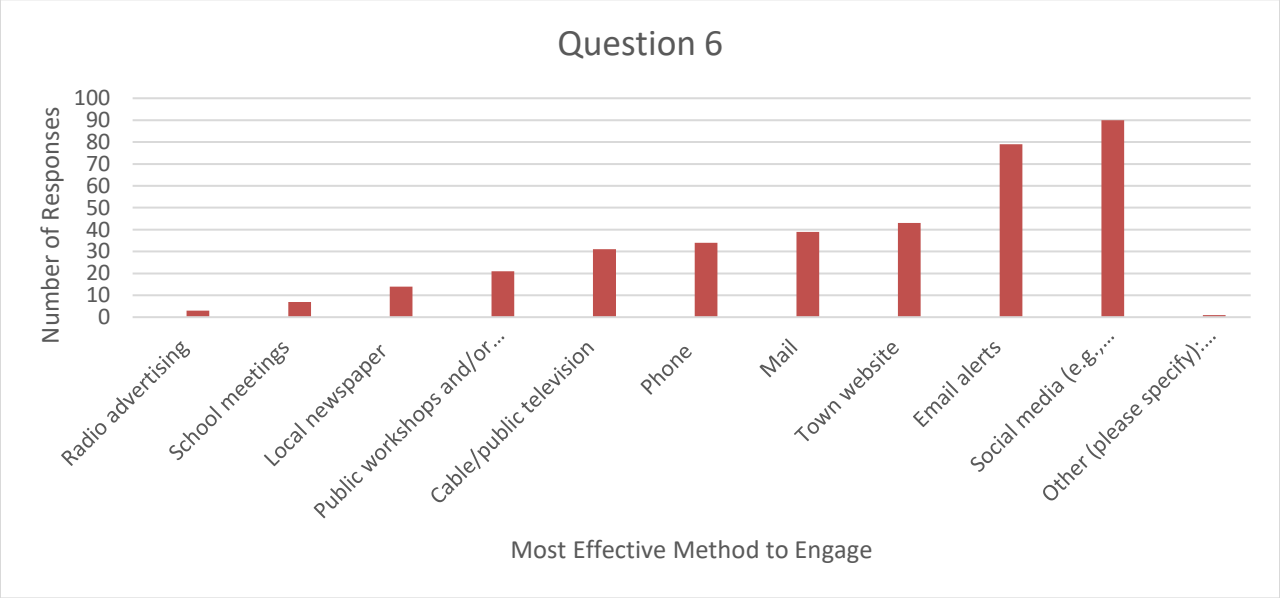


5. Which of the following actions have you taken to make you or your property more hazard resistant?
(You can select more than 1 answer)

5	Purchased flood insurance
9	None of the above
17	Participated in educational activities and trainings about hazard and emergency preparedness
17	Obtained an emergency response kit
75	Removed debris and hazardous materials from my property
79	Acquired a generator
84	Pruned trees on or near my property
6	Other (please specify): _____

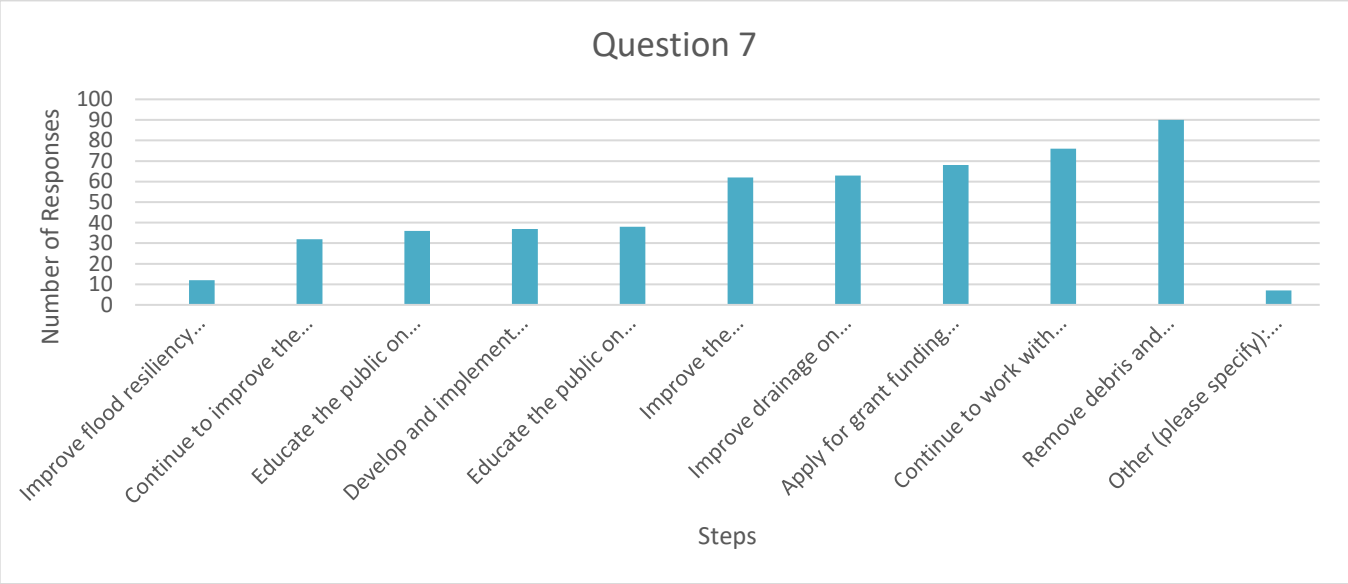
6. What is the most effective way to engage you in hazard planning and emergency preparedness activities? ***(You can select more than 1 answer)***

3	Radio advertising
7	School meetings
14	Local newspaper
21	Public workshops and/or meetings
31	Cable/public television
34	Phone
39	Mail
43	Town website
79	Email alerts
90	Social media (e.g., Facebook)
1	Other (please specify): _____



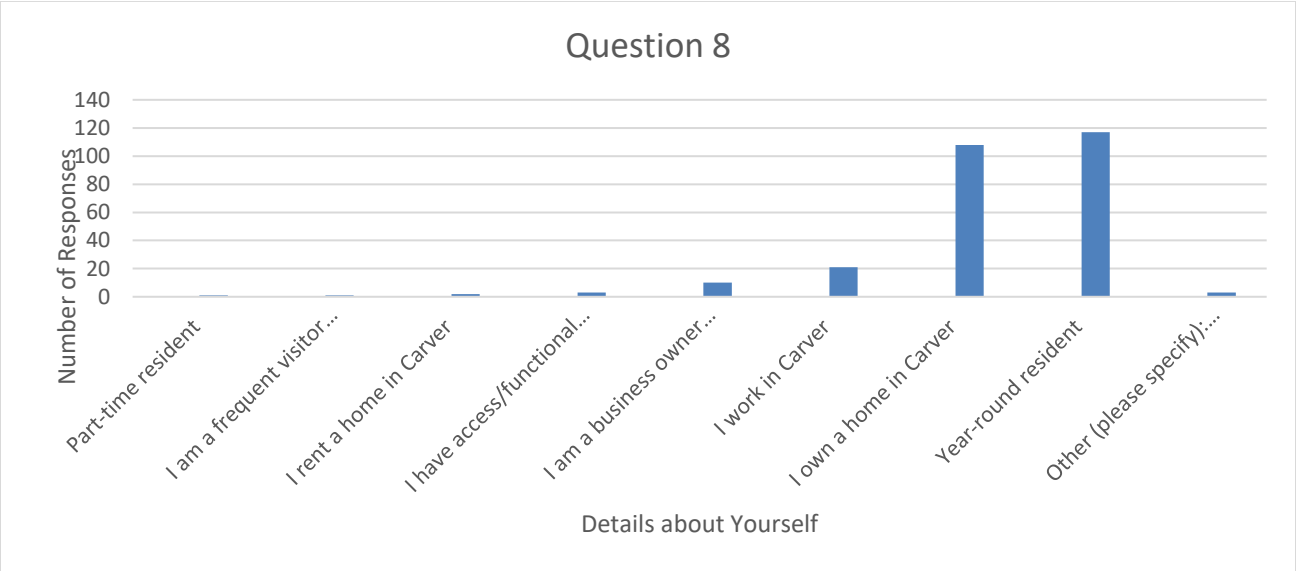
7. What steps can your local government take to reduce its risk from natural hazards and protect the buildings and people of Carver? ***(You can select more than 1 answer)***

12	Improve flood resiliency and flood proofing of critical water infrastructure
32	Continue to improve the emergency shelter(s)
36	Educate the public on evacuation methods
37	Develop and implement climate change adaptation plans
38	Educate the public on the science of natural hazards and emergency preparedness
62	Improve the alert/warning/notification system
63	Improve drainage on area roads
68	Apply for grant funding to reduce Carver's risk to natural hazards
76	Continue to work with regional partners to prepare for and recover from natural hazards
90	Remove debris and hazardous materials, as well as prune trees on town property
7	Other (please specify): _____



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

1	Part-time resident
1	I am a frequent visitor to Carver
2	I rent a home in Carver
3	I have access/functional needs
10	I am a business owner in Carver
21	I work in Carver
108	I own a home in Carver
117	Year-round resident
3	Other (please specify): _____



Sarah Hewins
July 2 ·

Many thanks to Tom Walsh, Carver's Emergency Management Chief, for getting our Hazard Mitigation Core Team Kick-off meeting organized yesterday.
Every 5 years, the Town has to update its Hazard Mitigation Plan to be eligible for state grant funding, and I've had the honor over the past 10 years to work with Tom and our Hazard Mitigation teams to research, write, and update our plan.
Our goal is to make any natural hazards that may come our way—inland flooding, drought, wildfires, invasive species, etc.—less severe than they might otherwise be and lessen their impacts on the town's residents.
The meetings are public and posted on the town's website at carverma.gov. We'll continue our public outreach, so stay tuned!

SARAHHEWINS.COM
Sarah Hewins
Sarah Hewins, Town of Carver Select Board Chair
Learn More

8

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Write a comment...

Carver Fire Department
August 10 ·

The Town of Carver is currently working on updating its Hazard Mitigation Plan. Residents of Carver are encouraged to take this short survey to help the town respond to natural hazards. Please complete this survey by August 23rd.

https://www.surveymonkey.com/r/CarverHMP

SURVEYMONKEY.COM

Carver Hazard Mitigation Public Opinion Survey

Take this survey powered by surveymonkey.com. Create your own surveys for free.

3

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EVERYTHING CARVER

Private group · 5.0K members

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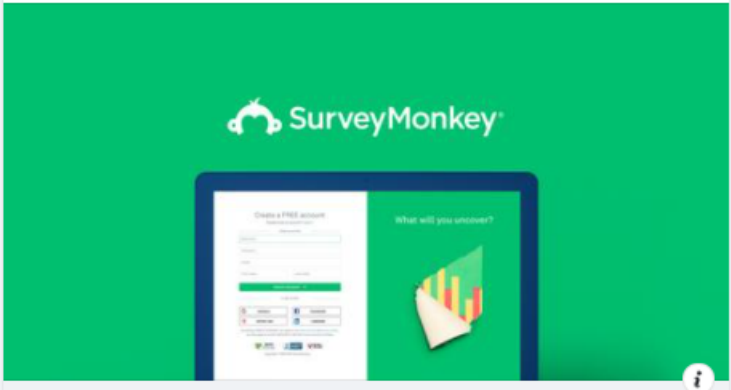
Sarah Hewins shared a link.
August 9 ·

The Town of Carver is currently working on updating its Hazard Mitigation Plan. The Hazard Mitigation Core Team met again last Thursday to, among other things, refine a survey to be sent out to Carver's residents. Residents of Carver are encouraged to take this short survey to help the town respond to natural hazards. Here is the link to the online survey: https://www.surveymonkey.com/r/CarverHMP Please complete this survey by August 23rd. Please also tell your friends and neighbors--especially if they don't have access to a computer--that copies of the survey are also available in paper format at the Town Hall, the Central Fire Station Dispatch, and at the clubhouses at both South Meadow Village and Cranberry Village. Paper copies of these surveys may be returned to the drop box at any of the four locations above or mailed to Tom Walsh, Emergency Management Chief, P. O. Box 580, Carver, MA 02330.



SURVEYMONKEY.COM
Carver Hazard Mitigation Public Opinion Survey
Take this survey powered by surveymonkey.com. Create your own surveys for free.

1 Comment

Like | Comment

Most Recent

Write a comment...

Sarah Hewins
A survey might sound boring, but we could really use your input. The survey is anonymous, too, unless you choose to provide your contact information.

Like · Reply · 10w

Sarah Hewins
August 9 ·

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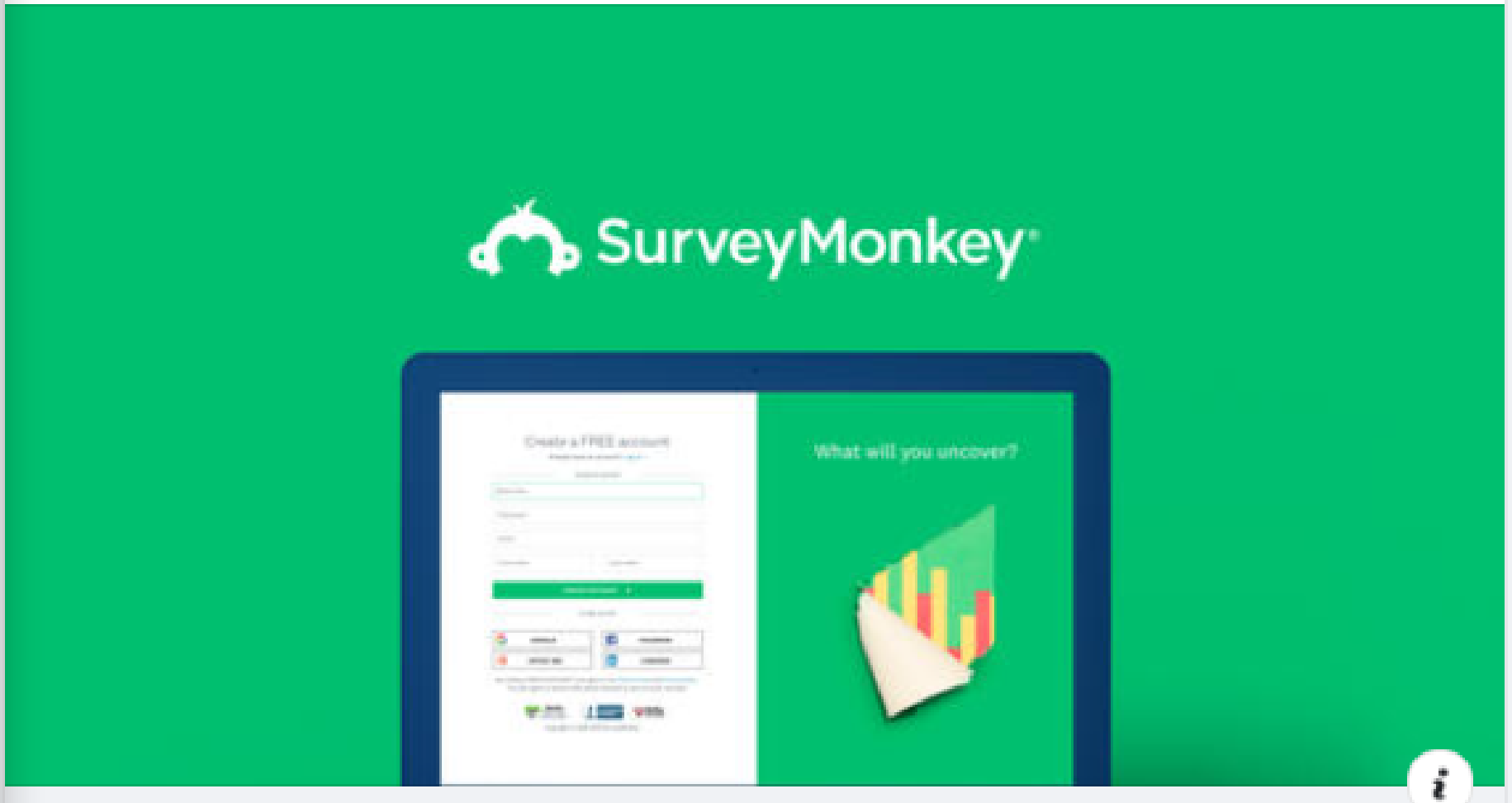

Carver Hazard Mitigation Public Opinion Survey
Take this survey powered by surveymonkey.com. Create your own s...

Send Message

2

Like Comment Share

Write a comment...

Sarah Hewins
August 9 ·

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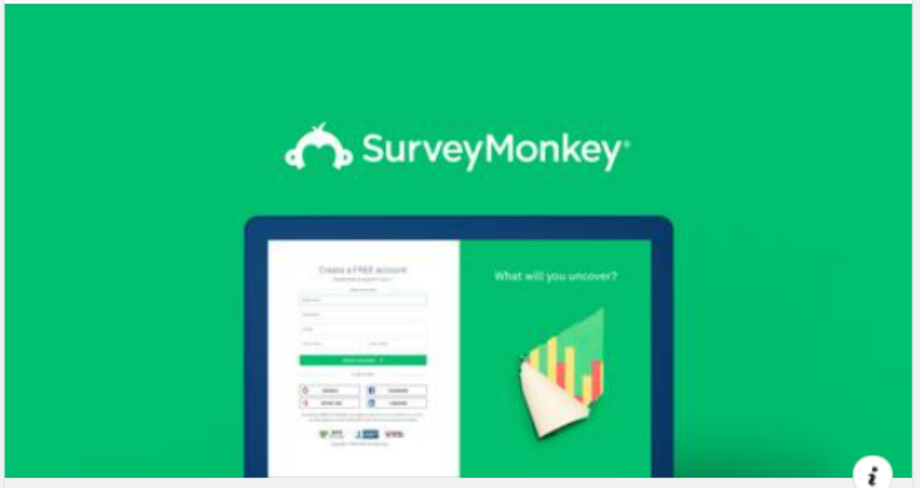

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Carver Hazard Mitigation Public Opinion Survey

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1

Like Comment Share

Write a comment...

Sarah Hewins
August 13 ·

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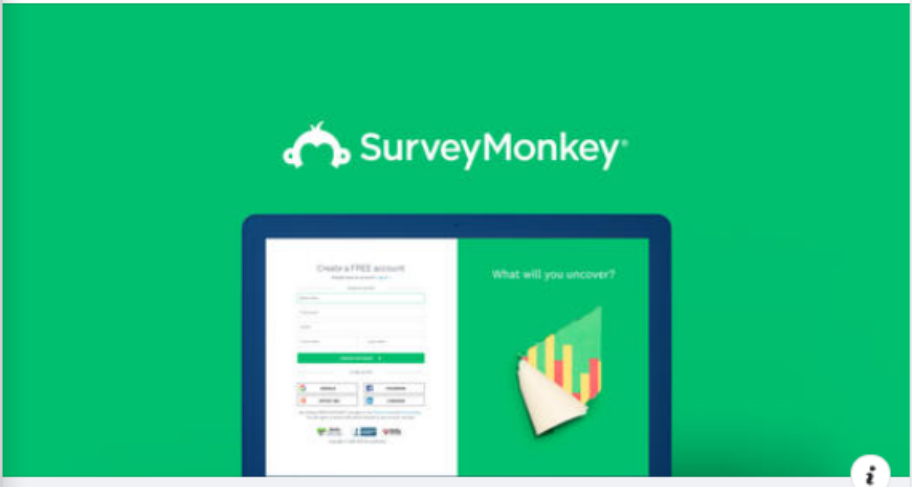

SURVEYMONKEY.COM

Carver Hazard Mitigation Public Opinion Survey

Take this survey powered by surveymonkey.com. Create your own surveys for free.

1 Comment

Like Comment Share

Most Relevant

Write a comment...

Author
Sarah Hewins
A survey may seem boring, but we could really use your input. The survey is anonymous, too, unless you choose to give your contact information.

Like · **Reply** · 10w

Sarah Hewins
August 13 ·

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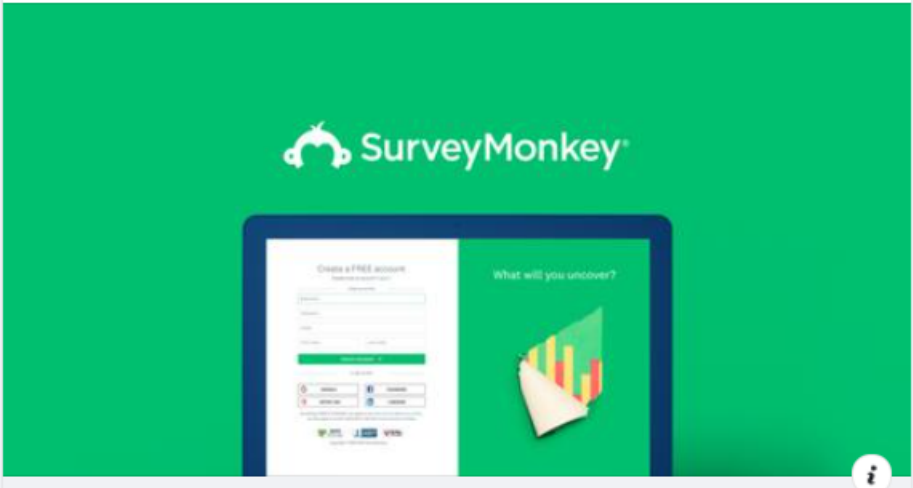

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Carver Hazard Mitigation Public Opinion Survey
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1 Comment

Like Comment Share

Sarah Hewins
A survey may sound boring, but we could really use your input. The survey is anonymous, too, unless you choose to give your contact information!

Like · **Reply** · 10w

Write a comment...

Town of Carver

August 9 ·

Please see the Town's Hazard Mitigation Plan Update survey at the following link:
https://www.carverma.gov/.../hazard-mitigation-plan-update

2 Shares

Like Comment Share

Write a comment...

EVERYTHING CARVER

Sarah Hewins
October 21 at 5:42 PM ·

CARVER HAZARD MITIGATION PLAN

Public Presentation

Tuesday
October 26, 2021
6 PM
Carver Town Hall, Room 4

Open to anyone who lives or works in Carver that is interested in Carver's Hazard Mitigation Plan update

Learn about what a hazard mitigation plan is, why Carver's plan needs an update, natural hazards in Carver, and the status of the update.

This is your opportunity to ask questions and voice your opinions about natural hazards in Carver. Come contribute to Carver's Hazard Mitigation Plan!

4 4 Comments

Like Comment

Most Recent

Write a comment...

Donna F Sisu
Who is running this program?

Like · Reply · 4d

Laura Edelstein-Pettine
Donna F Sisu believe it is Tom Walsh, our EMA manager.

Like · Reply · 4d · Edited 1

Sarah Hewins
October 21 at 5:43 PM ·

CARVER HAZARD MITIGATION PLAN

Public Presentation

Tuesday
October 26. 2021
6 PM
Carver Town Hall, Room 4

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Sarah Hewins
October 22 at 10:27 AM ·

CARVER HAZARD MITIGATION PLAN

Public Presentation

Tuesday
October 26. 2021
6 PM
Carver Town Hall, Room 4

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Learn about what a hazard mitigation plan is, why Carver's plan needs an update, natural hazards in Carver, and the status of the update.

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SARAHHEWINS.COM
Sarah Hewins
Sarah Hewins, Town of Carver Select Board Member

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Like Comment Share

Write a comment...

Sarah Hewins
October 21 at 5:42 PM ·

CARVER HAZARD MITIGATION PLAN

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Tuesday
October 26. 2021
6 PM
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- Atlantic Hurricane Season
- Carver Emergency Management Facebook Page
- Eversource (Report an Outage)
- FEMA
- FEMA Disaster Assistance
- Hazard Mitigation Plan
- MEMA
- Pilgrim Nuclear Power Station Emergency Information

Contact Info

Phone:
(508) 866-5219

Hazard Mitigation Plan Core Team Meeting

Event Date: Thursday, July 1, 2021 - 9:00am

Town Hall, basement - room #4

- Atlantic Hurricane Season
- Carver Emergency Management Facebook Page
- Eversource (Report an Outage)
- FEMA
- FEMA Disaster Assistance
- Hazard Mitigation Plan
- MEMA
- Pilgrim Nuclear Power Station Emergency Information

Contact Info

Phone:
(508) 866-5219

Hazard Mitigation Plan Working Group Meeting

Event Date: Thursday, September 2, 2021 - 9:00am

Town Hall, basement, room #4

Hazard Mitigation Plan Update

POSTED ON: AUGUST 9, 2021 - 2:11PM

The Town of Carver is currently working on updating its Hazard Mitigation Plan. The Hazard Mitigation Core Team met again last Thursday to, among other things, refine a survey to be made available to Carver's residents. Residents of Carver are encouraged to take this short survey to help the town respond to natural hazards. Here is the link to the online survey: https://www.surveymonkey.com/r/CarverHMP Please complete this survey by August 23rd. Please also tell your friends and neighbors--especially if they don't have access to a computer--that copies of the survey are also will be available in paper format at the Town Hall, the Central Fire Station Dispatch, and at the clubhouses at both South Meadow Village and Cranberry Village starting Wednesday August 11, 2021. Paper copies of these surveys may be returned to the drop box at any of the four locations above, mailed to Tom Walsh, Emergency Management Director, P. O. Box 580, Carver, MA 02330, or via e-mail at Thomas.Walsh@carverma.gov

Hazard Mitigation Plan Update 10-26-2021

POSTED ON: NOVEMBER 4, 2021 - 1:30PM

Attachment	Size
public_presentation_1.pdf	3.23 MB

Carver Mitigation Plan - Public Presentation

POSTED ON: OCTOBER 19, 2021 - 12:23PM

Attachment	Size
carver_public_presentation_flyer_10.26.pdf	114.07 KB
publicpresentationagenda.pdf	53.26 KB

Appendix C

CARVER CRITICAL FACILITIES

NAME	ADDRESS
Tier 1	
Emergency Response	
Carver Police Department	3 Center Street
Carver Fire Department Co. 1/Municipal Comm. Tower	99 Main Street
Carver Fire Station Co. 2	1 Green St.
Carver Fire Station Co. 3	120 So. Main Street
Carver EMS Station	110A Main street
Old Fire/Police Station	112 A&B Main Street
Carver EOC/Town Hall	108 Main street
Carver DPW Facility	51R Pond Street
Schools/Shelters	
Carver Elementary School	85 Main St.
Carver Middle High School/Public Shelter	60 So. Meadow Rd.
Council on Aging (Shelter)	48 Lakeview St.
Densely Populated Residential Areas & Water Resources	
Meadowbrook Apartments/Elderly Housing	10 MeadowBrook Way
So. Meadow Village & Well Site	36-10 Village Way
Cranberry Village & Well Site	86 Cranberry Road
Water View Village & Well Site	Silva St. & Jill Marie Dr.
Meadow Woods & Well Site	Melanie Lane (off Meadow St.)
Pine Tree Village & Well Site	west of 5 Carol St.
No. Carver Water District Pumps	off Pleasant St.
Carver Municipal Well	off Pleasant St.
Communications	
Carver Emergency Radio Tower	31 Main street (Rear)
Communication Tower (American Towers LLC)	off Montello St., end of Park Ave.
Communication Tower (Cingular Wireless)	32 Shoestring Rd.
Communication Tower	off Wenham Rd.
Communication Tower	8 Rochester Rd.
Tier 2	
Large Day Cares	
Capt Pal Pre School	115 Main St
Cranberry Crossing Day Care	42 N Main St
Kidstop Early Childhood Center	185 Plymouth St
Little Crusaders	145 S Main St
Animals	
Curry's Grooming Shop	145 S Main St #11
The Country Groomer & Kennels	38 N Main St #1
Hazardous Materials	
Agway	96 Forest Street
Cape Cod Ready Mix (Lakeville Redi-Mix Inc.)	334 Tremont Street
Communication Tower (Cingular Wireless)	32 Shoestring Rd.
Decas Cranberry Co.	4 Old Forge Parkway
Eversource	200 Main Street
Ocean Spray	60 Federal Road
Verizon Wireless	122 Main Street
Wrightingtons Gas	312 Tremont St.

VULNERABILITY ASSESSMENT

Critical Facility	Located in FEMA Flood Zone?	If so, which designation?
Tier 1		
Emergency Response		
Carver Police Department	No	
Carver Fire Department Co. 1/Municipal Comm. Tower	No	
Carver Fire Station Co. 2	No	
Carver Fire Station Co. 3	No	
Carver EMS Station	No	
Old Fire/Police Station	No	
Carver EOC/Town Hall	No	
Carver DPW Facility	No	
Schools/Shelters		
Carver Elementary School	No	
Carver Middle High School/Public Shelter	No	
Council on Aging (Shelter)	No	
Densely Populated Residential Areas & Water Resources		
Meadowbrook Apartments/Elderly Housing	**Yes**	AE: 1% annual chance of flooding, with BFE
So. Meadow Village & Well Site	**Yes**	A: 1% annual chance of flooding, no BFE
Cranberry Village & Well Site	**Yes**	AE: 1% annual chance of flooding, with BFE
Water View Village & Well Site	No	
Meadow Woods & Well Site	**Yes**	AE: 1% annual chance of flooding, with BFE; Regulatory floodway
Pine Tree Village & Well Site	No	
No. Carver Water District Pumps	**Yes**	A: 1% annual chance of flooding, no BFE
Carver Municipal Well	**Yes**	A: 1% annual chance of flooding, no BFE
Communications		
Carver Emergency Radio Tower	No	
Communication Tower (American Towers LLC)	No	
Communication Tower (Cingular Wireless)	No	
Communication Tower	No	
Communication Tower	No	
Tier 2		
Large Day Cares		
Capt Pal Pre School	No	
Cranberry Crossing Day Care	No	
Kidstop Early Childhood Center	No	
Little Crusaders	No	
Animals		
Curry's Grooming Shop	No	
The Country Groomer & Kennels	No	
Hazardous Materials		
Agway	No	
Cape Cod Ready Mix (Lakeville Redi-Mix Inc.)	No	
Communication Tower (Cingular Wireless)	No	
Decas Cranberry Co.	No	
Eversource	No	
Ocean Spray	No	
Verizon Wireless	No	
Wrightingtons Gas	No	

STATUS OF PROPOSED MITIGATION ACTIONS
FROM CARVER'S 2016 HAZARD MITIGATION PLAN (p. 35-37)

Category of Protection Measure	Objectives	Action	Responsible Parties	Time frame	Funding/ Resources Needed	2016 Status	2021 Status			Notes
							Complete	In-Progress	Removed	When completed?/ Why not completed?
Capital Improvement Planning/ Structural Improvements	To reduce wildfire in a rural community without a town-wide water supply and with high wildfire risk.	1. Develop wildfire prevention education in Elementary School 2. Public awareness at town-wide events	Fire Dept. and State	2016-2021	Fire Dept. personnel and some state personnel; part of responsibility and salary	Wildfire prevention education is conducted in the schools on an annual basis.	2016			Ongoing annually
Regulations/ Bylaws/ Codes	Ensure all new mobile homes constructed with tie-downs to prevent structural hurricane damage soil conditions examined to meet code to prevent frost heave under slabs; and c) meet wind load and other requirements	Update local process based on new state building codes and incorporate into local codes	Building Commissioner	2016-2021	Town funding through Building Commissioner's salary	State building code changes yearly. Local process accomplished as applications arrive.	2016			Incorporated into Building Code
	All new construction, remodeling, additions on existing residential homes meets hazard mitigation code	Update all new homes plans to guarantee hazard mitigation features of code are being met	Building Commissioner	2016-2021	Town funding through Building Commissioner's salary	To be done as all new applications arrive in Inspections office.	2016			Incorporated into Building Code
Operations, Administration, and Enforcement										
Planning	Ensure Master Plan is consistent with Hazard Mitigation Plan (HMP) and cross-references HMP.	Comprehensive Master Plan—No mention of disaster mitigation. At next re-write add cross-references to this plan.	Planning Board	2015-2020	Town funding through Town Planner's salary	Committee is in the process of updating the Master Plan		X		Will be in next years update
Emergency Management	Ensure that Mitigation Plan is up-dated regularly and coordinated with other Town Plans.	Update Mitigation Plan on 5-year cycle – coordinate with Carver's Emergency Management Plan (CEM), Open Space & Recreation Plan, and Master Plan updates; develop coordination process	Emergency Mgmt. Director	2016-2018	Town funding through Emergency Mgmt. Director's salary and, if needed, FEMA HMA program funds.	Emerg. Mgmt. Dept. will set up coordina-tions with-in next 12 months		X		Ongoing
	Increase public awareness of hurricane hazards, particularly in mobile home communities	Update CEM's Hurricane Disaster Information Package and deliver informational talks at mobile home parks annually.	Emergency Management Director	12/2015-12/2016	Town funding through Emergency Management Director's salary	This is the standard education process that occurs every year.	2016			Ongoing annually
Conservation	Ensure Open Space and Recreation Plan consistent c/ HMP and cross-references HMP.	Open Space Plan—at next re-revision, add cross-references to this plan.	Conservation Agent / Commission / OS&RP Committee	2016-2019	Town funding through Conservation Agent's salary	Revised / Updated Goals & Objectives are due 2017 for 2015-2019 OS&RP		X		Update in process.
	Re-establish a regional watershed council to help bring together resources for comprehensive analysis, planning, decision-making, and cooperation to study and advice on water issues, including flooding and groundwater pollution.	Formalize and appoint members to a regional aquifer advisory committee from the seven towns in the Plymouth / Carver Sole Source Aquifer region.	Boards of Selectmen in Towns of Bourne, Carver, Kingston, Middle-borough, Plymouth, Plympton, Wareham appointed 7 voting dele-gates (one/town) and 7 non-voting alternates	2017-2019	Town funding through Conservation Agent's salary	Re-estab-lished in 2006 and was on-going. Usually met once a month. Has not met since 2013. Town to review staffing resources.			X	Committee discontinued in 2014

MITIGATION ACTIONS

Mitigation Action No.	Mitigation Action Name	Hazard(s) Addressed	Goal(s) Addressed	Objectives	Proposed Action	Responsible Parties	Time frame	Funding / Resources Needed
1	Wildfire Prevention Awareness	Wildfire	1, 4, 5	To reduce wildfire in a rural community without a town-wide water supply and with high wildfire risk.	1. Annual wildfire prevention education in Elementary School 2. Public awareness at town-wide events annually	Fire Dept. and State	2021-2026	Fire Dept. personnel and some state personnel; part of responsibility and operating budget; Safe Grant from the Department of Fire Services
2	Update and Enforce Regulations/ Bylaws/ Codes for Mobile Homes	Hurricane/Tropical Storm, Wind, Tornado	1, 3, 6	Ensure all new mobile homes constructed with tie-downs to prevent structural hurricane damage soil conditions examined to meet code to prevent frost heave under slabs; and meet wind load and other requirements	Update local process based on new state building codes and incorporate into local codes. The local process is accomplished as applications arrive. State building codes change annually.	Building Commissioner	2021-2026	Town funding through Building Commissioner's operating budget
3	Update and Enforce Regulations/ Bylaws/ Codes for Single-Family Homes	Hurricane/Tropical Storm, Wind, Tornado	1, 3, 6	All new construction, remodeling, additions on existing residential homes meets hazard mitigation code.	Update all new homes plans to guarantee hazard mitigation features of code are being met as all new inspections arrive in Inspections Office	Building Commissioner	2021-2026	Town funding through Building Commissioner's operating budget
4	Hurricane Hazard Awareness	Hurricane/Tropical Storm, Wind, Tornado	1, 4, 5	Increase public awareness of hurricane hazards, particularly in mobile home communities	Update CEM's Hurricane Disaster Information Package and deliver informational talks at mobile home parks annually. This is the standard education process that occurs every year.	Emergency Management Director	2021-2026	Town funding through Emergency Management Director operating budget
5	Update / Incorporate Comprehensive Master Plan Goals and Objectives	All hazards	4, 5, 6	Ensure Master Plan is consistent with Hazard Mitigation Plan (HMP) and cross-references HMP.	1. Update Master Plan and ensure that updates moving forward utilize and cross-reference Hazard Mitigation Plan 2. Ensure Hazard Mitigation Plan updates continue to utilize and cross-reference Master Plan	Planning Board / Appointed Master Plan Committee	2022	Town funding through Town Planner operating budget
6	Follow Open Space & Recreation Plan Goals and Objectives	Invasive Species, Mosquito-borne Illnesses, Drought, Inland Flooding, Dams/Culvert Failure, Average/Extreme Temperatures	4, 5, 6	Ensure Open Space & Recreation Plan consistent c/ HMP and cross-references HMP.	Update Open Space Plan and ensure future revisions cross-reference and utilize the Hazard Mitigation Plan. Committee is in the process of updating the Open Space Plan.	Conservation Agent / Commission / OS&RP Steering Committee	2021-2022	Southeast Regional Planning & Economic Development District (SRPEDD) Municipal Assistance Fund & District Local Technical Assistance (DLTA)
7	Re-establish Plymouth Carver Aquifer Advisory Committee (Regional Watershed Council)	Drought, Inland Flooding, Dams/Culvert Failure, Excessive Precipitation	4, 5, 6	Re-establish a regional watershed council to help bring together resources for comprehensive analysis, planning, decision-making, and cooperation to study and advise on water issues, including flooding and groundwater pollution.	Conduct initial outreach to the 7 Conservation Agents in neighboring towns. Review staff resources. Formalize and appoint members to a regional aquifer advisory committee from the seven towns in the Plymouth / Carver Sole Source Aquifer region.	Boards of Selectmen in Towns of Bourne, Carver, Kingston, Middleborough, Plymouth, Plympton, Wareham. Appointed individual from each of the 7 towns, usually the Conservation Agent if workload permits.	2021-2026	Volunteer hours, Town funding for most towns through Conservation Agent operating budget Grant funding: Southeast New England Program Pilot Watersheds Initiative, USDA NRCS's Regional Conservation Partnership Program (RCPP), New England Forest and Rivers Fund - National Fish and Wildlife Foundation
8	Culvert Inspections & Replacement	Dams/Culvert Failure, Excessive Precipitation	1, 2	Assess the condition of existing culverts within Town and rank them by priority for replacement.	DPW conducts annual inspections of culverts in Town, updating the priority list as culverts are repaired/replaced.	Operations and Maintence Department	2021-2026	Town funded through O&M Department personnell, operating budget Grant funding: MA Division of Ecological Restoration - Culvert Replacement Municipal Assistance Grant (CRMA) Program or Priority Projects program, FEMA Flood Mitigation Assistance
9	Remote Water Level Sensor	Drought, Wildfires	1, 6	Aquire and analyze water elevation data to identify supply issues, and promote future mitigation actions	1. Purchase and install meters to track water elevations in relation to storm events and drought conditions 2. Collect data on water levels within fire supression resevoris, and store data for analysis.	Town Planner and Consultant Town Planner and Consultant	2021-2023	Town funded-though Fire Department operating budget Grant funding: MA Division of Ecological Restoration - Priority Projects program, USDA NRCS's Regional Conservation Partnership Program (RCPP)

MITIGATION ACTION PRIORITIZATION

3=Best/Most Benefit/Low Cost/Easy or no permitting; 2=Some benefit/Moderate Cost/Some potential permitting complications; 1=Little to no benefit/High Cost/Complicated permitting required

		Benefits					Feasibility				Economic		Regulatory		
	Goals and Potential Mitigation Actions	Protects Properties and Structures	Protects Natural Resources	Technical/Capacity Improvement (Training, Evaluations, Regs)	Improves Public Awareness	Improves Emergency Response or Public Protection After an Emergency	Appropriate Staffing Available	Technically Feasible	Public Support	Town/Political Support	High Cost = Greater than $10k Moderate Cost = Between $10k and $2k Low Cost = Less Than $2k	Funding Available / Attainable	Permitting/Regulatory Feasibility	Consistent with Local, State, & Federal Goals	**Total Score**
	Goal 1. Reduce the loss of life, property, infrastructure, and environmental and cultural resources from natural disaster.														
1	1a. Wildfire Prevention Awareness	2	2	2	3	1	3	3	3	3	3	3	3	3	34
2	1b. Update and Enforce Regulations/ Bylaws/ Codes for Mobile Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
3	1c. Update and Enforce Regulations/ Bylaws/ Codes for Single-Family Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
4	1d. Hurricane Hazard Awareness	2	1	2	3	1	3	3	3	3	3	3	3	3	33
5	1e. Culvert Inspections & Replacement	3	1	2	1	2	3	2	3	3	1	3	3	3	30
6	1f. Remote Water Level Sensor	1	1	3	1	3	2	3	3	3	1	2	3	3	29
	Goal 2. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from riverine flooding.														
9	2a. Culvert Inspections & Replacement	3	1	2	1	2	3	2	3	3	1	3	3	3	30
	Goal 3. Investigate, design, and implement structural projects that will reduce and minimize the risks and impacts from non-flooding hazards such as wildfires, tornadoes, hurricanes, etc.														
10	3a. Update and Enforce Regulations/ Bylaws/ Codes for Mobile Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
11	3b. Update and Enforce Regulations/ Bylaws/ Codes for Single-Family Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
	Goal 4. Improve pre-disaster planning, communication, and coordination among federal, state, county, community, private, and non-profit entities so that they can plan for and mitigate natural hazards in a clear and comprehensive manner.														
12	4a. Follow Open Space & Recreation Plan Goals and Objectives	3	3	3	2	2	3	3	3	3	3	3	3	3	37
13	4b. Update/Incorporate Comprehensive Master Plan Goals and Objectives	3	1	3	2	2	3	3	3	3	3	3	3	3	35
14	4c. Re-establish Plymouth Carver Watershed Aquifer Advisory Committee (Regional Watershed Council)	3	3	3	1	3	2	3	3	3	2	2	3	3	34
15	4d. Wildfire Prevention Awareness	2	2	2	3	1	3	3	3	3	3	3	3	3	34
16	4e. Hurricane Hazard Awareness	2	1	2	3	1	3	3	3	3	3	3	3	3	33
	Goal 5. Increase the awareness of the public and communities to the risks presented by the multiple natural hazards that affect the region as well as to the mitigation activities and grant opportunities available to minimize the impacts of these hazards.														
17	5a. Wildfire Prevention Awareness	2	2	2	3	1	3	3	3	3	3	3	3	3	34
18	5b. Hurricane Hazard Awareness	2	1	2	3	1	3	3	3	3	3	3	3	3	33
	Goal 6. Improve existing policies and programs to reduce further or eliminate the impacts of natural hazards.														
19	6a. Follow Open Space & Recreation Plan Goals and Objectives	3	3	3	2	2	3	3	3	3	3	3	3	3	37
20	6b. Update/Incorporate Comprehensive Master Plan Goals and Objectives	3	1	3	2	2	3	3	3	3	3	3	3	3	35
21	6c. Re-establish Plymouth Carver Watershed Aquifer Advisory Committee (Regional Watershed Council)	3	3	3	1	3	2	3	3	3	2	2	3	3	34
22	6d. Update and Enforce Regulations/ Bylaws/ Codes for Mobile Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
23	6e. Update and Enforce Regulations/ Bylaws/ Codes for Single-Family Homes	3	1	3	2	1	3	3	3	3	2	3	3	3	33
24	6f. Remote Water Level Sensor	1	1	3	1	3	2	3	3	3	1	2	3	3	29

Legend	
Low	≤30
Med	31-33
High	≥34

GRANT FUNDING SOURCES

Source	Website	Description	Eligible Infrastructure/Resources/Activities
Dam and Seawall Repair or Removal Program Grants and Funds (Dams, Seawalls, Levees)	https://www.mass.gov/service-details/dam-and-seawall-repair-or-removal-program-grants-and-funds	The Dam and Seawall Repair or Removal Program offers financial resources to qualified applicants for projects that share our mission to enhance, preserve, and protect the natural resources and the scenic, historic and aesthetic qualities of the Commonwealth of Massachusetts.	Category 1 - Dams and similar regulated and unregulated impoundments Category 2 - Seawalls, coastal flood and/or foreshore protection Category 3 - Inland flood control structures and levees, excluding dams and non-jurisdictional impoundments
FEMA Flood Mitigation Assistance	https://www.mass.gov/info-details/fema-grants-portal	FEMA has several hazard mitigation grants that provide funds to assist state agencies and local governments implement measures that reduce or eliminate the long-term risk of flood damage.	Project scoping, mitigation, community flood mitigation projects.
MA Division of Ecological Restoration Priority Projects program	https://www.mass.gov/how-to/become-a-der-priority-project	Through the Priority Project program, DER selects projects that help advance their mission. Selections are based upon consideration of the project's cost, size, practicality, feasibility, opportunity for public benefits-including ecological services, education and recreation, ecological restoration potential, and/or urban stream revitalization, available DER resources, direct benefits to aquatic resources, and partner support.	Cranberry bog wetland restoration Dam removal River restoration
National Estuary Program Coastal Watersheds Grant Program	https://estuaries.org/initiatives/watershedgrants/	The NEP Coastal Watersheds Grant Program addresses loss of key habitats resulting in significant impacts on fisheries and water quality in tidal, freshwater , forested wetlands.	habitat loss invasive species water quality
New England Forest and Rivers Fund – National Fish and Wildlife Foundation	https://www.nfwf.org/newengland/Pages/home.aspx	Competitive grants dedicated to restoring and sustaining healthy forests and rivers for diverse native bird and freshwater fish populations in New England.	Restore river function , water quality , and enhance long term persistence of native aquatic species
Southeast New England Program Pilot Watersheds Initiative	https://www.grants.gov/web/grants/view-opportunity.html?oppId=332504	The goal of the initiative is to demonstrate the effectiveness of concentrated, collaborative efforts and holistic (watershed scale) planning to address common environmental challenges in the SNEP geographic boundary, -advancing ecosystem resiliency, protecting and restoring water quality, habitat, and ecosystem function, and developing and applying innovative policy, science, and technology to environmental management.	Watersheds
USDA NRCS's Regional Conservation Partnership Program (RCPP)	https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/	The Regional Conservation Partnership Program (RCPP) promotes coordination of NRCS conservation activities with partners that offer value-added contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns.	Land management/land improvement/restoration practices
MA Division of Ecological Restoration - Culvert Replacement Municipal Assistance (CRMA) Grant Program	https://www.mass.gov/how-to/culvert-replacement-municipal-assistance-grant-program	To replace culverts with better designed crossings that meet improved structural and environmental design standards and climate resiliency criteria. Eligible projects must be on a public way, owned and maintained by the applying municipality, and must cross a natural freshwater, nontidal river or stream channel. The stream channel may be either intermittent or perennial.	Culverts (non-tidal)

Appendix D

BOARD OF SELECTMEN

Richard LaFond
Town Administrator

Elaine M. Weston
Ass't. to the Town Administrator

108 Main Street
Carver, MA 02330
Telephone: 508-866-3401/Fax: 508-866-4213

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN, Carver, Massachusetts

A RESOLUTION ADOPTING THE Town of Carver Hazard Mitigation Plan 2022, Carver, MA

WHEREAS, the Town of Carver, Massachusetts established a Committee to prepare the Town of Carver Hazard Mitigation Plan 2022; and

WHEREAS, the Town of Carver, Massachusetts participated in the development of the Town of Carver Hazard Mitigation Plan 2022; and

WHEREAS, the Carver, Massachusetts, Town of Carver Hazard Mitigation Plan 2022 contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Carver; and

WHEREAS, a duly-noticed public meeting was held by the CARVER BOARD OF SELECTMEN on _____, for the public and municipality to review prior to consideration of this resolution; and

WHEREAS, the Town of Carver authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the Plan; and

NOW, THEREFORE, BE IT RESOLVED that the Town of Carver, Massachusetts BOARD OF SELECTMEN formally approves and adopts the Carver, Massachusetts, Town of Carver Hazard Mitigation Plan 2022 in accordance with M. G. L c. 40

ADOPTED AND SIGNED this _____
Month Day Year

_____ _____

_____ _____

_____

ATTEST: