CITY OF MARLBOROUGH
HAZARD MITIGATION PLAN
2024 UPDATE

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Final Plan
FEMA Approvable Pending Adoption
April 24,2024

ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the City of Marlborough by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR). The plan was funded by the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP).

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SECTION 1: EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five-year intervals.

PLANNING PROCESS

This is an update of the original Marlborough Hazard Mitigation Plan, which was approved by FEMA on September 26, 2016. Prior to that, Marlborough's first plan was approved by FEMA on August 7, 2008. Planning for the Hazard Mitigation Plan Update was led by the Marlborough Hazard Mitigation Team, composed of staff from multiple City departments. Throughout the planning process the team met four times, on August 16, 2022, October 19, 2022, December 14, 2022,and March 27, 2023. The team assisted in updated local data, including critical facilities, local hazard areas, and new development sites, and discussed where the impacts of natural hazards most affect the City, goals for addressing these impacts, updates to the City's existing mitigation measures and new or revised recommended hazard mitigation measures that would benefit the City.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the City takes to mitigate them. The Local Team hosted two public meetings, the first on February 13, 2023, hosted by the Planning Board with several City Councilors in attendance, and the second on May 22, 2023 hosted by the City Council. Neighboring communities and city stakeholders were notified and invited to attend the meeting.

RISK ASSESSMENT

The Marlborough Hazard Mitigation Plan assesses the potential impacts to the City from multiple natural hazards, including flooding, hurricanes and tornadoes, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. Flooding, driven by hurricanes, northeasters and other storms, clearly presents the greatest hazard to the City. These are shown on the map series (Appendix B).

The Marlborough Local Hazard Mitigation Planning Team identified 155 Critical Facilities. These are compiled in an inventory in Table 35, identifying which facilities are located within the mapped hazard zones. The locations of the Critical Facilities are shown on the hazard map series, copies of which are found in Appendix A.

A HAZUS-MH analysis provided estimates of damages from Hurricanes of category 2 and 4 ($25.1 million to $99.5 million as well as earthquakes of magnitudes 5 and 7 ($586 million to $7.5 billion). Flood damage estimates range from $41 million to $208 million.

HAZARD MITIGATION GOALS

The Marlborough Local Hazard Mitigation Planning Team identified the following hazard mitigation goals for the City: The Team added Goal 12, addressing climate change.

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

Goal 2: Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

Goal 3: Increase cooperation and coordination among private entities, City officials and Boards, State agencies and Federal agencies.

Goal 4: Increase awareness of the benefits of hazard mitigation through outreach and education.

Goal 5: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 6: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 7: Prevent and reduce the damage to public infrastructure resulting from all hazards.

Goal 8: Encourage the business community, major institutions and non-profits to work with the City to develop, review and implement the hazard mitigation plan.

Goal 9: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 10: Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

Goal 11: Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

Goal 12: Consider the impacts of climate change and incorporate climate sustainability and resilience into the City's planning and policies.

HAZARD MITIGATION STRATEGY

The Marlborough Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the City's vulnerability to natural hazard events.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Marlborough will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and a variety of other factors impact the City's vulnerability and in the future, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the City's other related plans and policies.

PLAN REVIEW & UPDATE PROCESS

The process for developing Marlborough's Hazard Mitigation Plan 2024 Update is summarized in Table 1.

Table 1 - Plan Review and Update

Section	Reviews and Updates
3 – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Team. The plan was also available on the City's website for public comment.
4 – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with City staff to identify changes in local hazard areas and development trends. City staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS to assess the impacts of flooding, hurricanes, and earthquakes. .
5 - Goals	The Hazard Mitigation Goals were reviewed, and endorsed by the Marlborough Local Hazard Mitigation Planning Team. For this plan update the local team added a goal addressing climate change.
6 – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the City.
7 & 8 – Hazard Mitigation Strategy	Mitigation measures from the 2008 plan were reviewed and assessed as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2016 Plan Update, modify, or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2008 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current conditions.
9 – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the City in incorporating hazard mitigation issues into other City planning and regulatory review processes and better prepare the City for the next comprehensive plan update.

Since approval of the 2016 plan by FEMA the City has made progress with several hazard mitigation measures, including completion of flood mitigation for the Boundary Street Bridge, replacement of a culvert on Route 85, and replacement of the Millham Brook culvert on Elm Street. Fire management activities included a 25-acre prescribed burn on the Desert Conservation Area, with plans for 30 additional acres on an adjacent site, and logging operations conducted in the Millham Reservoir watershed area. Mitigation for winter hazards include the design and rehabilitation of the salt sheds and fuel depot, and implementation of pre-treatment of streets with a brine mixture for better management of snow and ice. Emergency backup generators were installed for City Hall and the Police Department.

Partially completed mitigation measures include drainage improvements made on Millham Brook in the Glen Brook Neighborhood, with designs completed for the final phase of work to reconstruct the inlet, and land acquisition and preparation for a new Fire Station in the western section of the city.

In addition, the City completed a Municipal Vulnerability Preparedness planning process in 2018 and has been designated an MVP Community by the Executive Office of Energy and Environmental Affairs. Much of the critical data in the City's 2016 Hazard Mitigation Plan was utilized in the MVP planning process. The MVP project referred to the 2016 plan's assessment of critical infrastructure and local hazard vulnerability to inform the MVP project. When the MVP project was completed, it in turn contributed to this 2024 updated Hazard Mitigation Plan. Several mitigation actions discussed at the MVP workshop have been integrated into this plan update.

In 2023 the City adopted Resilience Design Guidance to address flooding, heat, and other natural hazards for new developments, as part of an MVP Action Grant project.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the City's decision making processes, plans, policies, and operations. The City will document any actions taken within this iteration of the updated Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Marlborough Hazard Mitigation Team, as described in Section 9, Plan Adoption and Maintenance.

SECTION 2: INTRODUCTION

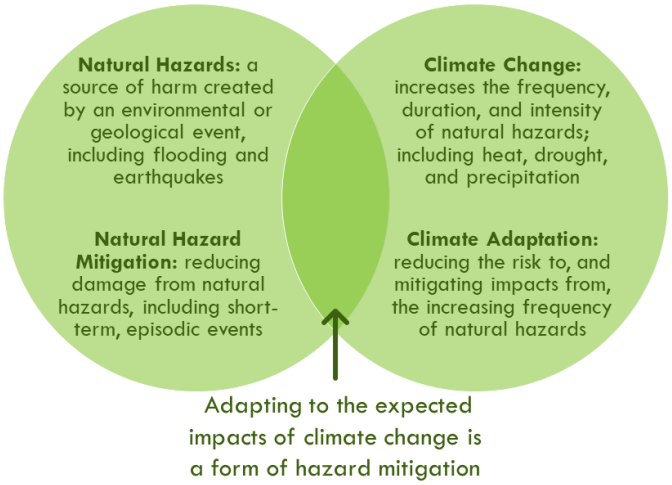
PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan and update this plan in five year intervals. This planning requirement does not affect disaster assistance funding. Federal hazard mitigation planning and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Department of Conservation and Recreation (DCR). The City of Marlborough contracted with the Metropolitan Area Planning Council (MAPC), to assist the City in updating its original local Hazard Mitigation Plan, which was first adopted in 2010. MAPC is the Regional Planning Agency (RPA) serving the 101 communities in the greater Boston area, and provided facilitation and technical support for this project.

WHAT IS A HAZARD MITIGATION PLAN?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities. FEMA's 2022 Local Mitigation Planning Policy Guide recognized that adapting to the expected impacts of climate change is a form of hazard mitigation (FEMA, 2022). Therefore, this plan incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather fueled by a warming planet.

Figure 1: Natural Hazards and Climate Change Overlap



PREVIOUS FEDERAL/STATE DISASTERS

Since 1991, there have been 24 natural hazard events that triggered disaster declarations that included Middlesex County, which includes the City of Marlborough. These are listed in Table 2 below. The majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

Table 2: Presidentially Declared Disasters 1991-2023

Disaster Name	Date of Event	Declared Areas
Hurricane Bob	August 1991	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Severe Coastal Storm No Name Storm	October 1991	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Blizzard	March 1993	Statewide
Blizzard	January 1996	Statewide
Severe Storms, Flood	October 1996	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
Heavy Rain, Flood	June 1998	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms, Flood	March 2001	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Snowstorm	March 2001	Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Snowstorm	February 2003	Statewide
Snowstorm	December 2003	Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding	April 2004	Essex, Middlesex, Norfolk, Suffolk, Worcester
Snow	January 2005	Statewide
Hurricane Katrina	August 2005	Statewide
Severe Storms, Flooding	October 2005	Statewide
Severe Storms, Flooding	May 2006	Statewide
Severe Storm, Inland, Coastal Flooding	April 2007	Statewide

Disaster Name	Date of Event	Declared Areas
Severe Winter Storm	December 2008	Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, Worcester
Severe Storms, Flooding	December 2008	Statewide
Severe Storms, Flooding	March/April 2010	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Severe Winter Storm, Snowstorm	January 2011	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Severe Storm, Snowstorm	October 2011	Berkshire, Franklin, Hampden, Hampshire, Middlesex, Worcester
Severe Winter Storm, Snowstorm, Flooding	February, 2013	Statewide
Severe winter storm, snowstorm, and flooding	April 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and Snowstorm	March 2018	Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: database provided by MEMA

In addition to Federal disaster declarations the Commonwealth of Massachusetts has declared state emergencies fourteen times since 2011 (Table 3). Eight of these emergencies were related to natural hazards such as winter storms, Nor'easters, flooding, and hurricanes.

Table 3: Massachusetts State Declared Emergencies

Declaration Date	Termination Date	Event
9/15/23	9/16/23	Hurricane Lee
9/12/23	9/16/23	Severe Weather & Flooding
2/9/15	2/25/15	Winter Storm
1/26/15	1/28/15	Winter Storm
2/8/13	2/13/13	Winter Storm
10/27/12	11/1/12	Hurricane Sandy
10/29/11	11/7/11	Nor'easter
8/26/11	9/6/11	Hurricane Irene

Source: Massachusetts Emergency Management Agency
State of Emergency Information | Mass.gov

FEMA FUNDED MITIGATION PROJECTS

Over the last 20 years the City of Marlborough has not received funding from FEMA for any mitigation projects.

COMMUNITY PROFILE

The City of Marlborough is a small city with an economic development focus that is currently attracting new growth and development. Bordered by Hudson on the north, Sudbury and Framingham to the east, Southborough to the south, and Berlin and Northborough on the west, Marlborough is 17 miles east of Worcester, and 27 miles west of Boston. Its central, easily accessible location on I-495 and several state arteries such as Routes 20 and 85 makes Marlborough one of New England's most convenient locations for businesses and visitors. Tourists and meeting planners favor Marlborough for its thousand-plus hotel rooms, range of function facilities and proximity to the entire region's largest cities. Major employers like Marlborough's progressive management, pro-business administration and well maintained infrastructure. For its residents, Marlborough offers a small town feel with the amenities of a city. Newcomers drawn by high tech employers enjoy a sense of community, first forged by the craftsmen who came to work in the city's shoe factories years ago and whose descendants remain as residents. Together they enjoy an impressive array of local recreational and cultural activities all within an hour's drive of Boston, Worcester, Foxborough, Providence, Cape Cod, the historical attractions of Concord and Lexington, and New Hampshire.
The City is governed by a Mayor and City Council. The City maintains a website at http://www.marlborough-ma.gov/gen/index.

The significant demographic characteristics of the City of Marlborough are summarized in Table 3. Some of these features are important to keep in mind for hazard mitigation as well as emergency preparedness and response in the City.

Table 4. City of Marlborough Characteristics

Population	
Total population	41,505
Residents under 5 years old	6.6%
Residents 65 years old and over	14.2%
Race & Ethnicity	
American Indian and Alaska Native	0.1%
Asian	14.9%
Black or African American	4.7%
Native Hawaiian and Pacific Islander	0.0%
White	34.7%
Other Race	32.7%
Two or More Races	12.9%
Hispanic or Latino	29.6%
White alone, Not Hispanic or Latino	27.7%
Household Income	
Total Households	17,147
Mean Household Income	$107,576
Housing units built before 1960	30.7%
Renter occupied housing units	42.2%

Languages	
Speak a language other than English at home	36.8%
Spanish	14.6%
Other Indo-European languages	19.0%
Asian and Pacific Island languages	2.1%
Other languages	1.1%
Speaks English less than "very well"	14.9%
Additional Information	
Residents with a Disability	9.7%
Age 65 to 74 with a disability	21.1%
Age 75 and over with a disability	47.9%
Residents in Poverty	8.3%
Households with no vehicle	8.5%

Sources: 2020 Decennial Census and American Community Survey (ACS) 5-Year Estimates (US Census Bureau, 2021)

Economic Elements

Marlborough has local economic centers located in multiple areas of the city. Significant centers of economic development include Downtown Village, the Route 20 corridor, and the Southwest Quadrant, all of which have been the subject of recent plans and studies. Downtown serves as the civic center as well as the focus of recent revitalization efforts. The Route 20 corridor is characterized by a mix of uses including significant strip commercial development. The Southwest Quadrant is accessible from Routes 20, 290 and 495 and is the home of many of Marlborough's largest employers. This area is being envisioned as a mixed-use development area, as opposed to the older single-use office park model.

Historic, Cultural, and Natural Resource Areas

Boston Post Road (Route 20) is part of the historic road network from Boston to the Connecticut River. This route in Marlborough in the 1800's was lined by apple orchards and dairy farms, which, along with shoe factories, were the primary commercial operations in the city. Most of these farms have been replaced by businesses, residential developments, and office parks.

Lake Williams is the only true natural lake in the city and historically was a focal point for recreation. Before the settlers used this lake it was a gathering place for American Indians. However, today it is an important part of the city's water supply and no longer a recreational resource.

Two historic districts have been established in the downtown area of the city. The first was established in 1996 as recommended by the Historic Commission and is a very small Local Historic District known as Monument Square which includes the area around the monument near the main library on Main St. up Mechanic St. to Lincoln St. This district was established under the local historic district MGL Ch. 40C. The second district is the Marlborough Center

National Register district, which includes Main St. from the Library to the Old now renovated Fire station office building

The Historic Commission has also compiled an inventory of all historic properties within the city. All historic properties including houses, cemeteries, and landscapes have been documented and inventoried. The inventory is thorough and provides important documentation of these historic sites, however there are no rules or ordinances local or state, which currently provide protection to any of these structures. The hope is that as people realize the historic values of these properties, they may be more willing to help protect them. Historic structures help to provide a sense of history to any community and lend their character to the community.

In 2009 the Historic Commission worked with volunteers to inventory all the headstones within the historic cemeteries in the city. This data is now stored with the Historic Commission.

Due to local small business efforts in 2012, downtown Marlborough was recognized as a Cultural District in Massachusetts - one of only 14 districts awarded this distinction during the first year of the MCC Cultural Districts Initiative.

SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

PLANNING PROCESS SUMMARY

MAPC employs a six-step planning process based on FEMA's hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through:

- Meetings and work with the Local Teams
- Two public meetings, shared on Local Access TV and advertised through email, webpage content, a flyer, press release to local media, and social media posts,
- Outreach to Environmental Justice populations with meeting flyer translated into Spanish and Portuguese due to the significant Latino and Brazilian immigrant population (see Appendix C),
- A project website at: www.mapc.org/resource-library/marlborough-hmp and a dedicated email for public comments,
- Launching a public comment period at the second public meeting, and posting the draft plan to the project website to facilitate public review,
- Outreach to neighboring communities, City boards and commissions, the local chamber of commerce and businesses, and other local or regional entities.

By working on hazard mitigation plans in several communities in the region, MAPC is often able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the six-step process described below and summarized in Figure 2 allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality's existing mitigation measures, and progress made on actions identified in previous plans.

Figure 2: Six-Step Planning Process

- **Map the Hazards** – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred. These maps can be found in Appendix B.

- **Assess the Risks & Potential Damages** – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community. MAPC drew on the following resources to complete the plan:

    - Blue Hills Observatory
    - City of Marlborough General Code
    - City of Marlborough Draft Open Space Plan 2011-2018
    - City of Marlborough Subdivision Regulations
    - Commonwealth of Massachusetts, Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), 2018
    - Commonwealth of Massachusetts, State Hazard Mitigation Plan 2013
    - Commonwealth of Massachusetts, Massachusetts Climate Change Assessment, 2022
    - DCR, Community Information System, Community Overview, 2022
    - FEMA, Disaster Declarations for States and Counties, 2023
    - FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2014
    - FEMA, HAZUS, 2022
    - FEMA, Local Mitigation Planning Policy Guide, 2022
    - FEMA, Local Mitigation Plan Review Guide; October 1, 2011
    - Massachusetts Office of Dam Safety, Inventory of Dams, 2018
    - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
    - New England Seismic Network, Boston College Weston Observatory,
    - NOAA National Centers for Environmental Information,
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - Supplemental Final Environmental Impact Report. Phase 1 Muddy River Flood Control, Water Quality and Habitat Enhancement and Historic Preservation Project.
    - Tornado History Project
    - US Census, 2020, American Community Survey
    - USDA Forest Service, Wildfire Risk to Communities
    - USGS, National Water Information System,
    - U.S. Global Change Research Program, Fourth National Climate Assessment, 2018
    - USACE Ice Jam Database

- **Review Existing Mitigation** – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures have been documented.

- **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter VII.

- **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter IX and documentation of plan adoption can be found in Appendix D.

- **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Chapter IX includes more detailed information on plan implementation.

2016 PLAN IMPLEMENTATION & MAINTENANCE

The 2016 City of Marlborough Hazard Mitigation Plan contained a risk assessment of identified hazards for the City and mitigation measures to address the risks and vulnerability from these hazards. Since approval of the plan by FEMA the City has made progress with several hazard mitigation measures, including completion of flood mitigation for the Boundary Street Bridge, replacement of a culvert on Route 85, and replacement of the Millham Brook culvert on Elm Street. Fire management activities included a 25-acre prescribed burn on the Desert Conservation Area, with plans for 30 additional acres on an adjacent site, and logging operations in the Millham Reservoir watershed area. Mitigation for winter hazards include the design and rehabilitation of the salt sheds and fuel depot, and implementation of pre-treatment of streets with a brine mixture for better management of snow and ice. Emergency backup generators were installed for City Hall and the Police Department.

Partially completed mitigation measures include drainage improvements made on Millham Brook in the Glen Brook Neighborhood, with designs completed for the final phase of work, and land acquisition and preparation for a new Fire Station in the western section of the city.

See Section 7 for more information on the status of mitigation measures from the 2016 Hazard Mitigation Plan.

In addition, the City completed a Municipal Vulnerability Preparedness planning process in 2018 and has been designated an MVP Community by the Executive Office of Energy and Environmental Affairs. Much of the critical data in the City's 2016 Hazard Mitigation Plan was utilized in the MVP planning process. The MVP project referred to the 2016 plan's assessment of critical infrastructure and local hazard vulnerability to inform the MVP project. Several mitigation actions discussed at the MVP workshop have been integrated into this plan update.

In 2023 the City adopted Resilience Design Guidance to address flooding, heat, and other natural hazards for new developments, as part of an MVP Action Grant project.

THE LOCAL HAZARD COMMUNITY PLANNING TEAM

MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team for Marlborough. MAPC briefed the local representatives as to the desired composition of that team as well as the need for public participation in the local planning process.

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. The local team was tasked with working with MAPC to set plan goals, provide information on the hazards that impact the city, existing mitigation measures, and helping to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership can be found in Table 4.

Table 5 - Marlborough Hazard Mitigation Planning Team

Frederick F. Flynn	Fire Dept, Emergency Management Director
Nathaniel Bowen	DPW, GIS Administrator
Mark Dascoli	DPW, Assistant City Engineer
Tom Dipersio	DPW, City Engineer
Priscilla Ryder	Conservation Commission, Conservation Officer
Theodore Scott	DPW, Assistant Commissioner of Operations
Eric Williams	Emergency Management, Assistant Director

The Conservation Commission and Public Works Department are responsible for managing and regulating development and infrastructure in the City. MAPC, the State-designated Regional Planning Agency for Marlborough, coordinates with all state and regional agencies that regulate development and infrastructure in the region, including the Department of Transportation, the Massachusetts Water Resources Authority and the Department of Conservation and Recreation.

The Local Team met four times on the dates listed below. The agendas for these meetings are included in Appendix C. The topics of each meeting are summarized below:

- **August 16, 2022:** discuss the project overview and update the inventory and GIS maps of local flood and fire hazard areas and critical facilities.

- **October 19, 2022:** update the hazard mitigation goals and review the current status of the existing mitigation measures, and prepare for Public Meeting #1
- **December 14, 2022:** review the status of the recommended mitigation from the 2016 plan and determine which measures should be retained in the 2024 plan.
- **March 27, 2023:** to develop new recommended mitigation measures and prepare for Public Meeting #2

PUBLIC MEETINGS

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the City hosted two public meetings, one during the planning process hosted by the Planning Board, and one after the draft plan was available for review, hosted by the City Council.

One of the best strategies for increasing the impact of local meetings is to invite one of the municipal boards or commissions to host the public discussion of the hazard mitigation plan. With this strategy, the meeting receives widespread advertising and a guaranteed audience of the board or commission members in addition to members of the public who are invited to attend the meeting. These board and commission members represent an engaged audience that is informed and up to date on many of the issues that relate to hazard mitigation planning in the locality and will likely be involved in plan implementation, making them an important audience with which to build support for hazard mitigation measures. In addition, these meetings frequently receive press coverage or are broadcast on local CATV, expanding the audience that has the opportunity to hear the presentation and provide comment.

The public had an opportunity to provide input to the Marlborough hazard mitigation planning process during and following a meeting of the Planning Board, on February 13, 2023 held in Marlborough City Hall. At a second public meeting, the draft plan update was presented at a City Council meeting held on May 22, 2023 in Marlborough City Hall. Both meetings were publicized as part of regular meetings of the Planning Board and City Council according to the Massachusetts Public Meeting Law. The draft Marlborough Hazard Mitigation Plan 2024 Update was posted on the City's website for the second public meeting, and the meeting was also broadcast on local public access television. See public meeting notices and comments in Appendix C.
Considering the significant non-English-speaking population, the meeting outreach was translated into both Spanish and Portuguese and distributed to the local and regional press serving those communities. (See Appendix C).

LOCAL STAKEHOLDER INVOLVEMENT

The local Hazard Mitigation Planning Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan:

The Local Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan update, including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following City boards, committees, departments; regional and state organizations; and neighboring municipalities inviting them to participate in the public meetings, review the draft HMP, and submit comments to the City. No written comments were received by the City

- Brazilian Times
- Building Commissioner
- National Grid
- Campus at Marlborough
- Hancock Associates
- MEDC Director
- Dow
- Boston Scientific
- GE Health
- OARS - Executive Director
- Recreation Director
- Historical Commission
- Council on Aging
- Director Board of Health
- Public Health Nurse
- Marlborough EDC
- Marlborough Downtown Village
- Marlborough Chamber of Commerce
- MetroWest Chamber of Commerce
- Library Director
- Town of Berlin
- Town of Framingham
- Town of Hudson
- Town of Northborough
- Town of Southborough
- Town of Sudbury

CONTINUING PUBLIC PARTICIPATION

Following the adoption of the plan update, the Marlborough Hazard Mitigation Team will continue to provide residents, businesses, and other stakeholders the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the city's understanding of local hazards. The Marlborough Emergency Management Coordinator will act as the coordinator for the Team. As updates and a review of the plan are conducted by the Hazard Mitigation Team, these will be placed on the City's web site, and any meetings of the Hazard Mitigation Team will be publicly noticed in accordance with city and state open meeting laws.

PLANNING TIMELINE

PLAN UPDATE PROCESS 2022-23

Major milestones in the planning process to prepare this plan update included the following:

August 16, 2022	Local Team Meeting #1
October 14, 2022	Local Team Meeting #2
December 19, 2022	Local Team Meeting #3
February 13, 2023	Public Meeting #1
March 27, 2023	Local Team Meeting #4
May 22, 2023	Public Meeting #2
June 30, 2023	Draft Plan Update submitted to MEMA
August xx, 2023	Revised Draft Plan Update submitted to MEMA
April 1, 2024	Draft Plan Update submitted to FEMA
April 24, 2024	Notice of Approvable Pending Adoption sent by FEMA
TBD	Plan Adopted by the City of Marlborough
TBD	FEMA Formal Approval of the plan for 5 years

PLAN IMPLEMENTATION MILESTONES 2024-2029

After this plan update is approved by FEMA for a five-year period, the City should take note of the following milestones for the ongoing implementation, review, and updating of this plan:

2026	Conduct Mid-Term Plan Survey on Progress
2027	Seek FEMA grant to prepare next plan update
2028	Begin process to update the plan
2029	Submit Draft 2029 Plan Update to MEMA and FEMA
2029	FEMA approval of 2029 Plan Update

SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the City as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large-scale natural hazard events. In order to update Marlborough's risk assessment, MAPC gathered the most recently available hazard and land use data and met with the Local Team to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, Hazards US (HAZUS).

The projected impacts of our warming climate on natural hazards are integrated throughout this risk assessment. Key impacts include rising temperatures, which in turn affect precipitation patterns and extreme weather. Analysis of these impacts included in this plan aligned closely with the data and assessment presented in Massachusetts' 2018 State Hazard Mitigation and Climate Adaptation Plan (2018 SHMCAP) and the Massachusetts' 2022 Climate Change Assessment.

> *"Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth's history. Global average temperature has increased by about 1.8°F from 1901 to 2016, and observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause."*
>
> Fourth National Climate Assessment, 2018 (Chapter 2-1)

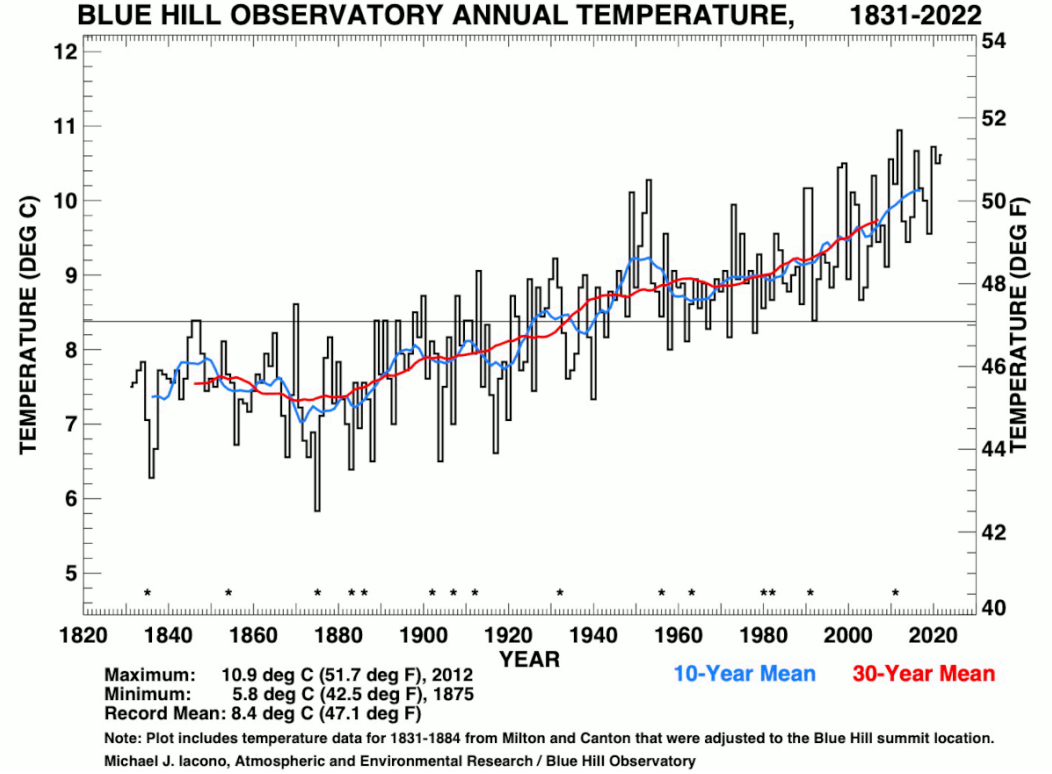
CLIMATE CHANGE OBSERVATIONS AND PROJECTIONS

Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in predicting future conditions, climate projections are generally expressed as a range of possible impacts.

TEMPERATURE

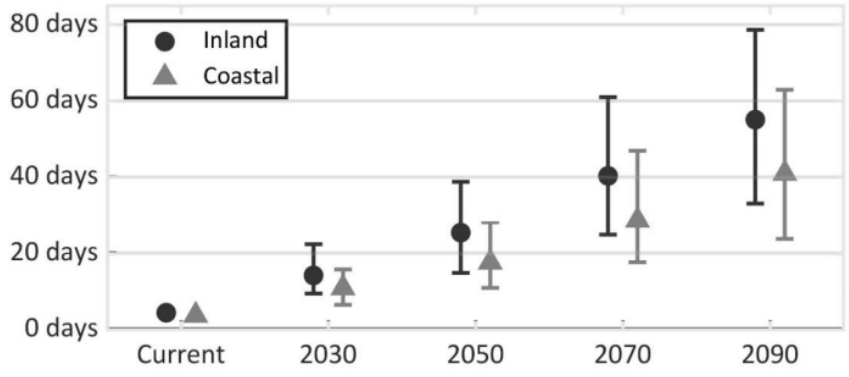
Our climate has always been regulated by gases, including carbon dioxide, methane, and nitrous oxide, which blanket the earth. These gases trap heat that would otherwise be reflected out to space; without them our planet would be too cold to support life. We refer to these gases as "greenhouse gases" (GHGs) for their heat trapping capacity. The combustion of fossil fuels, our primary energy source in the age of industrialization, releases GHGs into the atmosphere. In the past century, human activity associated with industrialization has contributed to a growing concentration of GHGs in our atmosphere. Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831. See Figure 3 below for more information.

Figure 3: Observed Increase in Temperature



Climate projections include an increase in average temperature and in the number of extreme heat days. Extreme cold days are projected to decrease in number. By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013). By 2070, there could be 58 fewer days below freezing, which could lead to an increase in ticks. By mid-century, the State anticipates about 25 more days per year where the temperature exceeds 90°F for inland areas, and about 19 more days above 90°F for coastal areas (Commonwealth of Massachusetts, 2022).

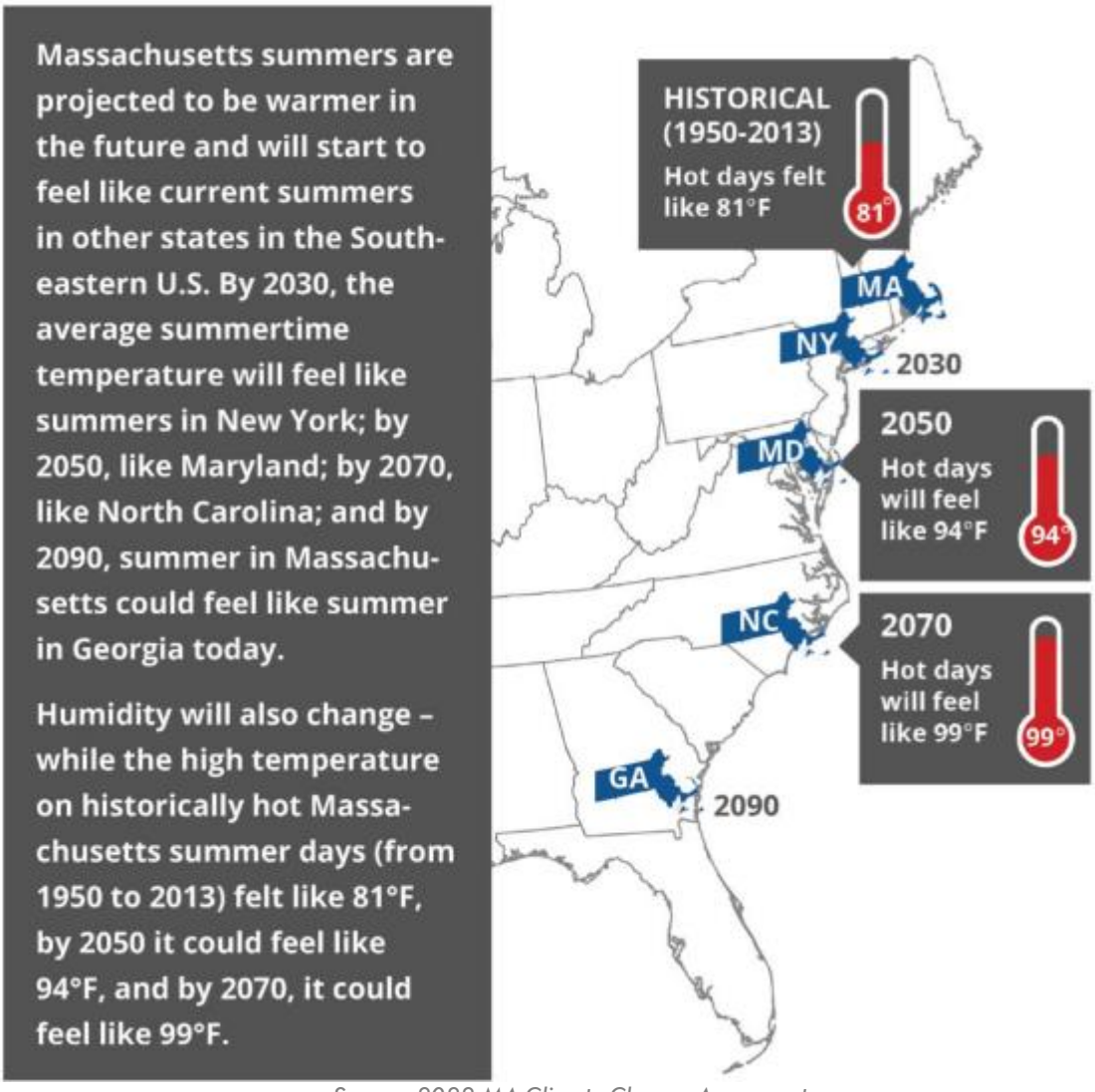
Figure 4: Change in the Annual Number of Days Over 90°F Compared to Today



Sources: 2022 MA Climate Change Assessment and Stochastic Weather Generator

These changes could result in Massachusetts summers feeling like a more southern state, as described in the infographic in Table 5 from the State's 2022 Climate Change Assessment.

Figure 5: Change in Average Summertime Temperatures for Massachusetts

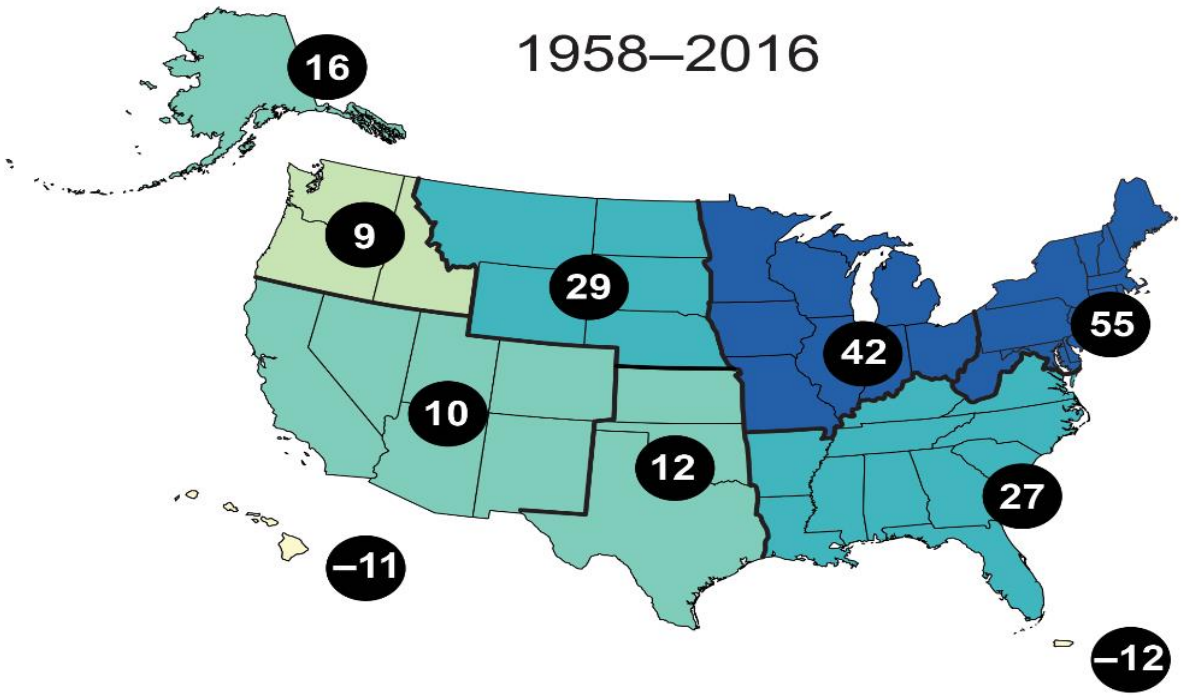


Source: 2022 MA Climate Change Assessment

PRECIPITATION PATTERNS

Annual precipitation in Massachusetts has increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA EEA, 2011). Moreover, there has been a significant increase in the frequency and intensity of large rain events. For the Northeast US, according to the Fourth National Climate Assessment 2018, in the past sixty years there has been a 55% increase in the amount of annual precipitation that falls in the top 1% of storm events, as shown in Figure 6 below (US Global Change Research Program, 2018). Changes in precipitation are fueled by warming temperatures which increase evaporation and, therefore, the amount of water vapor in the air.

Figure 6: Observed Change in Total Annual Precipitation in the Heaviest 1% Events

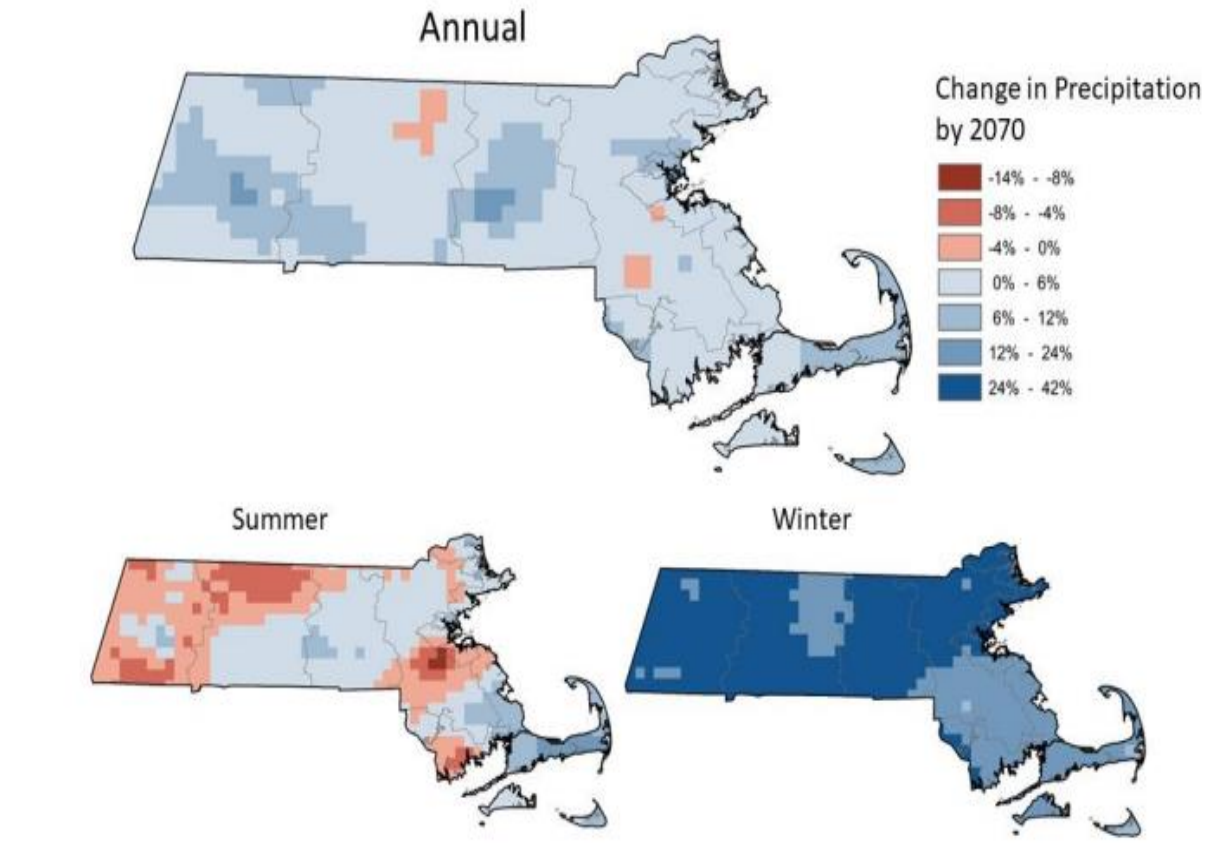


Source: Fourth National Climate Assessment, 2018
Numbers circled in black indicate % change.

Massachusetts' 2022 Climate Change Assessment anticipates that most parts of the State will see a future increase in annual total precipitation of less than 8% per year. Most of these increases are anticipated during the winter months (see Figure 7 below).

Additionally, the historic 10% annual chance daily rainfall event (2.8-4.0" of rain) could occur four times more frequently by 2090 (Commonwealth of Massachusetts, 2022).

Figure 7: Change in Annual and Seasonal Precipitation in 2070 Compared to Today



Source: 2022 MA Climate Change Assessment. Current climate is the 1986-2005 era, the projection for 2070 is for a 20-year era centered on 2070. Maps show LOCA downscaled GCM projections at the 50th percentile across 20 LOCA GCMs that overlap with the GCMs used in the Stochastic Weather Generator.

Despite overall increasing precipitation, more frequent and significant summer droughts are also a projected consequence of climate change. This is due to projections that precipitation will increase in winter and spring and decrease slightly in the summer and, a result of earlier snow melt, and higher temperatures that will reduce soil moisture. Massachusetts' 2022 Climate Change Assessment anticipates that these changes will vary by region. The Eastern Inland region where Marlborough is located may experience slightly more consecutive dry days, and significantly more days without rain per year, by 2090 (Commonwealth of Massachusetts, 2022). See Figure 8 below for more information.

Figure 8: Consecutive dry day events (number of multiple-dry-day events per year)

Panel A: Consecutive dry day events (number of multiple-dry-day events per year)

Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	29	29	30	30	31
Greater Connecticut River Valley	31	31	32	32	33
Central	32	32	32	33	33
Eastern Inland	32	32	32	33	33
Boston Harbor	31	31	32	32	33
North & South Shores	31	31	32	32	33
Cape, Islands, & South Coast	31	31	32	32	33
Statewide	**31**	**31**	**31**	**32**	**33**
Statewide Percent Change	**0%**	**1%**	**2%**	**4%**	**6%**

Source: Stochastic Weather Generator

Panel B: Annual number of days without rain (days per year)

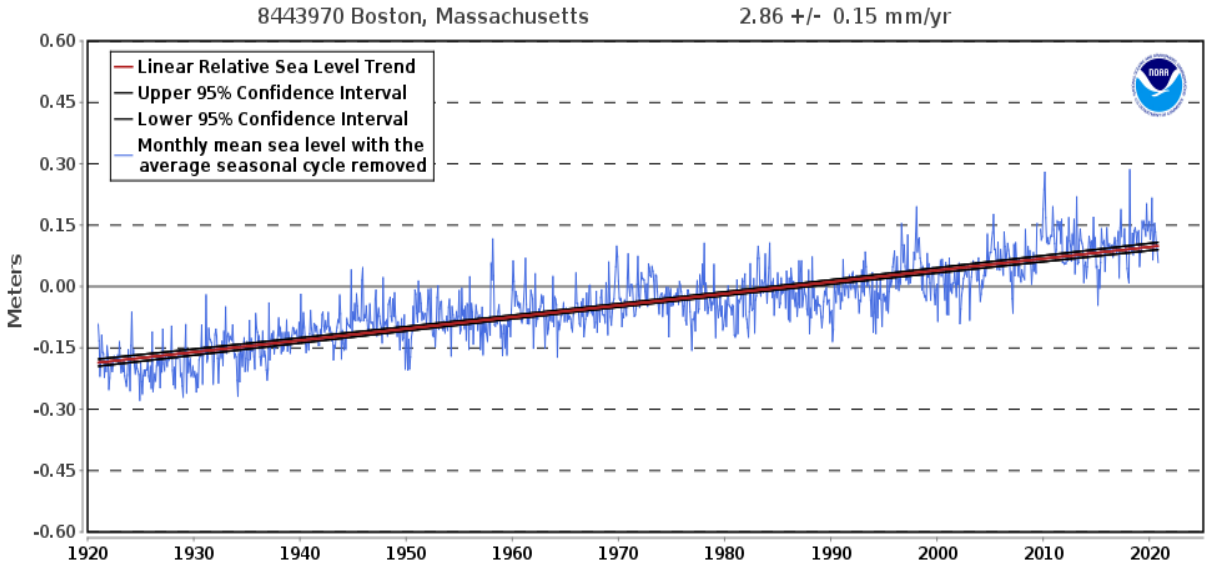
Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	159	161	165	167	170
Greater Connecticut River Valley	171	172	175	178	181
Central	180	182	185	188	192
Eastern Inland	186	181	185	188	193
Boston Harbor	192	185	192	194	198
North & South Shores	184	182	187	190	195
Cape, Islands, & South Coast	186	182	187	191	194
Statewide	**176**	**175**	**179**	**182**	**187**
Statewide Percent Change	**0%**	**-1%**	**2%**	**3%**	**6%**

Source: 2022 MA Climate Change Assessment. The City of Marlborough is located in the Central Region, outlined by the blue box above.

SEA LEVEL RISE

While Marlborough is not a coastal community, high-level information on sea level rise is discussed here as the regional economy of the Boston Metro area may be impacted by sea level rise in the future. Warming temperatures contribute to sea level rise in three ways. First, warm water expands to take up more space. Second, rising temperatures are melting land-based ice which enters the oceans as melt water. A third, quite minor, contributor to sea level rise in New England is not related to climate change. New England is still experiencing a small amount of land subsidence (drop in elevation) in response to the last glacial period. NOAA's records from the Boston Tide Station show nearly one foot of sea level rise over the past century. See Figure 9 below for more information.

Figure 9: Observed Increase in Sea Level Rise



Source: NOAA

The sea level rise information in Massachusetts' 2022 Climate Change Assessment considers sea-level changes, land-level changes, and other regional facts that can impact the rate of change. The report includes the following approximate sea level rise projections for the State:

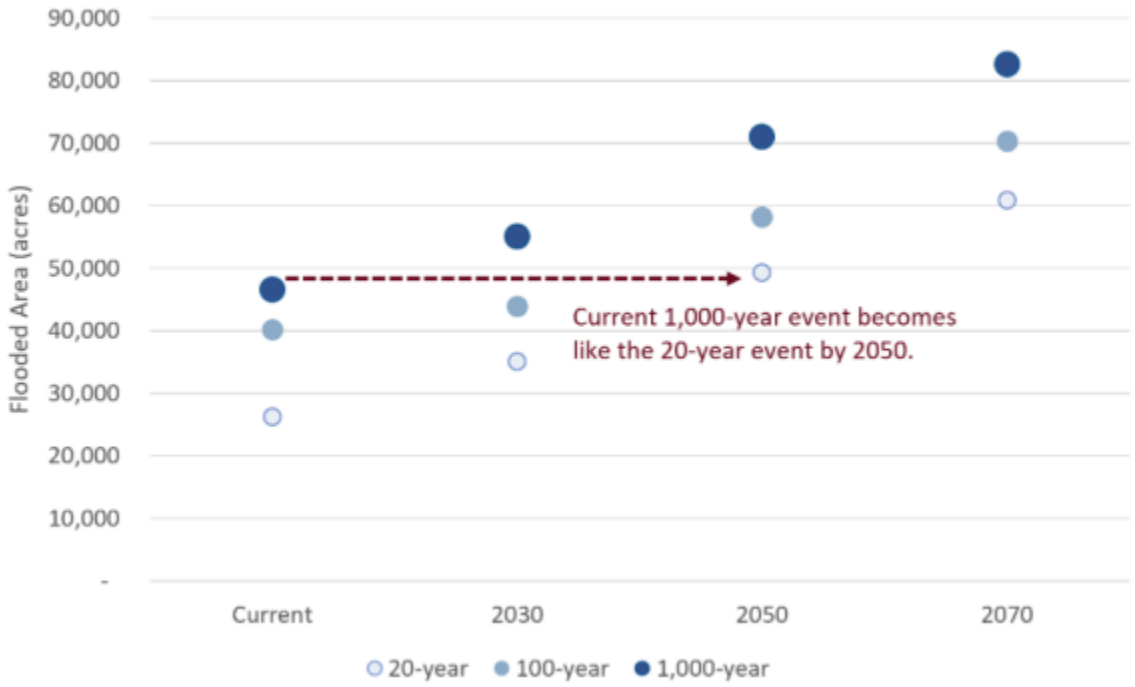
- **Northern Massachusetts:** 21 inches by 2050, and 43 inches by 2070
- **Southern Massachusetts:** 23 inches by 2050 and 45 inches by 2070

The 2022 Climate Change Assessment also quantified the developed land area flooded for events including:

- the 20-year (5% annual probability)
- 100-year (1% probability)
- 1000-year (0.1% probability) events

This approach found that the area flooded by the current 1000-year event is comparable to the area of a 20-year event by 2050. Even more area could be impacted by the annual probability event by 2070. See Figure 10 below for more information.

Figure 10: Total Flooded Area of the Commonwealth for Selected Events



Source: 2022 MA Climate Change Assessment

Following the outline of the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes. The table below, which is originally from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

Table 6: Climate Change & Natural Hazards

Primary Climate Change Interaction	Natural Hazard	Other Climate Change Interactions	Representative Climate Change Impacts
 **Changes in Precipitation**	Inland Flooding	Extreme Weather	Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, increased potential for loss of life, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetland
	Drought	Rising Temperatures, Extreme Weather	
	Landslide	Rising Temperatures, Extreme Weather	
 **Sea Level Rise**	Coastal Flooding	Extreme Weather	Increase in tidal and coastal floods, storm surge, coastal erosion, marsh migration, inundation of coastal and marine ecosystems, loss of wetlands
	Coastal Erosion	Extreme Precipitation	
	Tsunami	Rising Temperatures	
 **Rising Temperatures**	Average/Extreme Temperatures	N/A	Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, increase in vector-borne illnesses (West Nile, Zika, EEE), ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, increased potential for loss of life, drying of streams and wetlands, eutrophication of lakes and ponds
	Wildfires	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
 **Extreme Weather**	Hurricanes/Tropical Storms	Rising Temperatures, Changes in Precipitation	Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life
	Severe Winter Storm / Nor'easter		
	Tornadoes		
	Other Severe Weather (Strong Wind & Thunderstorms)		

OVERVIEW OF HAZARDS AND IMPACTS

The 2018 SHMCAP and the 2013 Massachusetts State Hazard Mitigation Plan are two key planning documents that examine natural hazards that have the potential to impact the Commonwealth. The 2013 State HMP set the stage by defining considerations such as frequency and severity and summarizing the frequency and severity of hazards of greatest concern. The 2018 SHMCAP used similar definitions for hazard considerations and expanded on this research by including additional climate projections. Because the 2013 State HMP includes definitions that were not specified in the 2018 SHMCAP, both resources are referred to in this report.

Frequency: The frequency designations used for Marlborough were based on the 2018 State Hazard Mitigation and Climate Action plan supplemented with NOAA's county-level storm event data, local information from the Hazard Mitigation Team, and HAZUS results, as well as the 2013 State HMP definitions, which define frequency categories as:

- **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%-2% per year).
- **Medium:** Events that occur from once in five years, to once in 50 years (2%-20% per year).
- **High:** Events that occur more frequently than once in five years (Greater than 20% per year)

Severity: The 2018 SHMCAP defines severity as, "the extent or magnitude of a hazard, as measured against an established indicator (e.g., Richter Scale, Saffir-Simpson Hurricane Scale, or Regional Snowfall Index)." The severity designations used for Marlborough were based on NOAA's county-level storm event data, local information from the Hazard Mitigation Team, HAZUS result, and the 2013 State HMP definitions, which define severity categories as:

- **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

The Table 6 below summarizes the frequency and severity of hazard risks for Massachusetts and Marlborough, based on available data, including:

- **State-level data** including the 2022 Climate Change Assessment, 2018 SHMCAP, and 2013 State HMP)
- **County-level data** from NOAA's National Climatic Data Center and Storm Events Database for Middlesex County (where Marlborough is located)
- **Local-level information** including input from the Local Team, the hazard mapping included in Appendix A, and the HAZUS results in Tables 36-38.

Table 7: Hazards Risk Summary

Natural Hazard	Frequency		Severity	
	MA	Marlborough	MA	Marlborough
Inland Flooding	High	High	Serious to Catastrophic	Serious
Drought	Medium	Medium	Minor to Serious	Minor to Serious
Landslide	High	Very Low	Minor to Extensive	Minor
Coastal Flooding	High	N/A	Serious to Extensive	N/A
Coastal Erosion	Variable	N/A	Serious to Extensive	N/A
Tsunami	Very Low	N/A	Extensive to Catastrophic	N/A
Extreme Temperatures	High	High	Minor to Serious	Minor
Wildfires/Brushfire	High	Medium	Minor to Extensive	Minor to Serious
Invasive Species	High	High	Minor	Minor
Hurricanes/Tropical Storms	Medium	Medium	Serious to Catastrophic	Minor to Serious
Severe Winter Storm / Nor'easter	High	High	Minor to Extensive	Minor
Tornadoes	High	Very Low	Serious to Extensive	Serious
Other Severe Weather (Strong Wind & Thunderstorms)	High	High	Minor to Extensive	Minor
Earthquakes	Very Low	Very Low	Serious to Catastrophic	Serious to Catastrophic

Sources: Frequency information for MA comes from the 2018 SHMCAP. Severity information for MA comes from the 2013 State HMP. Frequency and severity information for Marlborough come from NOAA's county-level data, local information from the Hazard Mitigation Team, and HAZUSs results.

Not all hazards included in the 2018 SHMCAP apply to the City. Given Marlborough's inland location, the City is not impacted by coastal hazards and tsunamis and therefore these are listed as Not Applicable ("N/A") in the table above.

Ice jams are also not a hazard in Marlborough. The US Army Corps Ice Jam Database shows no record of ice jams in Marlborough, and the City did not identify ice jams as an issue of concern.

Given the City's location in an area of low landslide incidence (Map 6 in Appendix A), and designated in the table above as the lowest category of frequency (very low) and the lowest category of severity (minor), as well as the lack of previous documented landslide events, the City did not identify landslides as a hazard of concern that warrants mitigation measures.

CLIMATE TRENDS: CHANGES IN PRECIPITATION

FLOODING HAZARDS

OVERVIEW OF WATERSHED RESOURCES

Flooding is generally caused by severe rainstorms, thunderstorms, hurricanes, and nor'easters. Large rainstorms can occur year-round. Hurricanes are most common in the summer and early fall. Nor'easters are most common in winter. Spring snowmelt may exacerbate flooding during storm events. Large rainstorms can occur year-round. Climate change has the potential to exacerbate these issues over time due to increasing extreme rainfall events. Increase in average annual rainfall may also lead to more incidents of basement flooding caused by high seasonal groundwater levels.

Flooding is one of the most prevalent natural hazards in Marlborough. Flooding can be associated with overflowing rivers and streams, as well as stormwater associated with impervious surfaces which overwhelm the capacity of natural or structured drainage systems and stormwater infrastructure.

Marlborough is located in the Assabet and Sudbury River watersheds, which flow together downstream to form the Concord River, a tributary of the Merrimack River at Lowell, MA.. The western part of Marlborough is in the Assabet River watershed and the eastern part of the City is in the Sudbury. The city is divided into six major watersheds, which include Lake Williams and Millham Reservoir watershed; Sudbury Reservoir watershed and Wachusett open channel; Ft. Meadow Reservoir watershed and Ft. Meadow Brook; and the Hop Brook watershed. The Millham, Ft. Meadow Reservoirs and Hop Brook systems drain north and are all part of the Assabet River watershed, whereas the remaining watersheds drain south and east into the Sudbury River watershed.

Marlborough is fortunate to have no less than five large surface water impoundments within its limits, all serve distinct and different primary functions as well as provide secondary recreational and open space benefits.

Millham Reservoir and Lake Williams, totaling 150 acres, until recently served as the city's principal drinking water supplies. The City now obtains all of its water supply from the Massachusetts Water Resources Authority, and retains these reservoirs as emergency backup water sources. Fort Meadow Reservoir, which covers 290 acres, is the city's only active recreational water body, providing swimming, boating and fishing opportunities. A portion of the Department of Conservation Recreation Sudbury Reservoir extends into Marlborough on the southeast corner and serves as a backup drinking water supply for the MWRA's regional water supply for the greater Boston region. Hager Pond, located on the east side of the community, is a privately owned body of water covering 24 acres and is the backdrop for the historic Wayside Inn.

Other important water resources are the city's many rivers and streams, including twelve main streams. The largest of these is the Assabet River, which flows through the northeast portion of the city. This river has long been a favorite of local canoeists and fishermen, both upstream and downstream of the flood control facility known as Tyler Dam. Two boat access points along the river below the Tyler Dam at Robin Hill St. and on Donald Lynch Blvd. are now in use.

FEMA flood map information has been incorporated into the city's Floodplain and Wetland Protection District ordinance map. The high flood hazard areas lie along the major tributaries. Along many of the significant streams is a 50' or 30' set back requirement has been instituted through this zoning ordinance to eliminate building close to streams that have flooding potential. The FEMA maps are now available on line through FEMA's website and the City of Marlborough Public Works website.

Marlborough has many small wetlands and several large areas of wetlands including 200 acres Crane Meadow, 86 acres Flagg Swamp, 40 acres Howe Pond, the South Street swamp more than 50 acres and large parcels of land abutting the Sudbury Reservoir off Farm Road and Broadmeadow Road.

Wetlands are important resources to the community wildlife. Wetlands have long been recognized as resources, which help attenuate storm water flows and improve water quality. The city's Conservation Commission through the state's Wetland Protection Act manages protection and preservation of these areas.

Beginning in 1974, the city took steps to protect its surface water supplies by acquiring over 200 acres of land abutting Millham Reservoir. This land was originally acquired for expansion of the reservoir itself; however, the cost to develop it for this purpose was later judged to outweigh the benefit of a very marginal estimated increase in supply. The land has remained undeveloped in order to protect the reservoir's watershed.

In 1992, the city acquired 122 acres of land immediately adjacent to Millham Reservoir when it purchased a portion of the property owned by Hillside School. Public access on this land is also not permitted due to state and federal water supply regulations.

In 1997, the City Council passed the Water Supply Protection District Ordinance that limits and controls development within the watersheds of Lake Williams and Millham Reservoir

by prohibiting and/or limiting certain uses of these properties. It also requires 50-foot non-developable buffer zones along wetlands, streams and rivers within the watershed.

Along the northern border, the Town of Hudson has two drinking water wells. The protected areas around these wells extend into the city limits. Any development in these areas should honor the protection of these water sources and consultation from the Town of Hudson should be solicited.

REGIONALLY SIGNIFICANT FLOODS

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events have included those listed below (Commonwealth of Massachusetts, 2018) and (NOAA, 2022).

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- February 2013
- January 2018
- March 2018
- June 2020

The best available data on previous occurrences of flooding is available through NOAA's National Centers for Environmental Information Storm Events Database. Middlesex County, which includes the City of Marlborough, experienced 54 flood events from March 2010 to December 2022 (Table 8). No deaths or injuries were reported and the total reported property damage in the county was $42.06 million. See the table below for more information.

Table 8: Middlesex County Flood Events, 2010-2022

Date	Deaths	Injuries	Property Damage ($)
3/14/2010	0	0	26,430,000
3/29/2010	0	0	8,810,000
4/1/2010	0	0	0
8/28/2011	0	0	5,000
10/14/2011	0	0	0
6/8/2012	0	0	0
6/23/2012	0	0	15,000
7/18/2012	0	0	5,000
10/29/2012	0	0	0
6/7/2013	0	0	0
7/1/2013	0	0	0
7/23/2013	0	0	0

Date	Deaths	Injuries	Property Damage ($)
9/1/2013	0	0	10,000
3/30/2014	0	0	35,000
7/27/2014	0	0	0
8/31/2014	0	0	0
10/22/2014	0	0	20,000
10/23/2014	0	0	0
12/9/2014	0	0	5,000
12/9/2014	0	0	30,000
5/31/2015	0	0	0
8/4/2015	0	0	0
8/15/2015	0	0	125,000
9/30/2015	0	0	0
4/6/2017	0	0	0
6/27/2017	0	0	1,000
7/12/2017	0	0	1,000,000
7/18/17	0	0	0
8/2/2017	0	0	5,000
10/25/17	0	0	0
10/30/2017	0	0	0
1/12/2018	0	0	0
1/13/2018	0	0	0
4/16/2018	0	0	0
6/25/2018	0	0	15,000
8/8/2018	0	0	35,000
8/12/2018	0	0	30,000
8/17/2018	0	0	0
10/29/2018	0	0	0
11/3/2018	0	0	0
11/10/2018	0	0	0
7/6/2019	0	0	0
8/07/19	0	0	0
9/2/2019	0	0	300
6/21/20	0	0	0
6/28/20	0	0	5,000
7/23/20	0	0	0
9/10/20	0	0	3,000
7/9/21	0	0	0
9/2/21	0	0	0
11/12/21	0	0	10,000

Date	Deaths	Injuries	Property Damage ($)
8/5/22	0	0	0
8/7/22	0	0	0
9/5/22	0	0	0
Total	**0**	**0**	**$42.06 M**

Source: NOAA, National Centers for Environmental Information

Additionally, Marlborough experienced a flash flood event on September 18, 2018. The report from NCEI states: Post-Tropical Cyclone Florence moved up the East Coast, bringing heavy downpours and damaging thunderstorms to Massachusetts during September 18th. Storm total rainfall amounts reached two to five inches and went as high as seven inches in parts of Worcester County. At 9:53 AM EST, a car was trapped in floodwater on Farm Road near Clarke Drive in Marlborough.

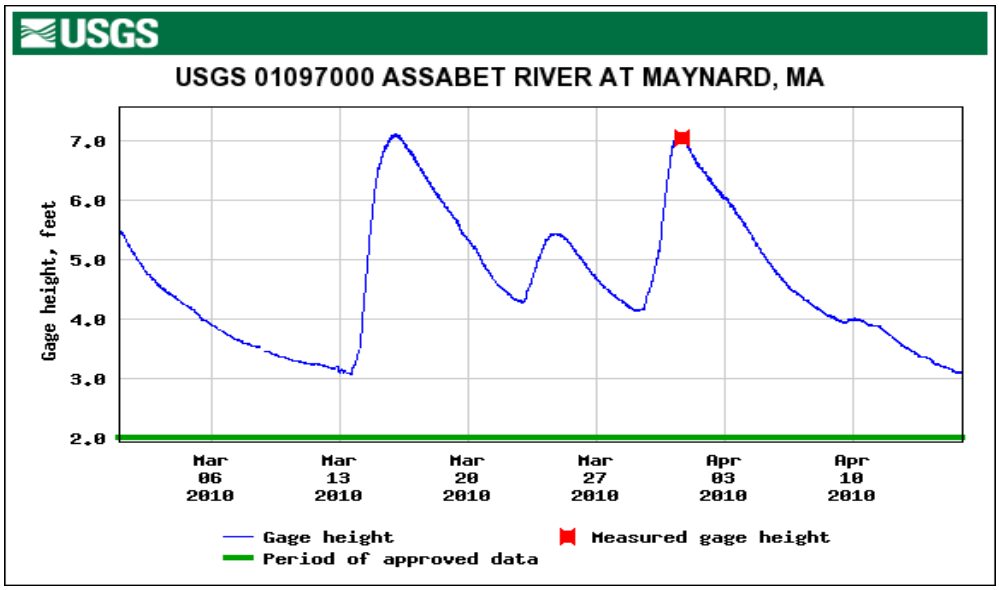
SEVERE PRECIPITATION

The most severe recent flooding occurred during the major storms of March 2010, when a total of 17.7 inches of rainfall was recorded by the Blue Hills Observatory from three storms over 19 days from March 13 to 31. accumulation was officially recorded by the National Weather Service (NWS). The weather pattern that caused these floods consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record. The March 2010 rainstorms fit the profile of a type of severe precipitation event expected to increase in frequency as the climate warms. That is, significant precipitation, falling in late winter as rain rather than snow, on frozen ground, and while vegetation is still dormant.

One indication of the extent of flooding is the level of flow in the Assabet River during this record flood. Based on USGS gage height data, Figure 11 shows that the Assabet River at Maynard, the closest USGS gage to Marlborough, exceeded 7 feet after the first storm on March 15, and again after the storm on March 31. Normal gage height at this time of year is about 4 feet. The cumulative impact of multiple storms kept levels high into April.

Damages from flooding from 20210 to 2022 in Middlesex County totaled $42.5 million. It is notable that $35.2 million of that was due to the March 2010 storms. Those storms were a federally declared disaster, making federal assistance available to residents who did not carry flood insurance. The HAZUS analysis estimates damages in Marlborough from a 100-year flood at $23.3 million and $28.4 from a 500-year flood.

Figure11: Assabet River Gage Height, March 2010 Floods



Source: USGS Water Information System

POTENTIAL FLOOD HAZARD AREAS

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix A and their definitions are listed below. Mapped flood plains are located along the Assabet River, the Sudbury Reservoir, and Fort Meadow Lake.

Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance) - Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-A30 (1% annual chance) **-** Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zones X500 (0.2% annual chance) **-** Zone X500 is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Zone VE (1% annual chance) **-** Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

In addition, information on areas subject to flooding was provided by local officials. The Locally Identified Areas of Flooding described below were identified by City staff as areas where flooding is known to occur. All of these areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Local Hazard Areas."

Table 9: Locally Identified Flooding Areas

Map	Location	Description
3	Culvert at Ripley and McGee Avenues	Drainage at intersection is undersized and needs to be replaced (handles drainage from Lake Williams/495 Industrial Park).
4	Glen Brook Neighborhood	Millham Brook: outlet culvert into downstream wetland from brook backs up and floods Glen Brook neighborhood in large rainstorms. Marlborough DPW did some upgrades; still need to address inlet configuration which takes a 90 degree turn; and leave linear section and swale as is.
5	Mowry Brook at Brook Village	Culverts from East Main Street to Curtis Avenue need to be enlarged as brook floods apartments. See also Mowry Brook under Cook Lane (25) and Phelps Street (26).
10	Culvert at Maple Street (Route 85) and Framingham Road	Flooding- culvert backs up during heavy rains
12	Bigelow Street	Need to upgrade culvert
16	Causeway Street,	Flooding due to beavers. Culvert failed; replacement needed (36-inch)
21	Granger Boulevard & Florence	Undersized drainage facilities
22	Stevens Street & Western View	flooding; upstream detention (some private land)
25	Mowry Brook under Cook Lane	Flooding at culvert
26	Mowry Brook at Phelps Street	Culvert flooding

Source: Marlborough Local Hazard Mitigation Team

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see http://www.fema.gov/business/nfip/replps.shtm. There are no repetitive loss structures in the City of Marlborough.

Based on the record of previous occurrences flooding events in Marlborough are a High frequency event. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

Flooding and Climate Change

Data from the 2022 MA Climate Change Assessment related to changes in precipitation patterns is included in an earlier section of this chapter. Those projections suggest that future rain events will be increasingly intense and lengthy, which could lead to increased inland and stormwater flooding.

Precipitation frequency estimates, which are used to derive stormwater design standards, were published in 1961 by the U.S. Commerce Department in a document known as TP-40 (Technical Paper 40). The 10-year, 24-hour storm for eastern Massachusetts was calculated as a 4.5-inch event. Recently the National Oceanic and Atmospheric Administration published updated estimates (NOAA Atlas 14), which increased this design storm by 0.6 inches to 5.14 inches for eastern Massachusetts. Communities should consider future rainfall rates when designing infrastructure. For example, communities could consider using NOAA Atlas 14 rainfall rates with an additional allowance to account for projected rainfall during the life of projects permitted today when sizing stormwater infrastructure. DEP takes a similar approach to describe current (not future) rainfall rates, called "NOAA14+". Mystic River Watershed Association (MyRWA) communities propose "NOAA14++", which they say reflects 2070 projections. The NOAA 14+ number is calculated by multiplying the NOAA 14 precipitation frequency estimate upper confidence interval by 0.9 (i.e., current but extreme precipitation events reflect 90% of upper confidence intervals). The NOAA 14++ number is the upper confidence interval. A comparison of these numbers is summarized in the table below (NOAA, 2023).

Table 10: Rainfall rates for the 10-year 24-hour storm

NOAA 14	NOAA 14+	NOAA 14++
5.27 inches	5.90 **inches**	6.56 **inches**

The 2022 MA Climate Change Assessment also highlights the following climate impacts for the Eastern Inland Region (where Marlborough is located), related to flooding:

- By 2050, the 1 percent annual chance river flood could be two times more likely to occur
- By 2090, the historical 10 percent annual chance daily rainfall event (2.8 to 4 inches) could occur four times more frequently
- Damage could occur to inland buildings from heavy rainfall and overwhelmed drainage systems
- Damage could occur to transit service due to flooding
- There could be a reduction in the availability of affordably priced housing from direct damage including from flooding (Commonwealth of Massachusetts, 2022)

DAM HAZARDS

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters.

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. Since 1984, three dams have failed in or very near to Massachusetts, one of which resulted in a death. There have been no recorded dam breaches in Marlborough.

The increasing intensity of precipitation is the primary climate concern related to dams, as they were designed based on historic weather patterns. The 2018 SHMCAP indicates that changing precipitation patterns may increase the likelihood of overflow events.

According to data provided by the Massachusetts Department of Conservation and Recreation (DCR) and the City, there are 11 dams located in Marlborough, shown in Table 11. These are summarized in Table 6. The City of Marlborough owns three of the Dams: Ft. Meadow Brook Dam, Millham Reservoir Dam, and Lake Williams Dam, the latter two being part of the City's water supply system. Five dams are owned by the state Department of Conservation and Recreation (DRC), and three are privately owned.

In addition to the dams in Marlborough, there are three dams in neighboring communities that include Marlborough in their Emergency Action Plans due to areas downstream in the City of Marlborough. These include the Lester G. Ross Floodwater Retarding Dam in Berlin and the Hop Brook Dam and Cold Harbor Brook Dam in Northborough.

Table 11: Inventory of Dams in Marlborough

DAM NAME	RIVER	IMPPOUNDMENT	OWNER	TYPE	HAZARD
Fort Meadow Dam	Assabet River	Fort Meadow Reservoir	Marlborough, Dept of Public Works	Municipality	High
Millham Reservoir Dam	Millham Brook	Millham Reservoir	Marlborough, Dept of Public Works	Municipality	Significant
Williams Lake Dam	Assabet River	Williams Lake	Marlborough, Dept of Public Works	Municipality	High
Hager Pond	Hop Brook	Hager Pond	Unknown	Private	High
Barefoot Brook Dam	Barefoot Brook	Barefoot Brook	Dept. Conservation & Recreation	State-DCR	Significant
Tyler Dam	Assabet River	Assabet River	Dept. Conservation & Recreation	State-DCR	High
Mfga Dam	Tributary of Assabet R.	Fish And Game Pond	Not Available-small Unregulated dam	Private	N/A
Water Quality Pond #1	Tributary of Assabet R.	Water Quality Pond #1	Not Available-small Unregulated dam	Private	N/A
Beebe Pond Dam	Angelica Brook	Beebe Pond	Dept. Conservation & Recreation	State-DCR	N/A

Hultman Intake Dam		Wachusett Aqueduct	Dept. Conservation & Recreation	State-DCR	N/A
Sudbury Res. Tributary Dam	Sudbury Res. Tributary		Dept. Conservation & Recreation	State-DCR	N/A

Source: MA DCR, Office of Dam Safety, 2018

DCR classified dams according to their potential hazard. It's important to note that this is Based on the potential damage that could be caused by a breach of the dam based on Its location and areas downstream that could be impacted, not on the condition of the dam or its likelihood to fail. The DCR defines hazard potential levels as follows:

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

Major dams in Marlborough are described below (numbers refer to location on map in Appendix A):

- **Tyler Dam** (2): This dam is owned by the Department of Conservation and Recreation and is classified as a high hazard dam due to expected elevated impacts if a breach were to occur. The dam is 38.5 feet high and normally impounds 650 acre-feet of water, with a maximum impoundment of 2,060 acre-feet of water.

- **Hager Pond Dam** (6): This is a privately owned dam, but the owner is not known. The dam is 14 feet high and has a normal impoundment of 144 acre-feet and a maximum impoundment of 400 acre-feet. Last inspected in 1998, the dam is classified as being in poor condition.

- **Fort Meadow Dam and Spillway** (7): City-owned, the Fort Meadow Dam is located in the Assabet River watershed. Flagg Brook and two smaller, unnamed brooks flow into the tree basins that make up the Fort Meadow Reservoir along with 24 street drain inlets at various locations surrounding the reservoir. The dam consists of an earthen embankment approximately 325 feet long and 30 feet high at the eastern end of the reservoir. A public beach and bathhouse are located on the crest of the embankment. The spillway to the reservoir is located 1,000 feet north of the dam in the Town of Hudson, on land owned by the City of Marlborough. The Fort Meadow Reservoir has maximum structural height of approximately 30 feet and a maximum storage capacity of 4,800 acre-feet.

- **Lake Williams Dam and Spillway** (8): The Lake Williams Dam, owned by the MA Department of Conservation and Recreation, was originally constructed around 1882 across a shallow valley at the outlet of a naturally formed lake and consists

of an earthen embankment, a concrete/mortared stone spillway, and a low level outlet. The maximum height of the embankment is approximately eleven (11) feet, and the length of the dam is approximately 270 feet. The upstream face of the dam's embankment is a 3H: 1V slope and the downstream face is a vertical rubble masonry wall. The dam has a maximum structural height of approximately 11 feet and a maximum storage capacity of 500 acre-feet.

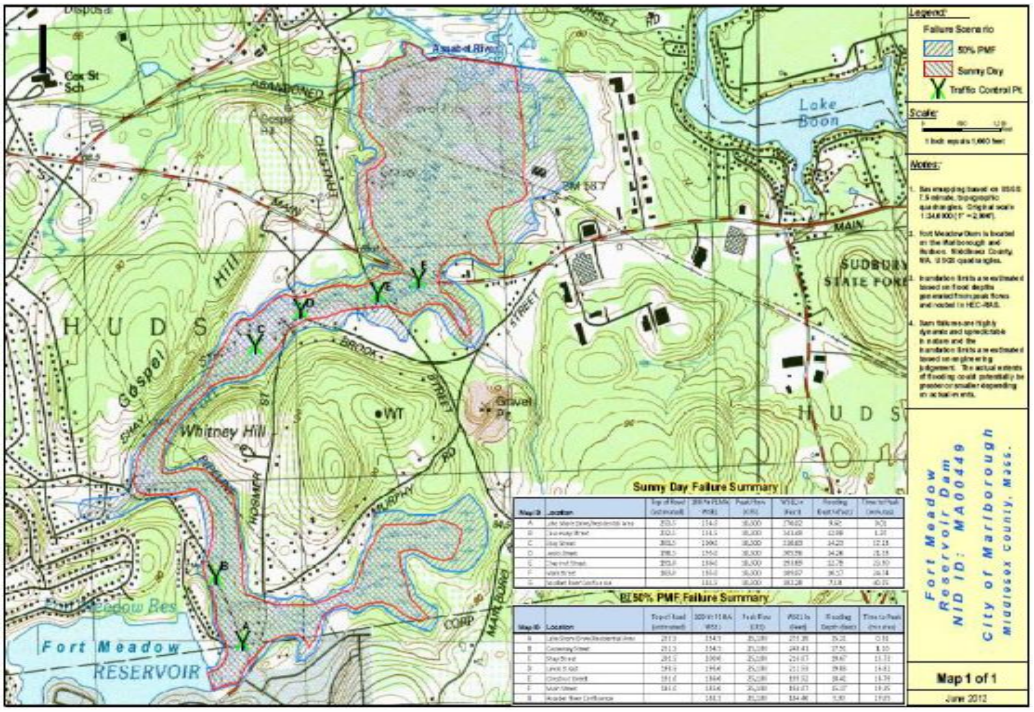
The City of Marlborough has completed Emergency Action Plans (EAP) for the Fort Meadow Dam, Williams Lake Dam, and Tyler Dam, and DCR prepared an EAP for the Hagar Pond Dam, which is privately owned with the owner not known. The town of Berlin prepared an EAP for the Lester G. Ross Floodwater Retarding Dam and the town of Northborough has EAP's for the Hop Brook Dam and Cold Harbor Brook Dam. A summary of key findings of the Emergency Action Plans for the dams in Marlborough follows.

Fort Meadow Dam and Spillway EAP

Two dam failure cases were analyzed in the EAP, including failures on a sunny day and a wet weather day (50% probable maximum precipitation). The "trigger" failure point for the wet weather case was the maximum water surface elevation achieved during the 50% PMF routing. This was used to estimate the maximum peak flow for the wet weather breach because it would represent the "worst case" scenario. The EAP estimates the peak outflow from a sunny day dam failure at 10,500 cubic feet per second (cfs), and 25,700 cfs for dam failure on a wet weather day.

Figure 12 from the EAP shows the potential areas of inundation under dam failure scenarios for a sunny day and for the 50% probable maximum precipitation.

Figure 12: EAP Map of Potential Inundation Areas for Ft. Meadow Dam



Source; Fort Meadow Dam Emergency Action Plan

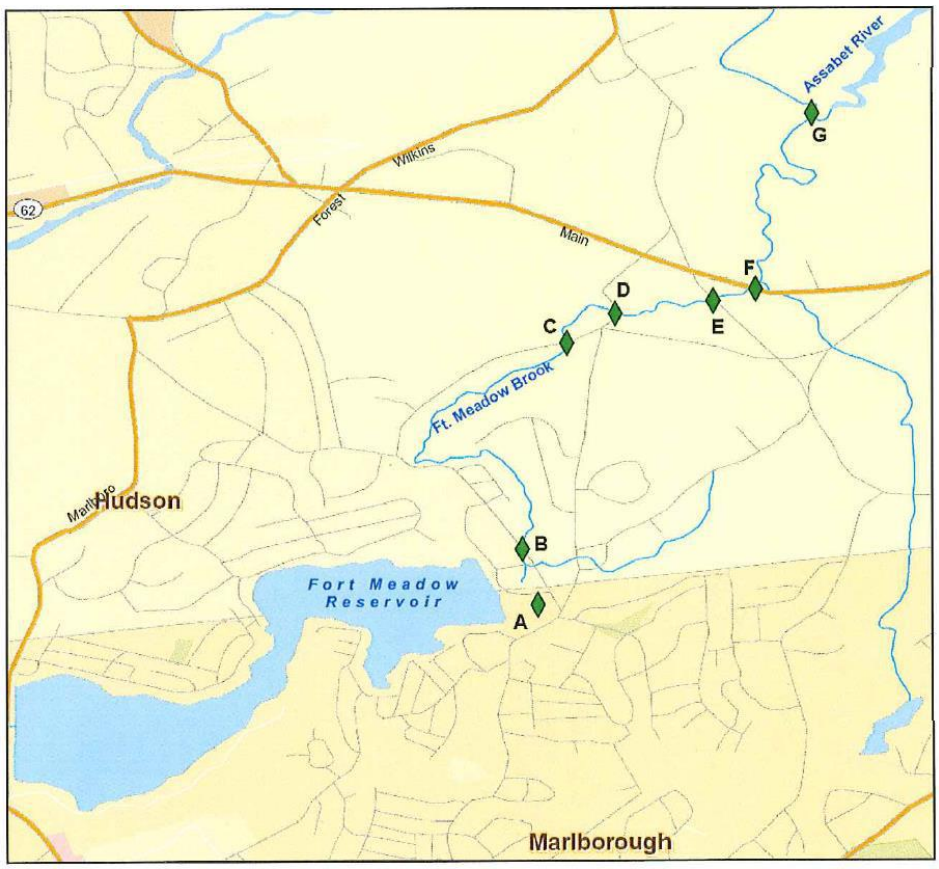
Directly downstream of the dam embankment there are several homes and along with 6 roadway crossings prior to the Confluence of Fort Meadow Brook with the Assabet River. In total, Fort Meadow Brook is approximately 2.5 miles in length from Fort Meadow Reservoir to its confluence with the Assabet River.

The EAP states that it appears that a failure of the dam at maximum pool may cause loss of life and damage to some homes, property and secondary roadways. Failure of the dam would result in the flooding of a municipal parking lot and many homes which reside on Hosmer Street, Lakeshore Drive and Causeway Street with the high potential for loss of life and excessive economic loss.

There are 7 total roadway crossings downstream of the dam along Fort Meadow Brook, including Lakeshore Drive, Causeway Street, Shay Road, Chestnut Street; Main Street, and Lewis Street. These are shown in Figure 13. All of these structures would be overtopped under any dam failure scenario. During an emergency situation closure of these roads is essential for protecting the safety of the public. Motorists attempting to cross flooded roads are at a huge risk to being consumed by the flood wave.

In addition to the streets which cross the Fort Meadow Brook, Hosmer Street in Marlborough and Lower Road off of Causeway Street in Hudson will be inundated by a breach of the Fort Meadow Dam.

Figure 13: Roadway Crossings Downstream of Ft. Meadow Dam



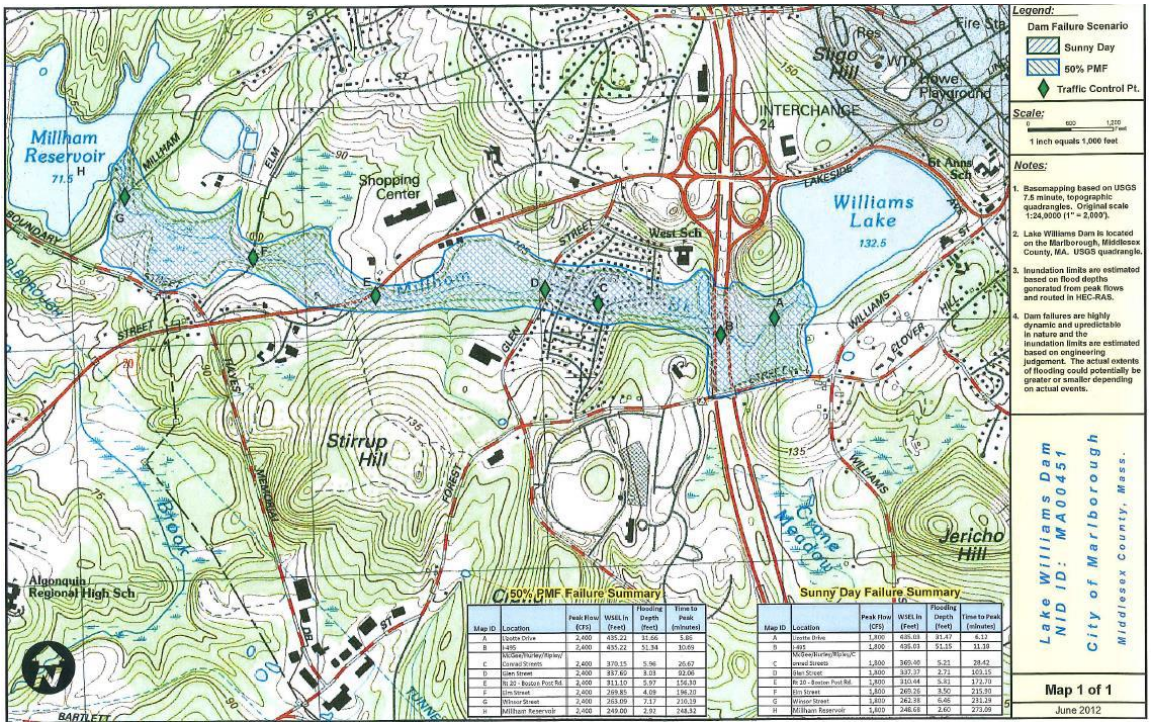
Source; Fort Meadow Dam Emergency Action Plan

Williams Lake Dam EAP

Two dam failure cases were analyzed in the EAP, including failures on a sunny day and a wet weather day (50% probable maximum precipitation). The "trigger" failure point for the wet weather case was the maximum water surface elevation achieved during the 50% PMF routing. This was used to estimate the maximum peak flow for the wet weather breach because it would represent the "worst case" scenario. The EAP estimates the peak outflow from a sunny day dam failure at 1,800 cubic feet per second (cfs), and 2,400 cfs for dam failure on a wet weather day.

Figure 14 from the EAP shows the potential areas of inundation under dam failure scenarios for a sunny day and wet weather day.

Figure 14: EAP Map of Potential Inundation Areas for Lake Williams Dam



Source; Lake Williams Dam Emergency Action Plan

There are several areas for concern along the downstream reach in the event of a dam failure. The first significant feature is the I-495 highway embankment. The highway embankment is approximately 30 feet (northbound lanes) and 60 feet (southbound lanes) above the invert of Millham Brook. A 6' x 8' concrete box culvert, nearly 400 feet in lengths conveys flows beneath the highway. During a dam failure flow would surpass the capacity of the culvert and water would be impounded behind the highway embankment until it was overtopped. The impounded water could spill into a secondary depression, Crane Meadow area, to the south at Forest Street. Southwest of the Forest Meadow/I-495 intersection is a corporate center that could potentially experience minor flooding during a dam failure.

Other areas of concern during a dam failure include a large residential development approximately 0.5 miles downstream of Lake Williams. Millham Brook currently flows through the development in a closed, pipe system. During a dam failure the capacity of these pipes would be exceeded, and the development would experience significant flooding. Prior to emptying into the Millham Reservoir, Millham Brook flows beneath several homes, businesses, and roads. During a dam failure these areas could experience flooding and should be closed to traffic.
The following is a list of the roads which cross the Millham Brook and roads which will be inundated by a dam failure. These locations are shown on Figure 15.

Lizotte Drive
Sandini Road
Ripley Avenue
Boston Post Road West (Rt.20)
Hurley Circle
Applebriar Lane
Burns Road
Elm Street
Conrad Road
Muddy Lane
Glen Street
Millham Street
Tucker Avenue
Flynn Avenue

Boston Post Road West (Rte. 20) would be inundated at the intersection with Ames Street. A hotel, located at 277 Boston Post Road West, and two office buildings, located at 293 and 313 Boston Post Road West, share the same driveway across from Ames Street. In addition to the streets which cross the Millham Brook, Tucker Avenue, Flynn Avenue, and Sandini Road will also be Inundated by a breach of the Lake Williams Dam. The streets do not cross over the Millham Brook, however, the streets are located in the potential flood area.

Figure 15: Roadway Crossings Downstream of Williams Lake Dam

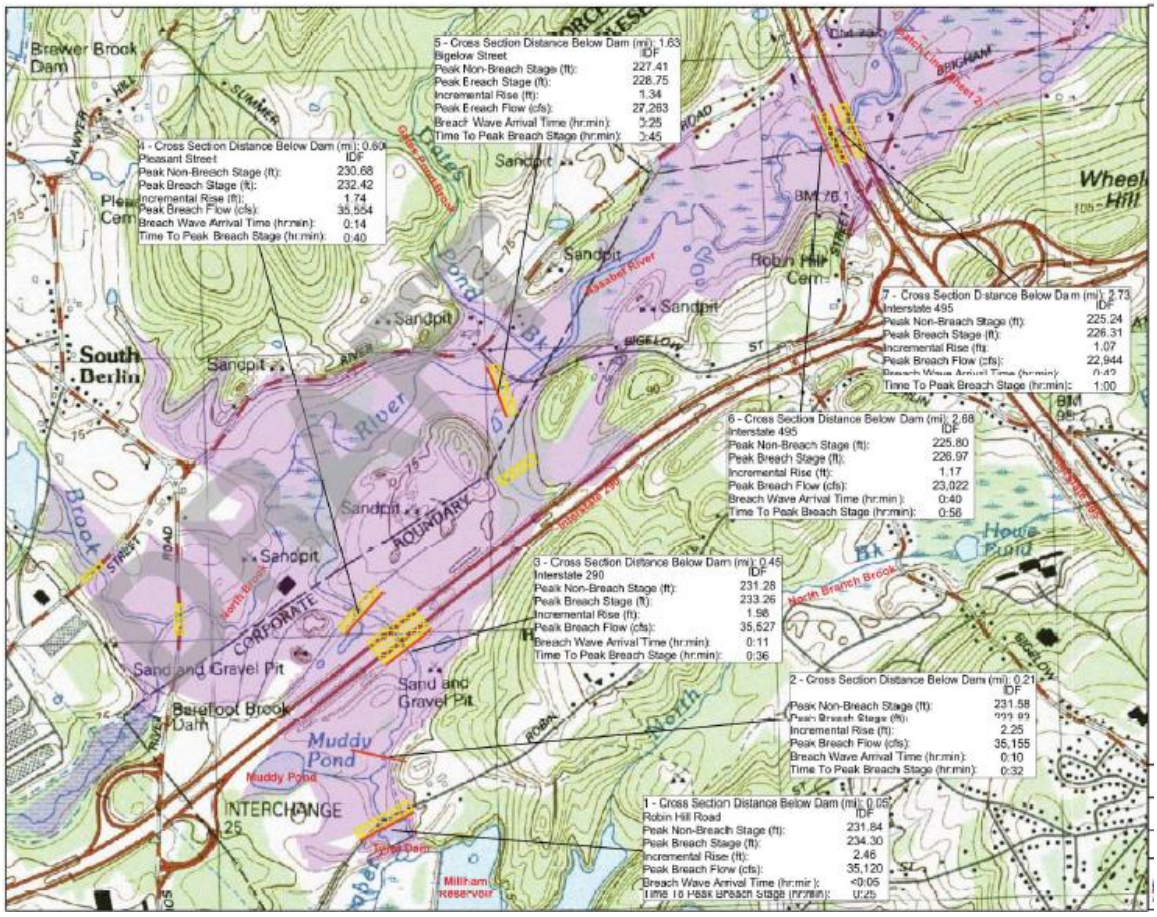
Source; Lake Williams Dam Emergency Action Plan

Tyler Dam EAP

The dam failure analysis for the Tyler Dam did not include a sunny day scenario because there is no impoundment under normal operating conditions; the pond level behind the dam is equal to the tailwater below the dam. Therefore, no flooding would occur downstream of the dam as a result of dam failure under sunny day conditions, and a simulation for this scenario is unnecessary. The analysis is based on the Probable Maximum Flood (PMF) test flood because the dam is of intermediate size and rated a high-hazard structure. The IDF level used for the analysis is 239.4 feet, which is two feet below the crest of the dam. The results of the IDF failure condition indicate a breach peak flow of approximately 36,000 cubic feet per second (cfs). The peak flow for a non-breach scenario is 19,500 cfs.

Figures 16 and 17 from the EAP show the potential areas of inundation in two segments downstream of Tyler Dam.

Figure 16: EAP Map of Potential Inundation Areas for Tyler Dam-Upstream Section



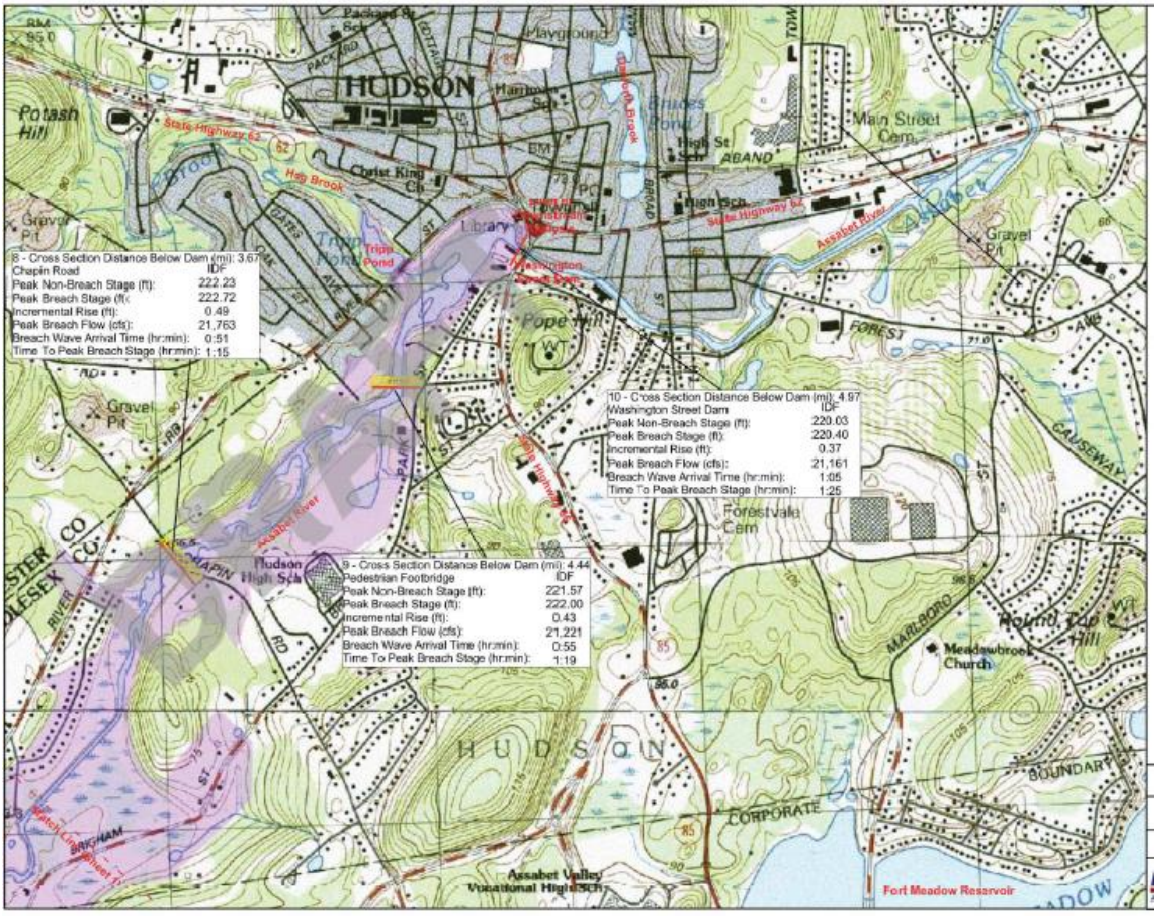
A breach of Tyler Dam is expected to inundate 27 occupied properties and portions of roadways in Marlborough, including commercial/industrial and residential properties, shown on the potential inundation maps. Four critical public facilities have also been identified in the inundation area, including:

- Hillside School, 404 Robin Hill Street
- Crossroads School, 295 Donald Lynch Boulevard
- Solomon Pond Mall, 601 Donald Lynch Boulevard
- New England Sports Center, 121 Donald Lynch Boulevard

The following streets have structures that are located in the inundation area:

- River Road
- Bigelow Street
- North Bigelow Street
- Waterford Drive
- Donald Lynch Boulevard
- Austen Way
- Robin Hill Street

Figure 17: EAP Map of Potential Inundation Areas for Tyler Dam-Downstream Section



Impacts on the Towns of Berlin and Hudson

A breach of Tyler Dam is also expected have downstream impacts on the neighboring towns of Hudson and Berlin.

In Hudson, a breach of Tyler Dam is expected to inundate 119 occupied properties and portions of roadways in Marlborough, including commercial/industrial and residential properties, shown on the potential inundation maps. No critical public facilities are expected to be inundated.

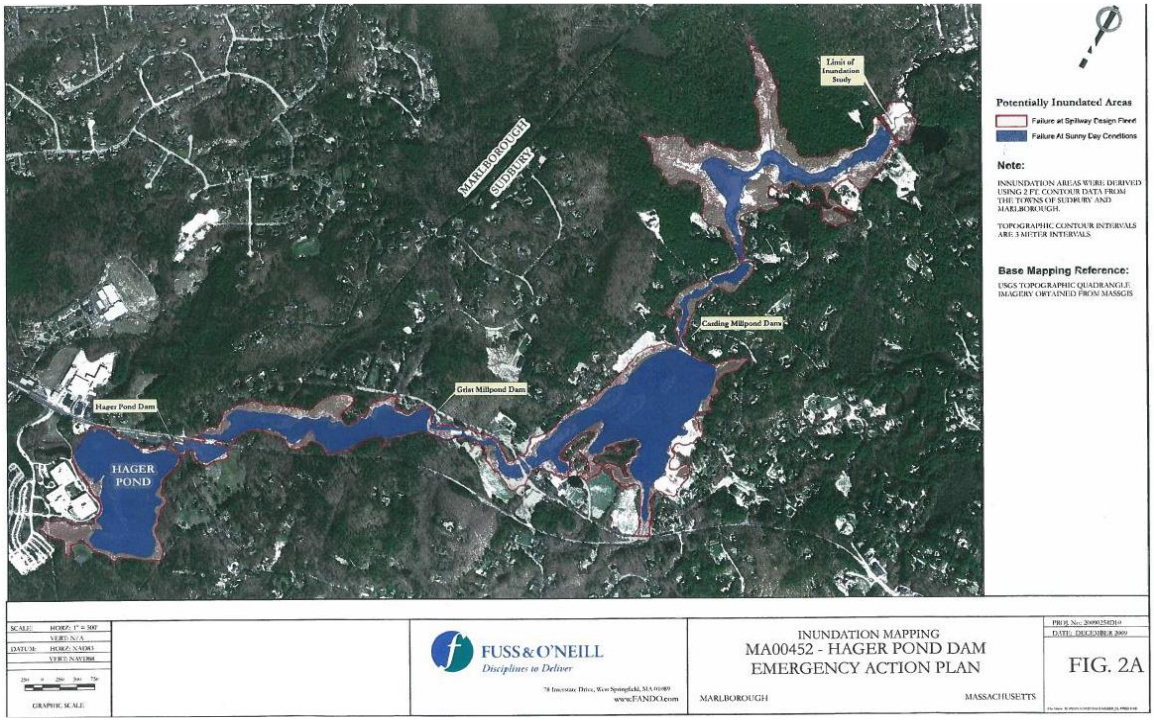
In Berlin, 19 occupied properties and portions of River Road and South Steet are expected to be inundated, including commercial/industrial and residential properties, shown on the potential inundation maps. No critical public facilities are expected to be inundated.

Hager Pond Dam EAP

As the owner of this privately owned dam is unknown, an EAP was prepared by the Massachusetts Department of Conservation and Recreation in 2018. Two dam failure cases were analyzed, a sunny day failure and a wet weather Spillway Design Flood (SDF) failure in which the dam fails during the 50% Probable Maximum Flood (PMF). The EAP estimates the peak outflow from a sunny day dam failure at 427 cubic feet per second (cfs), and 2,630 cfs for dam failure on a wet weather day.

Figure 18 from the EAP shows the potential areas of inundation under dam failure scenarios for a sunny day and wet weather day.

Figure 18: EAP Map of Potential Inundation Areas for Hagar Pond Dam



Failure of Hager Pond Dam will affect downstream residents in both Marlborough and Sudbury. The following are the areas from which residents will need to be evacuated during an emergency situation.

- Hager Street, Marlborough
- Wayside Inn Road, Sudbury
- Pride's Crossing Road, Sudbury
- Dutton Road, Sudbury

The EAP also notes that there are two dams located downstream of the Hagar Pond Dam, the Grist Millpond Dam and the Carding Millpond Dam. A wet weather (50% Probable Maximum Flood) failure of the Hager Pond Dam would cause both of these downstream dams to overtop and potentially fail. The EAP analysis makes the conservative assumption that breaching of these two dams would occur.

The EAP identified several bridges and culverts within the downstream inundation area, including:

- Hager Street Bridge
- Route 20 Bridge
- Wayside Inn Road
- Old Wayside Inn Road
- French Road
- Dutton Street
- Cart Path at Carding Mill Pond

Following a sunny day dam failure, the Hager Street Bridge may fail. All other roads are expected to remain dry. Damage could occur to bridge abutments due to scour from the high flows, which could compromise bridge safety. During a wet weather (Probable Maximum Flood) failure of Hager Pond Dam, all bridges listed above are likely to be overtopped and likely to fail and thus be impassable to any local and emergency response traffic.

Millham Reservoir Dam Inspection/Evaluation Report

The Millham Reservoir Dam does not yet have an Emergency Action Plan, but a detailed Dam Inspection/Evaluation Report was prepared by the City's consultant in 2020.

Currently the dam does not have an emergency action plan (EAP). The Massachusetts Department of Conservation and Recreation (DCR), Office of Dam Safety Guidelines now requires that EAPs be prepared for significant hazard dams. Therefore, and EAP should be prepared for this dam.

The report's findings are summarized below:

The dam is generally in good condition. Minor maintenance deficiencies noted during the inspection and described herein include:

1. Animal burrows were observed on the upstream faces of the dam at the left side. These burrows should be filled in and corrective action be taken to prevent further burrows.
2. The gate valve for the low-level outlet be routinely inspected and exercised to

evaluate its functionality.
3. The low-level riser, outlet pipe and gate should be video inspected.
4. The low-level outlet discharge and clearing of the vegetative and weed growth, if needed.
5. The toe drain manholes should be located and replaced as necessary and the toe drain pipe should be video inspected and cleaned.
6. Mowing and clearing of the downstream and upstream faces of the dam should be continued as a maintenance measure.
7. The damaged piezometer should be repaired.

The report also made the following recommendations:

- An Operations and Maintenance Plan should be developed
- The dam's construction drawings should be located.
- The dam should be inspected every 5 years per the guidelines in 302 CMR 10.00
- An Emergency Action Plan (EAP) should be prepared for this dam.

DAMS IN NEIGHBORING TOWNS

Lester G. Ross Floodwater Retarding Dam EAP, Town of Berlin

The EAP for the Lester G. Ross Floodwater Retarding Dam in the neighboring Town of Berlin identifies areas of Marlborough that would be impacted by a breach of that dam. Only one occupied property in Marlborough is expected to be impacted on North Bigelow Street. No critical public facilities are expected to be inundated.

Hop Brook Dam EAP, Town of Northborough

A breach of the Hop Brook Dam in neighboring Northborough is expected to inundate 17 occupied properties and portions of roadways in Marlborough, including:

- River Road
- Bigelow Street
- North Bigelow Street
- Waterford Drive
- Donald Lynch Boulevard
- Austen Way
- Robin Hill Street
- Boundary Street
- Pleasant Street

The following critical public facilities and gathering places have been identified in the inundation area:

- Hillside School, 404 Robin Hill Street
- Crossroads School, 295 Donald Lynch Boulevard
- Solomon Pond Mall, 601 Donald Lynch Boulevard
- Electricity Regulating Station, Donald Lynch Boulevard

Cold Harbor Stream Dam EAP, Town of Northborough

A breach of the Cold Harbor Brook Dam in neighboring Northborough is expected to inundate 17 occupied properties and portions of roadways in Marlborough, including:

- River Road
- Bigelow Street
- North Bigelow Street
- Waterford Drive
- Donald Lynch Boulevard
- Austen Way
- Robin Hill Street
- Boundary Street
- Pleasant Street

The following critical public facilities and gathering places have been identified in the inundation area:

- Crossroads School, 295 Donald Lynch Boulevard
- Electricity Regulating Station, Donald Lynch Boulevard

Probability of Occurrence

Based on the record of no previous occurrences dam failure in Marlborough this is a Very Low frequency event. This hazard may occur less frequently than once in 100 years (less than 1% chance per year

DROUGHT HAZARDS

Drought is a temporary irregularity in precipitation and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962-65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving moisture (U.S. Geological Survey). This is considered the drought of record in Massachusetts.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3 to 4 inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches. Statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of average.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape Cod, and

Islands. Marlborough is located in the Northeast Region. In Marlborough drought is a potential city-wide hazard.

The Massachusetts Drought Management Plan was revised in 2019 to change the state's classification of droughts by establishing four levels to characterize drought severity beyond normal conditions:

- Level 0-Normal Conditions (no drought)
- Level 1-Mild Drought (formerly Advisory)
- Level 2-Significant Drought (formerly Watch)
- Level 3-Critical Drought (formerly Warning)
- Level 4-Emergency Drought (formerly Emergency)

The Massachusetts drought levels are shown in comparison to the U.S. Drought Monitor levels in Table 12. The two sets of drought indices are similar, but Massachusetts combines the USDM's level D2 and D3 into one category, Critical Droughts.

Table 12: US Drought Monitor Compared to MA Statewide Drought Levels

USDM Names	Recurrence	Percentile Ranges	MA DMP Levels	MA Percentile Ranges	MA DMP Names
D0: Abnormally Dry	once per 3 to 5 years	21 to 30	1	>20 and ≤30%	Mild Drought
D1: Moderate	once per 5 to 10 years	11 to 20	2	>10 and ≤20%	Significant Drought
D2: Severe Drought	once per 10 to 20 years	6 to 10	3	>2 and ≤10%	Critical Drought
D3: Extreme Drought	once per 20 to 50 years	3 to 5			
D4: Exceptional Drought	once per 50 to 100 years	0 to 2	4	≤2%	Emergency

Source: Massachusetts Drought Management Plan, 2019

These levels are based on conditions of natural resources and provide information on the current status of water resources. As dry conditions can have a range of different impacts, a number of drought indices are available to assess these impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of seven regions in Massachusetts. County by county or watershed-specific determinations may also be made. A determination of drought level is based on seven indices:

1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.

4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

Table 13 shows the range of values for each of the indices associated with the drought levels. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for previous drought occurrences.

Determinations regarding the end of a drought or reduction of a drought level focus on precipitation and groundwater levels. These factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture, and forest fire potential.

Table 13: Indices Values Corresponding to Drought Index Severity Levels

Index Severity Level	Standardized Precipitation Index	Streamflow	Lakes and Impoundments	Groundwater	Keetch-Byram Drought Index	Crop Moisture Index
0	>30th percentile				< 200	> -1.0
1	≤30 and >20				200-400	≤-1.0 and > -2.0
2	≤20 and >10				400-600	≤-2.0 and < -3.0
3	≤10 and >2				600-700	≤ -3.0 and > -4.0
4	≤2				700-800	≤-4.0

Source: Massachusetts Drought Management Plan, 2019

The drought levels provide a framework from which to take actions to assess, communicate, and respond to drought conditions. Drought levels are used to coordinate both state agency and local response to drought situations. Water restrictions might be appropriate at the significant drought stage, depending on the capacity of each individual water supply system. A critical drought level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary.

Previous Occurrences

Because drought tends to be a regional natural hazard, the best available date on previous drought occurrences is state-wide data, summarized below.

The Executive Office of Energy and Environment's Drought Management Task Force also provides information on historic drought status for each drought level in Massachusetts. That information is summarized below.

Mild Drought/Advisory	2001, 2002, 2007, 2014, 2016, 2017, 2020, 2021, 2022
Significant Drought/Watch	2002, 2016, 2017, 2020, 2021, 2022
Critical Drought/Warning	2016, 2017, 2020, 2022
Emergency Drought/Emergency	None

A summary of Massachusetts long term historic drought events from 1879 to 2019 is shown in Table 13. This table was prepared for the 2019 Massachusetts Drought Management Plan, so it does not include the more recent droughts of 2020 (Level 3) and 2021(Level 2).

Table 14 - Chronology of major droughts in Massachusetts since 1879

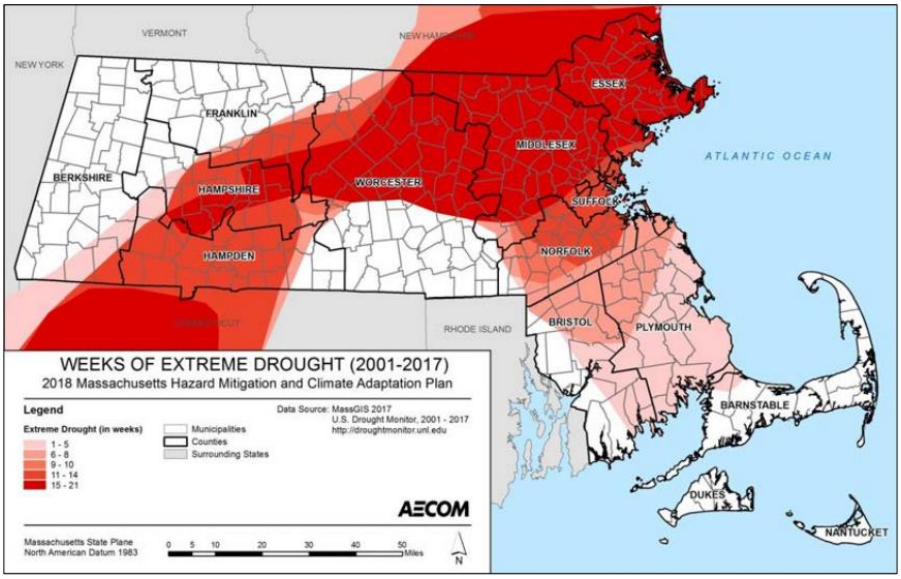
Date	Area affected	Recurrence interval (years)	Remarks	Reference
1879-83	–	–	Kinnison 1931 referenced these periods as two of three worst droughts on record in 1931, the third being the then current drought of 1929-1932.	Kinnison 1931
1908-12	–	–		
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.	USGS 1989
1939-44	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.	USGS 1989
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.	USGS 1989
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.	USGS 1989
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.	USGS 1989
1985-88	Housatonic River Basin	25	Duration and severity as yet unknown. Streamflow showed mixed trends elsewhere.	USGS 1989
1995	–	–	Based on statewide average precipitation	DMP 2013
1998-1999	–	–	Based on statewide average precipitation	DMP 2013
Dec 2001 - Jan 2003	Statewide	–	Level 2 drought (out of 4 levels) was reached statewide for several months	DCR 2017
Oct 2007 - Mar 2008	Statewide except West and Cape & Islands regions	-	Level 1 drought (out of 4 levels)	DCR 2017
Aug 2010 - Nov 2010	Connecticut River Valley, Central and Northeast regions	–	Level 1 drought (out of 4 levels)	DCR 2017
Oct 2014 - Nov 2014	Southeast and Cape & Islands regions	–	Level 1 drought (out of 4 levels)	DCR 2017
Jul 2016 - Apr 2017	Statewide	–	Level 3 drought (out of 4 levels)	DCR 2017

Source: Massachusetts Drought Management Plan, 2019

As shown in Table 19, another measure of drought is the U.S. Drought Monitor, which characterizes droughts as abnormally dry, moderate, severe, extreme, and exceptional.

Extreme drought is characterized by likely crop and pasture losses, water shortages, and water restrictions. As shown in Figure 19, Marlborough experienced between 15 and 21 weeks of severe drought between 2001 and 2017.

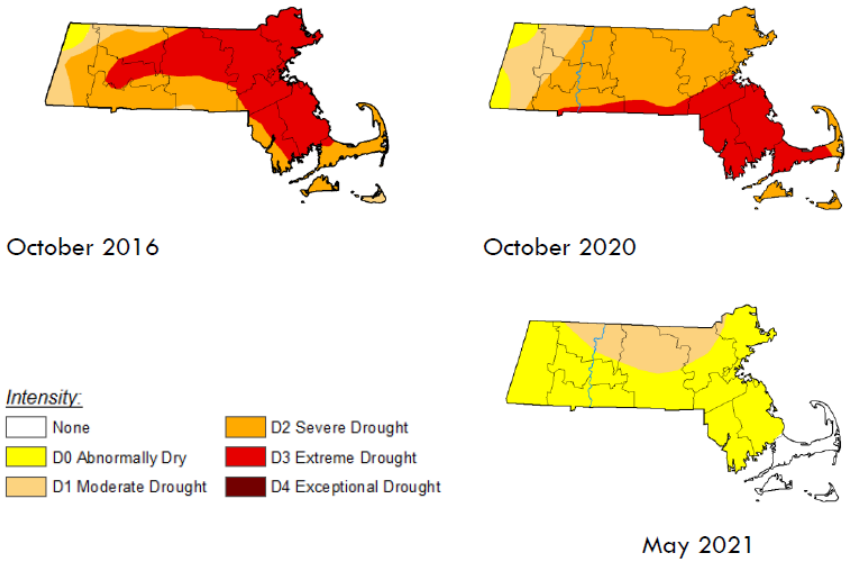
Figure 19: Weeks of Extreme Drought (2001-2017)



Source: SHMCAP 2018

In just the last five years there have been three droughts in Massachusetts. The drought of 2016 was the worst one since 1985, with more than half of the state reaching the Extreme Drought stage for several months (Figure 20). This was followed by another drought four years later in 2020, which was most severe in Southeastern Massachusetts.. Finally, in the early spring of 2021 a third, milder, drought was declared. By the summer of 2021 conditions in the northeast region improved.

Figure 20: Recent Massachusetts Drought Events (2016-2021)



Source: US Drought Monitor, 2016-2021

Potential Drought Vulnerability

The most significant potential impact of drought on any community is on the public water supply, which may have to impose restrictions on water use in the event of extended abnormally low precipitation. However, the City of Marlborough draws its water supply from the Massachusetts Water Resources Authority (MWRA). Because of the vast amount of storage in the MWRA's Quabbin and Wachusett Reservoirs (over 400 billion gallons), the system can withstand most droughts with little or no disruption to the water supply. Even the drought of historic record, a 3-year drought in the mid-1960's, did not deplete the MWRA's water system, while many other water supply systems in the Northeast were moderately to severely stressed. Therefore, having access to the MWRA water supply greatly diminishes the potential for drought impacts on the City of Marlborough.

However, there are other potential impacts of drought beyond limits on public water supply. Droughts stress vegetation, everything from landscaping to parks and playing fields, to urban trees and forests. A severe or prolonged drought can significantly increase the risk of brushfires and forest fires, which in some cases could threaten nearby structures or infrastructure. Smoke from wildfires also poses a public health threat due to degraded air quality, which can have more severe impacts on vulnerable populations.

Should there be a drought severe enough to impact even the MWRA system, the most widespread impact would likely be a curtailment or elimination of non-essential outdoor water use, such as watering lawns. Potential financial damages to the city could include the loss of landscaped properties such as parks and playing fields, though no existing cost estimates for such losses are available. Similar losses could be incurred by private property owners. An extremely severe drought could have economic impacts if essential water use for businesses, industry, and residences had to be restricted. There is no precedent for a drought of this severity in Massachusetts.

Probability of Future Occurrence

The SHMCAP, using data collected since 1850, calculates that statewide there is a 1% chance of being in a drought emergency in any given month. For drought warning and watch levels, the chance is 2% and 8% respectively in any given month. See Table 15 for more information.

Table 15: Frequency of Massachusetts Drought Levels

Drought Level	Frequency Since 1850	Probability in a Given Month
Drought Emergency	5 occurrences	1% chance
Drought Warning	5 occurrences	2% chance
Drought Watch	46 occurrences	8% chance

Source: 2018 SHMCAP

Droughts And Climate Change

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Factors contributing to this include increasing evaporation as a result of warmer weather, earlier snow melt, and more extreme weather patterns. Information from the 2022 Massachusetts Climate Change Assessment related to drought is included in the "Climate Change Observations and Projections" section of this report. Additionally, the 2022 Assessment highlights the following drought-related impacts to the Eastern Inland region where Marlborough is located:

- Freshwater ecosystem degradation due to drought and other impacts
- Increased contaminant concentrations in freshwater during drought conditions
- Loss of tree cover due to drought and other impacts

LANDSLIDE HAZARDS

According to the USGS, "The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors." Among the contributing factors are: erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, and stockpiling of rock or ore, from waste piles, or from man-made structures.

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies. Typically, a landslide occurs when the condition of a slope changes from stable to unstable. Natural precipitation such as heavy snow accumulation, torrential rain and run-off may saturate soil creating instability enough to contribute to a landslide. The lack of vegetation and root structure that stabilizes soil can destabilize hilly terrain.

In Massachusetts, according to the SHMCAP, the most common cause of landslides are geologic conditions combined with steep slopes and/or heavy rains. Landslides associated with heavy rains typically occur on steep slopes with permeable soils underlain by till or bedrock.

There is no universally accepted measure of landslide extent but it has been represented as a measure of destructiveness. Table 16 summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

The SHMCAP, utilized data from the MA Department of Transportation from 1986 to 2006 to estimates that, on average, roughly one to three known landslides have occurred each year in the state. A slope stability map published by the MA Geological Survey and UMass-Amherst indicates that the most significant risk of landslide is in western Massachusetts.

Table 16 Landslide Volume and Velocity

Estimated Volume (m^3)	Expected Landslide Velocity		
	Fast moving (rock fall)	**Rapid moving (debris flow)**	**Slow moving (slide)**
<0.001	Slight intensity	--	--
<0.5	Medium intensity	--	--
>0.5	High intensity	---	--
<500	High intensity	Slight intensity	--
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000	--	Very high intensity	High intensity
>500,000	--	--	Very high intensity

Source: *A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy*, M. Cardinali et al, 2002

The entire City of Marlborough is classified as having a low risk for landslides (Map 4, Appendix A). Although potentially a city-wide hazard, there are no documented previous occurrences of landslides in Marlborough. Should a landslide occur in the future in Marlborough, the type and degree of impacts would be highly localized. The city's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Because the impacts would be so localized, there are no existing estimates for potential financial damages from landslides in Marlborough; damages could vary widely depending on what if any development or infrastructure was affected. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Marlborough.

Based on past occurrences, landslides are of Low frequency, events that can occur once in 50 to 100 years (a 1% to 2% chance of occurring per year).

Climate Change and Landslides

Changes in precipitation may increase the chance of landslides, as extreme rain events could result in more frequent saturated soils which are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

CLIMATE TRENDS: RISING TEMPERATURES

EXTREME TEMPERATURE HAZARDS

AVERAGE AND EXTREME TEMPERATURES

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is prolonged period of excessively hot or cold weather. a

Marlborough has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal seasonal ranges for Massachusetts. The average temperatures for Massachusetts are: winter (Dec-Feb) Average = 31.8°F and summer (Jun-Aug) Average = 71°F. Extreme temperatures are a citywide hazard.

EXTREME HEAT

While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 21) is forecast to exceed 100-degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above105 degree F.

Figure 21: Heat Index Chart

Relative Humidity (%) \ Temperature (°F)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Source: National Weather Service

The best available data on past occurrences of extreme heat events is from NOAA's National Centers for Environmental Information (NCEI) for Middlesex County, which includes Marlborough. The NCEI records indicate that In the last decade, there have been two excessive heat events recorded, with one reported death, no injuries, and no property damage (see Table 16).

Table 17: Middlesex County Extreme Heat Occurrences 2010-2020

Date	Deaths	Injuries	Damage
7/6/2010	0	0	0
7/5/2013	1	0	0
TOTAL	**1**	**0**	**0**

Source: NOAA, National Centers for Environmental Information

Extreme heat poses a potentially greater risk to the elderly, children, and people with certain medical conditions. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather.

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions; in Marlborough, approximately 14.2% of the population is over age 65. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses. Areas with less shade and darker surfaces (pavement and roofs) will experience even hotter temperatures; these surfaces absorb heat during the day and release it in the evening, keeping nighttime temperatures warmer as well. Map 9 in Appendix B displays areas that are among the hottest 5% of land in the MAPC region based on land surface temperature derived from satellite imagery on July 13, 2016, when the high temperature at Logan Airport was 92°F. There are a few hot spots spread across parts of Marlborough in the downtown areas.

Hot summer days can worsen air pollution. With increased extreme heat, urban areas are likely to experience more days that fail to meet air quality standards. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage.

Extreme Heat and Climate Change

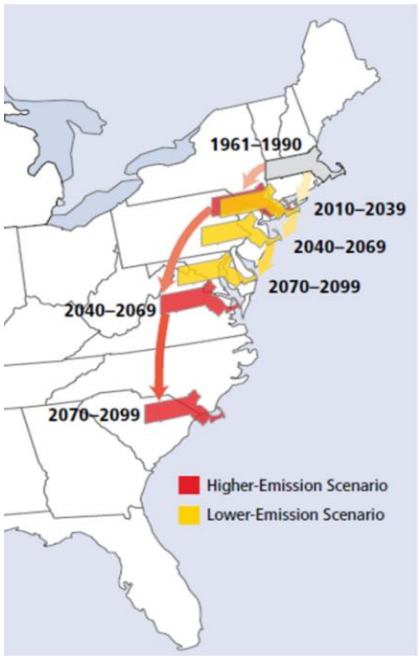
The 2022 MA Climate Change Assessment includes projections of climate-driven future increases in average temperature and in the number of extreme heat days. The assessment also highlights the following climate impacts for the Eastern Inland Region, related to temperatures:

- Warmer temperatures and more frequent heat waves are connected to impaired human health, increased droughts, reduced agriculture yields, species range shifts, and damaged infrastructure.
- By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013), worsening stress on electric transmission and utility distribution infrastructure.
- By 2070, there could be 58 fewer days below freezing, increasing the chance of ticks overwintering and reducing winter recreation opportunities.
- Increase in vector borne diseases and bacterial infections, including West Nile Virus and Lyme disease due to more favorable conditions for ticks and mosquitoes.
- Damage to electric transmission and utility distribution infrastructure associated with heat stress
- Damage to rails and loss of rail/ transit service, including flooding and track buckling during high heat events.
- Reduced ability to work, particularly for outdoor workers during extreme heat, as well as commute delays due to damaged infrastructure.
- Freshwater ecosystem degradation due to warming waters.
- Forest health degradation from warming temperatures and increasing pest occurrence

The 2018 SHMCAP identifies ecosystems that are expected to be particularly vulnerable to warming temperatures. These include cold-water fisheries, vernal pools, spruce-fir forests, northern hardwood forests (Maple, Beach, Birch), Hemlock forests, and urban forests (due to heat island impacts). Other Impacts on natural resources include a longer growing season and northern migration of plants and animals, including invasive species.

Over time our climate will become more similar to areas well to the south of New England (Figure 22).

Figure 22: Temperature Scenarios



Source: Union of Concerned Scientists

EXTREME COLD

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The severity of extreme cold temperature is typically measured using the Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. The index is provided in Figure 23. A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours.

Figure 23. Wind Chill Temperature Index and Frostbite Risk

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) Effective 11/01/01

Source: National Weather Service

The best available data on past occurrences of extreme cold events are from NOAA's National Centers for Environmental Information (NCEI) for Middlesex County, which includes Marlborough. There were three extreme cold events recorded by NCEI in the past ten years (Table 17), which caused no deaths, no injuries, or property damage.

Table 18: Middlesex County Extreme Cold and Wind Chill Occurrences

Date	Deaths	Injuries	Damages
2/15/2015	0	0	0
2/16/2015	0	0	0
2/14/2016	0	0	0
TOTAL	**0**	**0**	**0**

Source: NOAA, National Centers for Environmental Information

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. The greatest vulnerability to the city would be a power outage during a winter storm, which could temporarily leave many residents without heat. In Marlborough, 14.2% of residents are 65 years old and over, and 8.3% are living in poverty (US Census Bureau, 2021).

Extreme temperatures are a community-wide hazard in Marlborough. Extreme temperature events are projected to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year.

WILDFIRE HAZARDS

A wildfire is a non-structure fire occurring in a forested, shrub, or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush of a forested area. There are three different classes of wild fires:

- **Surface fires** are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees;
- **Ground fires** are usually started by lightning and burn on or below the forest floor;
- **Crown fires** spread rapidly by wind, jumping along the tops of trees.

Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat.

A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers and fire breaks.

The National Wildfire Coordinating Group (NWCG) classifies the severity of wildfires based on their acreage as follows:

- Class A - one-fourth acre or less;
- Class B - more than one-fourth acre, but less than 10 acres;
- Class C - 10 acres or more, but less than 100 acres;
- Class D - 100 acres or more, but less than 300 acres;
- Class E - 300 acres or more, but less than 1,000 acres;
- Class F - 1,000 acres or more, but less than 5,000 acres;
- Class G - 5,000 acres or more (NWCG, 2023).

The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes. Protecting structures from fire poses special problems and can stretch firefighting resources to the limit. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wild fire destroys the ground cover, then erosion becomes one of several potential problems.

Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts, shown in Figure 2 below, indicates that the wildfire extent in Marlborough consists of less than 99 acres burned, with fewer than 100 recordable fires from 2001 to 2009.

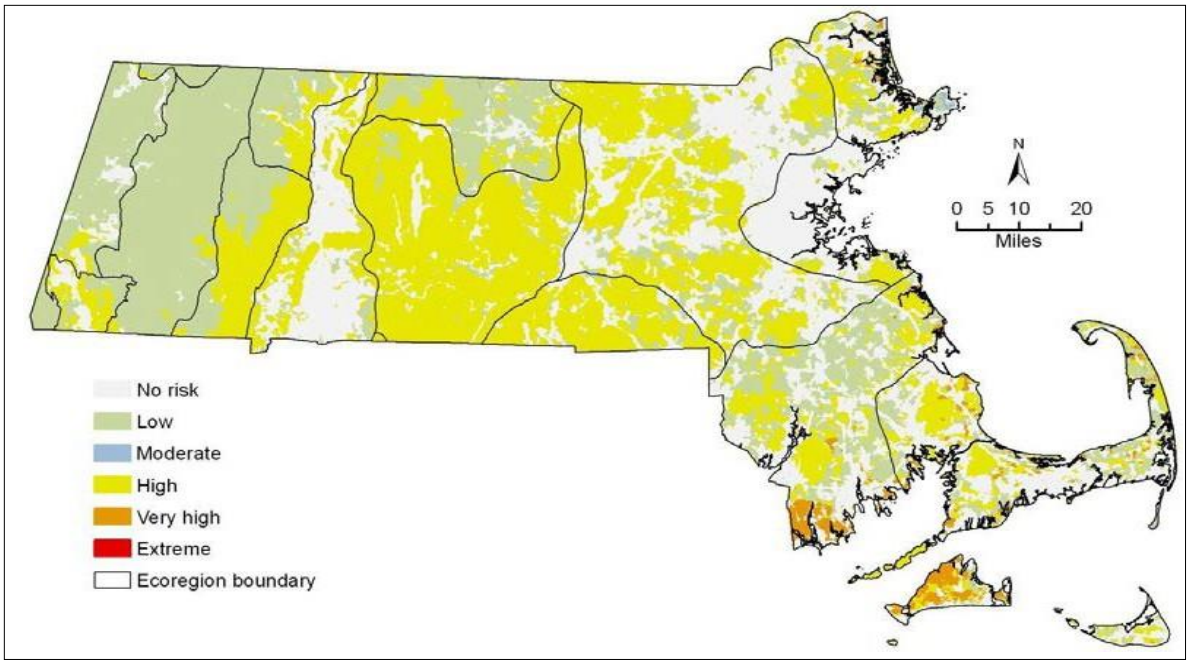
Potential Wildfire Hazard Areas

The 2018 SHMCAP includes a map that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 24). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. Marlborough is in the high-risk zone.

Although densely developed in some areas, Marlborough does have some large open spaces that could be susceptible to wildfires. The city has identified four parcels that are potential wildfire areas, listed below. These are also shown on Map 8 in Appendix A (numbers refer to location on the map). According to local officials, though, natural fires in Marlborough are not a major issue.

- State Forest Area at Concord Road (17)
- Desert Conservation Area (18)
- Millham Reservoir Area (19)
- State Forest at Parmenter Street (20)

Figure 24: Wildfire Risk Areas in Massachusetts



Source: 2018 SHMCAP

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources such as wildlife habitat. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. Should a wildfire occur in Marlborough or in other nearby communities, the resulting smoke could have negative impacts on air quality. This could have public health impacts, particularly for those with respiratory conditions such as asthma. The Massachusetts Department of Public Health Bureau of Environmental Health states that Marlborough has a lower pediatric asthma prevalence in K-8 students, and a lower rate of asthma emergency department visits, than the state average (MA Dept of Public Health, 2022). However, given the low extent of wildfires in the city and the immediate response times to reported fires in Marlborough, the likelihood of injuries and casualties is minimal.

To document wildfire occurrences since the previous Hazard Mitigation Plan, Marlborough's Emergency Management Director compiled Fire Department incident response records from 2018-2022. Table 19 summarizes 31 wildfire events over the five-year period. Most of these were relatively small fires under 1 acre, but four events stand out as more significant:

- 5/9/18: 2-acre fire on an island in the Sudbury River, Southborough FD assisted
- 8/5/22: 8 acres fire heading SW towards Turner Ridge Rd. DCR crew assisted'
- 8/19-21/22: Large 20+ acre brushfire in Desert Conservation area. Marlborough assisted by Sudbury, Districts 7, 8, 14, DCR, MEMA, and Fire Services Rehab Unit.
- 8/24/22: 2-acre fire at Sudbury Reservoir; MFD assisted by Southborough, Sudbury, District 14 Forest Fire Division and DCR.

Table 19: Marlborough Wildfire Records 2017-2022

Date	Address	Type	Description
4/17/2017	Parmenter Road	Small brushfire	
4/18/2017	50 Boston Scientific Way	Brushfire	
4/29/2017	181 Boston Post Road	Brushfire	Appx 150' x 150' brushfire. State assisted
6/12/2017	Route 495 South	Small brushfire	
8/20/2017	373 Littlefield Lane	Forest Fire	
9/11/2017	Route 495 South	Brushfire	Small brushfire on side of road
10/8/2017	197 Boston Post Road	Brushfire	3 shrubs on fire along with mulch
1/21/2018	121 Northborough Road	Brushfire	
2/21/2018	Route 495 North	Grass Fire	On side of roadway, appx 8' x 80'
4/1/2018	728 Berlin Road	Brushfire	Started by power line shorting out by tree branch
5/9/2018	3 Farmington Circle	Brushfire	Brush fire on island in Sudbury River, appx 2 acres. Accessed by boat via Southborough FD. Fire appeared to be burning for some time, possibly days.
1/18/2019	29 Morrissey Drive	Brushfire	Approximately 75' x 200'
4/11/2019	103 Bigelow Street	Brushfire	Improper burning of brush at residence
4/16/2019	728 Donald Lynch Blvd.	Brushfire	On side of roadway
5/6/2019	Route 495 North	Brushfire	In median of highway
8/28/2019	350 East Main Street	Brushfire	Vacant lot at Firefly's
5/7/2020	223 Vega Road	Brushfire	Approximately 30' x 30'
6/22/2020	Robin Hill Stret	Forest Fire	
5/18/2021	Route 290 East	Brushfire	At mile marker 19
5/19/2021	56 Framingham Road	Brushfire	
4/16/2022	98 Broadmeadow Road	Brushfire	Appx 3/4 acre brushfire. District 14 also responded
6/7/2022	24 Redbud Way	Brushfire	
7/31/2022	169 Broadmeadow Road	Brushfire	Appx 10' x 10' area burned, still smoldering
8/5/2022	35 Carriage Hill Circle	Brushfire	8 acres fire heading SW towards Turner Ridge Rd. DCR crew assisted' 2 forestry lines were put into operation to SE and NW. Fire lines established to confine fire.
8/19/2022	1110 Concord Road	Brushfire	Large 20+ acre brushfire in Desert Conservation area. MFD assisted by Sudbury FD, Districts 7, 8, and 14, DCR, MEMA, and Dept. of Fire Services Rehab Unit.
8/20/2022	11 Mosher Lane	Brushfire	In the Desert Conservation area
8/21/2022	920 Concord Road	Brushfire	Small brushfire
8/21/2022	1110 Concord Road	Forest Fire	Large 25-acre wildfire in Desert Conservation area, ongoing since 8/19. Mutual aid units from multiple fire district forestry task forces.
8/21/2022	Route 85 Connector	Brushfire	1/4 acre brushfire off the shoulder of the road
8/23/2022	Farm Road	Brushfire	Appx 2-acre fire in the woods at Sudbury Reservoir MFD assisted by Southborough, Sudbury, District 14 Forest Fire Division and DCR. Operation lasted 6 hours, used 3 brush pumps and extensive overhaul.
8/24/2022	1110 Concord Road	Brushfire	Wildland involved in multiple-day wildfire; 5 actively smoldering hot spots were extinguished.

Source: Marlborough Fire Dept Incident Records, Retrieved by Fred Flynn, EM Director

WILDFIRE AND CLIMATE CHANGE

As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable. Increasing drought and increasing damage to trees from pests, can also lead to greater fire risk. The 2022 Assessment cites anticipated forest health degradation from increasing wildfire frequency for the Eastern Inland Region, where Marlborough is located (Commonwealth of Massachusetts, 2022).

CLIMATE TRENDS: EXTREME WEATHER

Extreme weather includes wind-related hazards (such as hurricanes, tropical storms, tornadoes, and thunderstorms) as well as winter weather (such as Nor'easters, blizzards, and ice conditions. Following is a description of the types of natural hazards associated with extreme weather events.

WIND HAZARDS

Wind-related hazards include hurricanes, tropical storms, and tornadoes as well as high winds during Nor'easters and thunderstorms. As with many communities, falling trees that result in downed power lines and power outages are an issue in Marlborough. Information on wind related hazards can be found on Map 5 in Appendix A, which indicates that the 100-year wind speed in Marlborough is 110 miles per hour.

HURRICANES AND TROPICAL STORMS

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. Given its location approximately 25 miles from the coast, the city's entire area is vulnerable to hurricanes. Hurricanes occur between June and November. A tropical storm has similar characteristics, but wind speeds are between 34 and 73 miles per hour.

Since 1900, Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm. There have been three storm tracks through Marlborough, 1858, 1876, and 1906. However, Marlborough experiences the impacts of hurricanes and tropical storms regardless of whether the storm track passes directly through the city, and numerous hurricanes have affected the communities of eastern Massachusetts (see Table 20).

Table 20: Hurricane Records for Massachusetts, 1938 - 2012

Hurricane Event	Date
Great New England Hurricane*	September 21, 1938
Great Atlantic Hurricane*	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol*	August 31, 1954
Hurricane Edna*	September 11, 1954

Hurricane Event	Date
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012

*Category 3. Source: National Oceanic and Atmospheric Administration

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Scale No. (Category)	Winds(mph) Storm	Surge (ft)	Potential Damage
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

Falling trees and branches are a significant impact of the high winds of hurricanes, which often result in power outages or block traffic and emergency routes when they fall on roads. Rainfall associated with hurricanes can cause flooding in rivers and streams, as well as localized stormwater drainage flooding

Potential hurricane damages to Marlborough have been estimated using HAZUS-MH. Total damages are estimated at $26.6 million for a 100-yeaer hurricane and $112.3 million for a 500-year hurricane. Other potential impacts are detailed in the Vulnerability Analysis below.

Based on records of previous occurrences, hurricanes in Marlborough are a Medium frequency event. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Hurricanes and Climate Change

Climate models suggest that hurricanes and tropical storms will become more intense as warmer ocean waters provide more fuel for the storms. In addition, rainfall amounts associated with hurricanes are predicted to increase because warmer air can hold more water vapor

SEVERE THUNDERSTORMS

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. Generally defined as a storm that includes thunder, which always accompanies lightning, a thunderstorm is a storm event featuring lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The severity of thunderstorms ranges from commonplace and of short duration to intense storms that cause damage due to high winds, flooding, or lightning strikes.

Eastern Massachusetts is at risk of one to two severe thunderstorms per year. The best available data on previous occurrences of thunderstorms in Marlborough is through NOAA's National Centers for Environmental Information (NCEI). For the years 2010 to 2022, NCEI records show 84 thunderstorm wind events in Middlesex County (Table 21). These storms resulted in an estimate of $3.47 million in property damage. There were seven injuries and no death reported.

Table 21: Middlesex County Thunderstorm Wind Events, 2010 to 2022

DATE	MAGNITUDE (knots)	DEATHS		INJURIES	PROPERTY DAMAGE $
5/4/2010	50	0		0	30000
6/1/2010	50	0		0	5000
6/3/2010	50	0		0	20000
6/5/2010	50	0		0	40000
6/6/2010	50	0		1	100000
6/24/2010	50	0		0	30000
7/12/2010	50	0		0	50000
7/19/2010	50	0		0	25000
6/1/2011	50	0		0	5000
6/9/2011	50	0		0	15000
8/2/2011	50	0		0	1000
8/19/2011	50	0		0	15000
6/8/2012	50	0		0	25000
6/23/2012	45	0		0	5000
7/4/2012	50	0		0	10000
7/18/2012	70	0		0	350000
9/7/2012	50	0		0	10000
9/8/2012	40	0		0	3000
6/17/2013	50	0		0	25000
6/18/2013	45	0		0	10000
6/24/2013	45	0		0	3000
7/23/2013	50	0		0	20000

DATE	MAGNITUDE (knots)	DEATHS		INJURIES	PROPERTY DAMAGE $
7/29/2013	50	0		0	5000
7/3/2014	50	0		0	75000
7/7/2014	87	0		0	100000
7/15/2014	50	0		0	25000
7/28/2014	50	0		0	50000
9/6/2014	50	0		1	15000
5/28/2015	45	0		0	5000
8/4/2015	50	0		0	40000
8/15/2015	50	0		0	25000
2/25/2016	50	0		0	30000
3/17/2016	45	0		0	5000
7/22/2016	50	0		0	14,000
7/23/2016	50	0		0	0
8/22/2016	50	0		0	0
9/11/2016	50	0		0	10,000
5/18/2017	50	0		0	0
6/13/2017	52	0		0	0
6/23/2017	52	0		0	1000
6/27/2017	50	0		0	0
7/12/2017	50	0		0	0
8/2/2017	50	0		0	0
9/6/2017	50	0		0	0
5/15/2018	40	0		0	0
6/18/2018	50	0		0	0
6/25/2018	43	0		0	0
7/17/2018	50	0		0	3000
7/26/2018	50	0		0	5000
8/7/2018	50	0		0	3000
8/17/2018	50	0		0	4000
9/6/2018	50	0		0	2000
10/23/2018	46	0		0	10,000
6/30/2019	50	0		0	800
7/17/2019	50	0		0	7250
7/31/2019	50	0		0	2500
8/7/2019	50	0		0	800
9/4/2019	55	0		0	26700
5/15/20	50	0		0	285,000
6/06/20	50	0		0	7000
6/21/20	50	0		0	38,200

DATE	MAGNITUDE (knots)	DEATHS		INJURIES	PROPERTY DAMAGE $
6/28/20	55	0		0	6000
7/02/20	50	0		0	15300
7/05/20	50	0		0	12300
7/23/20	60	0		0	40600
7/30/20	50	0		0	3100
8/22/20	50	0		0	6000
8/23/20	50	0		0	25600
8/27/20	50	0		0	1600
10/07/20	61	0		5	6500
11/15/20	56	0		0	4000
5/6/21	50	0		0	800
6/30/21	50	0		0	500
7/6/21	50	0		0	18,500
7/7/21	55	0		0	7,600
7/27/21	52	0		0	33,800
8/19/21	50	0		0	1,300
9/13/21	50	0		0	400
3/7/22	56	0		0	19,000
7/2/22	50	0		0	800
7/21/22	50	0		0	500
8/5/22	50	0		0	9,900
8/7/22	60	0		0	30,300
8/26/22	50	0		0	7,800
TOTAL		**0**		**7**	**$3.47M**

*Magnitude refers to maximum wind speed Source: NOAA, National Climatic Data Center

Severe thunderstorms are a citywide hazard for Marlborough. The city's vulnerability to severe thunderstorms is like that of nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Marlborough are high frequency events. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Thunderstorms and Climate Change

As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. Neither the 2018 SHMCAP, nor the 2022 Massachusetts Climate Change Assessment, specifically address whether climate will affect the intensity or frequency of thunderstorms.

HAIL

Hail events are frequently associated with thunderstorms and other severe storm events. Hail size typically refers to the diameter of the hailstones. Warnings may report hail size through comparisons with real-world objects that correspond to certain diameters as shown in Table 22.

Table 22: Hail Size Comparisons

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.50
Baseball	2.75
Teacup	3.00
Grapefruit	4.00
Softball	4.50

Source: NOAA

Potential damages from larger-size hail could include damage to vehicles, windows, and other structures. The best available data on previous hail events are recorded for Middlesex County through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. There were 9 hail events recorded from December 2012 through December 2022, as shown in Table 23. There was no property damage, injuries, or deaths reported for any of these hail events.

Table 23: Middlsex County Hail Events, 2012-2022

Date	Magnitude	Deaths	Injuries	Property Damage ($)
5/4/2010	0.75	0	0	0
5/7/2011	0.75	0	0	0
6/1/2011	0.75	0	0	0
8/2/2011	0.75	0	0	0
8/19/2011	0.75	0	0	0
3/13/2012	1.25	0	0	0
3/14/2012	1	0	0	0
6/23/2012	0.75	0	0	0
7/18/2012	1	0	0	0
10/30/2012	1	0	0	0

Date	Magnitude	Deaths	Injuries	Property Damage ($)
6/17/2013	0.75	0	0	0
5/25/2014	0.75	0	0	0
7/3/2014	1	0	0	0
8/7/2014	0.75	0	0	0
9/6/2014	0.88	0	0	0
8/4/2015	1	0	0	0
8/15/2015	0.75	0	0	0
7/23/2016	.75	0	0	0
6/27/2017	1.00	0	0	0
8/2/2017	.75	0	0	0
6/29/19	.75	0	0	0
6/06/20	1.00	0	0	0
6/28/20	1.00	0	0	0
7/30/20	.75	0	0	0
8/23/20	1.00	0	0	0
TOTAL		**0**	**0**	**0**

Source: NOAA, National Centers for Environmental Information

**Magnitude refers to diameter of hail stones in inches*

Hail events are a potential city-wide hazard in Marlborough. Based on the record of previous occurrences in Middlesex County, hail events in Marlborough are a Medium frequency event. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

TORNADOES

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (from southeast at the surface to west aloft)
- Increasing wind speed with altitude in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet.)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornados are most common in the summer, June through August and most form in the afternoon or evening. Tornados are associated with strong thunderstorms.

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized in Table 24.

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. Although there have been no recorded tornadoes within the limits of the City of Marlborough, since 1955, there have been 18 tornados in Middlesex County recorded by the NCEI (Table 25 below). Two tornados were F3, four were F2, ten were F1and two were F0. These tornados resulted in one fatality, six injuries, and an estimated $4.88 million in property damage.

Table 24: Enhanced Fujita Scale

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Scale	Wind speed		Relative frequency	Potential damage	
	mph	km/h			
EF0	65–85	105–137	53.5%	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.	
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	
EF3	136–165	219–266	3.4%	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.	
EF4	166–200	267–322	0.7%	Extreme damage to near-total destruction. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.	
EF5	>200	>322	<0.1%	Massive Damage. Strong frame houses leveled off foundations and swept away; steel-reinforced concrete structures critically damaged; high-rise buildings have severe structural deformation. Incredible phenomena will occur.	

Source: SHMCAP 2018

Table 25: Tornado Records for Middlesex County

Date	Fujita Scale	Fatalities	Injuries	Property Damage $	Length (mile)	Width (yard)
10/24/1955	1	0	0	2.50K	10	0.1
6/19/1957	1	0	0	25.00K	17	1
6/19/1957	1	0	0	0.25K	100	0.5
7/11/1958	2	0	0	250.00K	17	1.5
8/25/1958	2	0	0	2.50K	50	1
7/3/1961	0	0	0	25.00K	10	0.5
7/18/1963	1	0	0	25.00K	50	1
8/28/1965	2	0	0	250.00K	10	2
7/11/1970	1	0	0	25.00K	50	0.1
10/3/1970	3	1	0	250.00K	60	35.4
7/1/1971	1	0	1	25.00K	10	25.2
11/7/1971	1	0	0	0.25K	10	0.1
7/21/1972	2	0	4	2.500M	37	7.6
9/29/1974	3	0	1	250.00K	33	0.1
7/18/1983	0	0	0	0.25K	20	0.4
9/27/1985	1	0	0	0.25K	40	0.1
8/7/1986	1	0	0	250.00K	73	4
8/22/2016	1	0	0	1.000M	400	.85
TOTAL		**1**	**6**	**4.88M**		

Source: NOAA
Source: The Tornado History Project

The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). Recent tornado events in Massachusetts resulted in significant damage in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in four deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16, moved north into Revere's business district along Broadway, and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damage and 13 homes and businesses were rendered uninhabitable. And on August 22, 2016, an F1 tornado passed through part of nearby Concord. It impacted an area 0.85 miles long by 400 yards wide. According to the report from the National Centers for Environmental Information:

> *"This tornado touched down near the Cambridge Turnpike and headed northeast. Most of the damage was concentrated in an area beginning near the intersection of Lexington Road and Alcott Road and continuing up to the neighborhood of Alcott and Independence Roads. Numerous trees were uprooted or had the tops sheared off. These subsequently blocked roads, damaged homes, and downed power lines, cutting off power to the neighborhood. In addition, utility poles were downed either from the wind or from the downed power lines. Thirty-nine houses in this area were damaged to some degree. Only one house suffered significant structural damage. The tornado continued for a short distance beyond this neighborhood before lifting. The historical home of Louisa May Alcott and her family was right next to the tornado path but was not damaged."*

Buildings constructed prior to current building codes may be more vulnerable to damage caused by tornadoes. Evacuation of impacted areas may be required on short notice.

Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes. At this time, the Massachusetts State Building Code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence.

Although tornadoes are a potential citywide hazard in Marlborough, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Marlborough would greatly depend on the track of the tornado. (Generally the central and southwestern portions of the city are more densely developed and would likely be subject to more damage in the event of a tornado.

Based on the record of previous occurrences since 1950, Tornado events in Marlborough are a Medium frequency event. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Tornadoes and Climate Change

According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity. Massachusetts' 2022 Climate Change Assessment does not include information related to tornadoes.

WINTER HAZARDS

SEVERE WINTER STORM/NOR'EASTER

A northeast storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 20 to 40 mph with gusts of up to 60 mph. These storms are accompanied by heavy rain or snow, depending on temperatures. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and extended heavy precipitation.

Previous occurrences of nor'easters include the storm events included in Table 26 below. Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in February 2013, January 2015, and in March 2018 were large nor'easters that caused significant snowfall amounts.

Table 26: Nor'easter Events for Massachusetts, 1978 - 2021

Date	Nor'easter Event
February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/Nor'easter
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
February 2013	Blizzard of 2013
January 2015	Blizzard of 2015
March 2015	March 2015 Nor'easters
January 2018	January 2018
March 2018	March 2018

Marlborough is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles.

The entire City of Marlborough could be at risk from the wind, rain or snow impacts from a Nor'easter, depending on the track and radius of the storm, but due to its inland location the city would not be subject to coastal hazards.

Based on the record of previous occurrences, Nor'easters in Marlborough are high frequency events. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

BLIZZARDS & HEAVY SNOW

Winter weather impacts including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas.

Winter storms are a combination hazard because they often involve wind, ice, and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12-hour period (NOAA, 2009). Blizzards and winter storms are often associated with a nor'easter event (see nor'easters section above).

A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow which reduces visibility to or below ¼ mile. These conditions must be the predominant conditions over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. The hazard related to the combination of snow, wind, and low visibility significantly increases when temperatures drop below 20 degrees.

The Regional Snowfall Index (RSI) characterizes and ranks the severity of northeast snowstorms. RSI has five categories: Extreme, Crippling, Major, Significant, and Notable. RSI scores are a function of the area affected by the storm, the amount of snow, and the number of people living in the path of the storm. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The RSI categories are shown in Table 27.

Table 27: Regional Snowfall Index

Category	RSI	Value Description
1	1 – 3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

Source: 2018 SHMCAP

Winter storms, including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response.

The best available data on previous occurrences and impacts of heavy snow events in Marlborough is available for Middlesex County from the National Centers for Environmental Information (NCEI) records. From 2010 to 2022, Middlesex County experienced nearly 40 days with heavy snowfall events, resulting in no injuries, deaths, and property damage of $142,000, as shown in Table 28.

Table 28: Heavy Snow Events in Middlesex County, 2010 to 2022

Date	Deaths	Injuries	Property Damage ($)
1/18/2010	0	0	0
2/16/2010	0	0	15,000
2/23/2010	0	0	8,000
1/12/2011	0	0	0
1/26/2011	0	0	0
10/29/2011	0	0	30,000

Date	Deaths	Injuries	Property Damage ($)
12/29/2012	0	0	0
2/8/2013	0	0	0
2/8/2013	0	0	0
2/23/2013	0	0	0
3/7/2013	0	0	0
3/18/2013	0	0	0
12/14/2013	0	0	0
12/17/2013	0	0	0
1/2/2014	0	0	0
1/18/2014	0	0	0
2/5/2014	0	0	0
2/13/2014	0	0	0
2/18/2014	0	0	0
11/26/2014	0	0	10,000
1/24/2015	0	0	0
1/26/2015	0	0	0
2/2/2015	0	0	0
2/8/2015	0	0	0
2/14/2015	0	0	0
2/5/2016	0	0	75,000
3/21/2016	0	0	0
4/4/2016	0	0	0
12/29/2016	0	0	0
3/14/2017	0	0	0
11/15/2018	0	0	0
12/1/2019	0	0	4,000
1/18/20	0	0	0
3/23/20	0	0	0
10/30/20	0	0	500
12/05/20	0	0	0
12/16/20	0	0	0
2/1/21	0	0	0
1/28/22	0	0	0
TOTAL	**0**	**0**	**$142,500**

Source: NOAA, National Climatic Data Center

Another indication of previous severe winter events is the list of Presidentially-declared disasters for blizzards snowstorms. There have been 14 since 1978, as shown in Table 29. The most significant single winter storm was the "Blizzard of 1978," which resulted in over three feet of snowfall and multiple day closures of roadways, businesses, and schools. The record snowfall of January 2015 resulted from a series of storms over that month. The most recent significant winter event was Winter Storm Kenan (January 29, 2022), which resulted in 30.9" of snow in Massachusetts (Stucker, 2022).

Table 29: Winter-Related Federal Disaster Declarations, 1978-2022

Disaster Name	Date of Event
Coastal Storms, Flood, Ice & Snow	February 1978
Winter Coastal Storm	December 1992
Blizzard	March 1993
Blizzard	January 1996
Snowstorm	March 2001
Snowstorm	February 2003
Snowstorm	December 2003
Snowstorm	January 2005
Severe Winter Storm, Snowstorm	January 2011
Severe Winter Storm, Snowstorm, Flooding	February 2013
Severe winter storm, snowstorm, flooding	January 2015
Severe winter storm and Snowstorm	March 2018
Severe winter storm and flooding	March 2018
Severe winter storm and snowstorm	January 2022

Sources: OpenFEMA Dataset: Disaster Declarations and FEMA Declared Disasters

Winter storms are a community-wide hazard in Marlborough. Map 6 in Appendix A illustrates the average annual average snowfall in Marlborough, which is between 48 to 72 inches.

The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall. This in turn can cause property damage and potential injuries. Power outages may also result from fallen trees and utility lines.

A number of public safety issues can arise during snowstorms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted, as they were in the 2015 blizzards which caused the closure of the MBTA system for one day and limited services on the commuter rail for several weeks.

Blizzards are considered high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

ICE STORMS

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects, creating ice buildups of one-fourth of an inch or more. An ice storm warning, which is now included in the criteria for a winter storm warning, is issued when a half inch or more of accretion of freezing rain is expected.

Sleet and hail are other forms of frozen precipitation. Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. The difference between sleet and hail is that sleet is a wintertime phenomenon whereas hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months (a description of hail is included in a subsequent report section).

The best available data on previous ice storm events are recorded at the county level through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. Middlesex County, which includes the City of Marlborough, experienced three events from 1998 to 2008 which caused a total of $3,155,000 in damages (Table 30). Unfortunately, Kevin Connelly of the Marlborough Forestry Department was killed during the storm on 12/11/08 when he was swept away by an overflowing stream and drowned.

Table 30: Middlesex County Ice Storm Events, 1998 –2008

BEGIN_DATE	EVENT_TYPE	DEATHS	INJURIES	DAMAGE
1/9/1998	Ice Storm	0	0	5,000
11/16/2002	Ice Storm	0	0	150,000
12/11/2008	Ice Storm	1	0	3,000,000
TOTAL		0	0	**3,155,000**

Source: NOAA, National Centers for Environmental Information.

The greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches causing power outages and blocking roadways. The impacts of winter storms may also include roof collapses and property damage and injuries related to the weight of snow and ice.

Ice storms are considered to be medium-frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 5 years to once in 50 years, with 2% to 20% chance of occurring each year.

Overall, Winter Storms are a city-wide hazard in Marlborough. Map 6 in Appendix A displays average annual snowfall, which is in the range of 48 to 72 inches for the city.

Winter Weather and Climate Change

As with hurricanes, warmer ocean water and air will provide more fuel for winter storms. According to the 2018 SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity. Further, the SHMCAP notes that research suggests that warmer weather in the Artic is producing changes to atmospheric circulation patterns that favor the development of winter storms in the Eastern United States. There is also some indication that as winters warm, temperatures may be more likely to produce icing conditions. Massachusetts' 2022 Climate Change Assessment predicts more mild winters, increased precipitation in the winter months, and multiple freeze-thaw cycles every winter due to warming temperatures (Commonwealth of Massachusetts, 2022)

NON-CLIMATE-INFLUENCED HAZARDS

EARTHQUAKES

Earthquakes are the sole natural hazard for which there is no established correlation with climate impacts. Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC). Earthquakes can also trigger landslides

Seismologists use a magnitude scale known as the Richter scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized in Table 31.

Table 31: Richter Scale and Effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally, not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 km. across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2016, 408 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes in the distant past, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in Table 32.

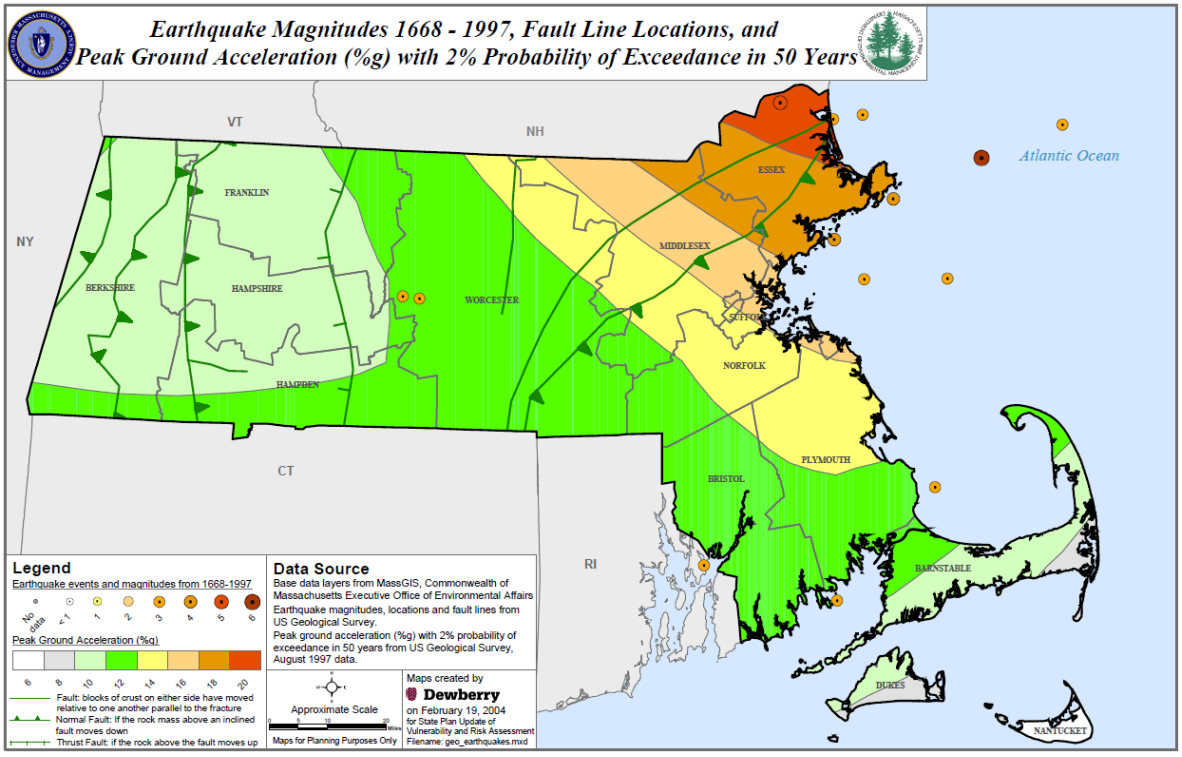
Table 32: Historic Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA – Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA – Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA – Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA – Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA – Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA – Brewster	8/8/1847	4.2
MA – Boxford	5/12/1880	NA
MA – Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA – Boston	12/27/74	2.3
MA - Nantucket	4/12/12	4.5
ME – Hollis	10/17/12	4.0

Source: Boston HIRA

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (%g). The range of peak ground acceleration in Massachusetts is from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years, as shown in Figure 25. Marlborough is in the middle part of the range for Massachusetts, at 12-14g, making it a moderate area of earthquake risk relative to the state, although Massachusetts as a whole is considered to have a low risk of earthquakes compared to the rest of the country. There have been no recorded earthquake epicenters within Marlborough.

Figure 25: Massachusetts Earthquake Probability Map



Source: 2018 SHMCAP

Although New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. The majority of older buildings and infrastructure were constructed without specific earthquake resistant design features.

Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not

properly secured, the operations at the hospital could be severely impacted during an earthquake.

Earthquakes are a potential city-wide hazard in Marlborough. The City has many un-reinforced, older buildings which would be vulnerable in the event of a severe earthquake. Potential earthquake damages to Marlborough have been estimated using HAZUS-MH. Total damages are estimated at $1,015,490,000 for a 5.0 magnitude earthquake. Other potential impacts of earthquakes such as sheltering and debris generation, are detailed in Table 32.

There are several ways the probability of future occurrences has been estimated. According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50-year time period. According to the SHMCAP there is a 10-15% chance of a magnitude 5 earthquake in a given ten-year period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less,

LAND USE AND DEVELOPMENT

EXISTING LAND USE

The most recent land use statistics available for Massachusetts communities are from aerial imagery completed in 2016. Some change has certainly occurred in Marlborough since then, but this data provides the most detailed city-wide description of land use available. Land use is shown on Map 2 in Appendix A. Table 33 shows the acreage and percentage of land uses in 27 categories. If the five residential categories are aggregated, residential uses make up 57% of the area of the city (2,493 acres). Commercial and industrial combined make up 4.9% of the city, or 214.6 acres. Recreation, urban public, and golf courses comprise a total of 17.1%, or 748.1 acres.

Table 33 - Marlborough Land Use

Land Use Type	Percent	Acres
Brushland/Successional	0.13	18
Cemetery	0.45	63
Commercial	5.49	776
Cropland	0.89	126
Forest	41.04	5805
Forested Wetland	5.47	774
Golf Course	0.75	106
High Density Residential	3.74	530
Industrial	4.52	639
Junkyard	0.04	5
Low Density Residential	5.26	743
Medium Density Residential	12.37	1750
Multi-Family Residential	4.70	665
Non-Forested Wetland	2.22	314
Open Land	0.94	133
Orchard	0.02	3
Participation Recreation	1.05	148
Pasture	0.38	54
Powerline/Utility	0.36	51
Spectator Recreation	0.06	9
Transitional	0.58	82
Transportation	2.20	311
Urban Public/Institutional	1.57	222
Very Low Density Residential	0.23	33
Waste Disposal	0.30	43
Water	5.24	741
Water-Based Recreation	0.01	1
Total Acres	**100%**	**14,145**

Source: MassGIS Land Use Database

For more information on how the land use statistics were developed and the definitions of the categories, please go to https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use. Refer to the "Community Profile" in Section 3 for more information on Marlborough's natural, cultural, and historic resources.

DEVELOPMENT TRENDS

Marlborough has experienced significant new development since the last Hazard Mitigation was approved in 2016, including residential, commercial and light industrial developments. The City tracks new development projects, and the information in Table 33 below was provided by the City's GIS Administrator and reviewed and updated by the Conservation Officer.

The 46 new developments listed in Marlborough include 15 that have been completed, 8 that are currently under construction, 23 that are permitted or planned for future development. The developments include 18 residential developments, 14 commercial/industrial developments, 3 office buildings, 3 mixed-use projects, 2 medical offices, 2 mixed-use developments, one assisted living facility, and one school. (Table 34).

Table 34: Summary of Marlborough New Developments 2017-2023

#	Development Site	Development Type	Status
A	Regency at Assabet Ridge		Planned
AA	Hayes Memorial Dr. Devonshire @ 495	3 story building with mixed office, lab, and R & D on a 24-acre parcel, 204,000 sq. ft. GSF. 507 parking spaces	Construction
B	Mixed Use Overlay District - Marlborough Hill Development	Mixed Use	Planned
BB	Hayes Memorial Dr. (Parcel G)	167,400 sq. ft. distribution center/warehouse/industrial use	Permitted
C	The Preserve at James	Residential	Planned
CC	28 South Bolton St	36 Residential Units	Construction
D	Lake Williams condos	Residential development	Permitted
DD	Simarano Dr - Green District	Construction 123,000 sf, Self-storage facility	Construction
E	Mauro Farm	Residential	Permitted
EE	57 Main St.	Mixed use, 86, 600 sq. ft., 5 story with 55 residential units, 11,000 sq. ft. office and restaurant, 83 parking spaces	Permitted
F	Howes Landing Subdivision	Residential subdivision	Planned
FF	Hayes Memorial Dr. Lot K	New 30,140 s.f. warehouse	Permitted
G	Cider Knoll Subdivision	Residential subdivision	Completed
GG	19 Ash St. (Trailside Terrace)	11-unit residential townhouse community and convert the historic single-family home to a 2-family dwelling.	Construction
H	257 (aka 215) Simarano Dr.		Planned
HH	487 Lincoln St	Housing special permit	Construction
I	Lincoln St (ALTA)	Mixed use development with 276 residential units, 9,908 sq. ft. of commercial/retail space, parking,	Permitted
II	Hayes Memorial Dr. Lot L	New 70,200 s.f. one story warehouse	Permitted
J	Farm Rd. (677-681)	Commercial/light industrial	Construction
JJ	Hayes Memorial Dr. Lot M	New 24,020 s. f. one story warehouse	Permitted

#	Development Site	Development Type	Status
K	401 Elm St	2 office buildings totaling 200,000 sq. ft. with associated parking	Planned
KK	239 Boston Post Rd West	2,800 sq. ft. Adult Use Marijuana Retail Establishment and associated parking, utility, and landscaped improvements.	Permitted
L	Donald Lynch Blvd. (739-769))	New stealth wireless communications facility alongside the R.K. Plaza	Planned
LL	600 Nickerson Rd	33,435 sq. ft. of GMP space, conversion of existing office to GMP space and stie improvements	Permitted
M	FKA 90 Crowley Dr.	3 story building containing 130 senior apartment units. Building 182,000 gsf, 143 parking spaces;	Planned
MM	700 Nickerson Rd	14,653 sq. ft. of new GMP space, conversion of existing office to GMP space	Permitted
N	Forest & William St.	Two-story office building and parking s	Completed
NN	1000 Nickerson Rd	120,000 sq.ft. building with utilities, parking area, ang stormwater management	Construction
O	890 Boston Post Rd	Site Plan Review	Completed
OO	Raising Cane's Chicken Fingers (141 Boston Post Rd. West)	Demolish existing retail structure and develop a 3,603 sq. ft. restaurant	Construction
P	180 Boston Post Rd West	Apex Entertainment	Completed
PP	Jenks Ln Subdivision	Residential subdivision	Permitted
Q	Benchmark Senior Living - Bolton St	Assisted living facility with a special care unit, including parking and utilities	Completed
QQ	Slocumb Ln Subdivision	Residential subdivision	Planned
R	Poirier Drive	New elementary school - Richer-Goodnow School	Completed
RR	Bolvin Dr Subdivision	Residential subdivision	Completed
S	416 Boston Post Rd.	Medical marijuana treatment center and retail marijuana establishment.	Completed
SS	Bemis Rd Subdivision	Residential subdivision	Completed
T	200 Forest St	123 apartment units	Completed
TT	Lacombe St Subdivision	Residential subdivision	Permitted
U	William Street Crossing	Two-story industrial use building with a 20,389 s.f. footprint. Williams Street Crossing	Completed
V	Whittemore House	Demolition of existing Whittemore House and construction of a new dormitory building with childcare	Completed
W	27 Jefferson St	Two story multi-family dwelling, 11 units, garage under (24 parking spaces)	Completed
X	20 Brigham St	A & P Business Park, Automotive building	Completed
Y	100 Campus Dr	New 312 space, four story structured parking facility. Phase 11A	Completed
Z	E on Main	6 Story building with 32 condo units and a ground floor restaurant	Permitted

DEVELOPMENT IN HAZARD AREAS

In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the hazard maps. The analysis is summarized in Table 35.

The analysis shows that small portions of six of the 46 sites are partially located within a FEMA A or AE flood hazard area, ranging between 1.14% and 14.02% of site area, typically a portion of the lot that is not built on. The vast majority, 40 developments, are not within a designated FEMA flood hazard area. As as the population of Marlborough has grown, new housing has not increased the City's vulnerability. Overall since the 2016 plan, new development poses no significant increase in vulnerability to flood hazards for the City of Marlborough.

With respect to extreme heat, one development site is located in a "hot spot," typically related to large parking lots or dense development with little or no vegetation. About two-thirds of another developments site and 50 percent of two other sites are located in in hot spot areas, as well as smaller portions of five other development sites. Thirty-seven developments are not located in hot spot areas. Given that four of the 46 new developments are 50 percent or more in hot spot areas, new development since the previous plan slightly increased the City's vulnerability to extreme heat.

Regarding landslide risk , all development sites in Marlborough are located in areas designated as low incidence for this hazard. New development has not significanly increase the City's vulnerability to landslides.

All new development in Marlborough is located in areas with the same maximum wind speed (110 mph) and the same amount of average annual snowfall (48-72 inches). Given the uniform level of these hazards city-wide, and considering the most recent Massachusetts State Building Code requirements addressing wind and snow loads, new developments in Marlborough have not significantly increased the City's vulnerability to these two hazards.

Given these growth and development trends, the City's regulations under the Floodplain District, Wetlands and stormwater regulations, and new climate resilience guidelines, and the Massachusetts State Building Code, new developments have not significantly increased the City's overall vulnerability to natural hazards except a potential slight increase in extreme heat, as noted above.

Table 35: Marlborough New Developments in Relation to Hazard Areas

#	Development Site	FEMA Flood Zones	Landslide Risk	Max. Wind Speed	Avg. Annual Snowfall	Hot Spots*
A	Regency at Assabet Ridge		Low Incidence	110 mph	48-72 inches	0.57%
AA	Hayes Memorial Dr. Devonshire @ 495		Low Incidence	110 mph	48-72 inches	

#	Development Site	FEMA Flood Zones	Landslide Risk	Max. Wind Speed	Avg. Annual Snowfall	Hot Spots*
B	Mixed Use District--Marlborough Hill		Low Incidence	110 mph	48-72 inches	25.03%
BB	Hayes Memorial Dr. (Parcel G)		Low Incidence	110 mph	48-72 inches	
C	The Preserve at James		Low Incidence	110 mph	48-72 inches	
CC	28 South Bolton St		Low Incidence	110 mph	48-72 inches	64.87%
D	Lake Williams condos		Low Incidence	110 mph	48-72 inches	1.18%
DD	Simarano Dr - Green District		Low Incidence	110 mph	48-72 inches	
E	Mauro Farm		Low Incidence	110 mph	48-72 inches	
EE	57 Main St.		Low Incidence	110 mph	48-72 inches	
F	Howes Landing Subdivision		Low Incidence	110 mph	48-72 inches	
FF	Hayes Memorial Dr. Lot K		Low Incidence	110 mph	48-72 inches	
G	Cider Knoll Subdivision	7.53% in X: 0.2% Annual Chance of Floodaing	Low Incidence	110 mph	48-72 inches	
GG	19 Ash St. (Trailside Terrace)		Low Incidence	110 mph	48-72 inches	
H	257 (aka 215) Simarano Dr.		Low Incidence	110 mph	48-72 inches	
HH	487 Lincoln St		Low Incidence	110 mph	48-72 inches	
I	Lincoln St (ALTA)		Low Incidence	110 mph	48-72 inches	
II	Hayes Memorial Dr. Lot L	11.04% in A: 1% Annual Chance of Flooding	Low Incidence	110 mph	48-72 inches	
J	Farm Rd. (677-681)		Low Incidence	110 mph	48-72 inches	
JJ	Hayes Memorial Dr. Lot M		Low Incidence	110 mph	48-72 inches	
K	401 Elm St		Low Incidence	110 mph	48-72 inches	
KK	239 Boston Post Rd West		Low Incidence	110 mph	48-72 inches	54.55%
L	739-69 Donald Lynch Blvd		Low Incidence	110 mph	48-72 inches	58.41%
LL	600 Nickerson Rd		Low Incidence	110 mph	48-72 inches	
M	FKA 90 Crowley Dr.		Low Incidence	110 mph	48-72 inches	
MM	700 Nickerson Rd		Low Incidence	110 mph	48-72 inches	

#	Development Site	FEMA Flood Zones	Landslide Risk	Max. Wind Speed	Avg. Annual Snowfall	Hot Spots*
N	Forest & William St.		Low Incidence	110 mph	48-72 inches	
NN	1000 Nickerson Rd		Low Incidence	110 mph	48-72 inches	
O	890 Boston Post Rd		Low Incidence	110 mph	48-72 inches	
OO	Raising Cane's Chicken		Low Incidence	110 mph	48-72 inches	
P	180 Boston Post Rd W.	1.14% in A: 1% Annual Chance of Flooding	Low Incidence	110 mph	48-72 inches	
PP	Jenks Ln Subdivision		Low Incidence	110 mph	48-72 inches	
Q	Benchmark Senior Living		Low Incidence	110 mph	48-72 inches	
QQ	Slocumb Ln Subdivision	13.27% in X: 0.2% Annual Chance of Flooding	Low Incidence	110 mph	48-72 inches	
R	Poirier Drive		Low Incidence	110 mph	48-72 inches	
RR	Bolvin Dr Subdivision		Low Incidence	110 mph	48-72 inches	
S	416 Boston Post Rd.		Low Incidence	110 mph	48-72 inches	38.25%
SS	Bemis Rd Subdivision		Low Incidence	110 mph	48-72 inches	
T	200 Forest St		Low Incidence	110 mph	48-72 inches	14.08%
TT	Lacombe St Subdivision	14.02% in A: 1% Annual Chance of Flooding, no BFE	Low Incidence	110 mph	48-72 inches	
U	William Street Crossing		Low Incidence	110 mph	48-72 inches	
V	Whittemore House	1.06% in AE: 1% Annual Chance of Flooding, and 0.08% in X: 0.2% Annual Chance of Flooding	Low Incidence	110 mph	48-72 inches	
W	27 Jefferson St		Low Incidence	110 mph	48-72 inches	
X	20 Brigham St		Low Incidence	110 mph	48-72 inches	
Y	100 Campus Dr		Low Incidence	110 mph	48-72 inches	4.71%
Z	E on Main		Low Incidence	110 mph	48-72 inches	100.0%

Source: MAPC Surface Temperature Analysis, 2017

***% of site area that is in the top 5% hottest land surface temperature in the MAPC region**

CRITICAL INFRASTRUCTURE IN HAZARD AREAS

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.).

The purpose of mapping the natural hazards and critical infrastructure is to present an overview of hazards in the community, how they relate to critical infrastructure, and to better understand which facilities may be vulnerable to particular natural hazards.

There are 150 facilities identified in Marlborough. These are listed in Table 36 and are shown on the maps in Appendix A. None of the Critical Facilities are located within a FEMA flood hazard area. All critical facilities are in the same hazard category for landslides, snowfall, and wind speeds: the "low incidence" category for landslides, the average annual snowfall category of 48 - 72 inches, and the 100-year wind speed category of 110 mph. No critical facilities are in brush fire hazard areas.

Table36: Marlborough Critical Facilities in Relation to Hazard Areas

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
1	UMASS/Marlborough Hospital	Hospital	Low	No	48-72”	110
2	Marlborough Hills Nursing Home	Nursing Home	Low	No	48-72”	110
3	The Reservoir Nursing Home	Nursing Home	Low	No	48-72”	110
4	Marlborough Animal Hospital	Veterinary Facility	Low	No	48-72”	110
5	CVS Pharmacy	Pharmacy	Low	No	48-72”	110
6	Walgreens	Pharmacy	Low	No	48-72”	110
8	Police Department	Police Station	Low	No	48-72”	110
9	Central Fire Station	Fire Station	Low	No	48-72”	110
10	Fire Station III	Fire Station	Low	No	48-72”	110
11	Pleasant Street Fire Station II	Fire Station	Low	No	48-72”	110
12	Marlborough High School	School	Low	No	48-72”	110
13	Marlborough Middle School	School	Low	No	48-72”	110
14	Kane Elementary School	School	Low	No	48-72”	110
15	Richer Elementary School	School	Low	No	48-72”	110
16	Assabet Valley Regional High School	School	Low	No	48-72”	110
17	Immaculate Conception School	School	Low	No	48-72”	110
18	New England Sports Center	Temporary Morgue	Low	No	48-72”	110
19	Navin Rink	Temporary Morgue	Low	No	48-72”	110
20	New Horizons	Assisted Living	Low	No	48-72”	110
22	Short/Rowe Funeral Home	Funeral Home	Low	No	48-72”	110
23	Collins Funeral Home	Funeral Home	Low	No	48-72”	110
24	Slattery Funeral Home	Funeral Home	Low	No	48-72”	110
25	EDS/Marlborough High School	Emergency Dispensing Site	Low	No	48-72”	110

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
26	EDS/Marlborough Middle School	Emergency Dispensing Site	Low	No	48-72”	110
27	EDS/Assabet Valley Regional	Emergency Dispensing Site	Low	No	48-72”	110
28	City Hall	City Hall	Low	No	48-72”	110
29	Walker Building	Municipal	Low	No	48-72”	110
30	Department of Public Works Facilities	Dept of Public Works	Low	No	48-72”	110
34	Council on Aging	Elderly Housing	Low	No	48-72”	110
35	Senior Housing	Elderly Housing	Low	No	48-72”	110
36	Senior Housing	Elderly Housing	Low	No	48-72”	110
37	Next Generation Day Care	Daycare	Low	No	48-72”	110
38	Bright Horizons Day Care	Daycare	Low	No	48-72”	110
39	Bright Horizons Day Care	Daycare	Low	No	48-72”	110
40	Kinder Care Learning Center	Daycare	Low	No	48-72”	110
41	Our Future Learning Ctr.	Daycare	Low	No	48-72”	110
42	Children's World Learning Center	Daycare	Low	No	48-72”	110
43	Bouvier Pharmacy	Pharmacy	Low	No	48-72”	110
44	Marriott Courtyard Hotel	Hotel	Low	No	48-72”	110
45	Embassy Suites Hotel	Hotel	Low	No	48-72”	110
46	Holiday Inn Hotel	Hotel	Low	No	48-72”	110
47	Royal Plaza/Best Western	Hotel	Low	No	48-72”	110
48	Hampton Inn Hotel	Hotel	Low	No	48-72”	110
49	Extended Stay America Hotels	Hotel	Low	No	48-72”	110
50	Solomon Pond Mall	Shopping Mall	Low	No	48-72”	110
51	Westerly Wastewater Treatment Plant	Wastewater Treatment Facility	Low	No	48-72”	110

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
52	Water Treatment Plant	Water Treatment Plant	Low	No	48-72”	110
53	Easterly Wastewater Treatment Plant (Also Cell Tower on site)	Wastewater Treatment/ Cell Tower	Low	No	48-72”	110
54	Jaworek School	School	Low	No	48-72”	110
55	Assabet Valley Collaborative	School	Low	No	48-72”	110
56	Early Childhood Center	School	Low	No	48-72”	110
57	Glenhaven Academy - JRI	School	Low	No	48-72”	110
58	Hillside School	School	Low	No	48-72”	110
59	Intermediate Elementary	School	Low	No	48-72”	110
60	The Cottage Children's Center	Daycare	Low	No	48-72”	110
61	The Little Flower Learning Center	Daycare	Low	No	48-72”	110
62	New Covenant Christian	School	Low	No	48-72”	110
63	AMSA Charter School	School	Low	No	48-72”	110
64	Marlborough Police Station	EOC	Low	No	48-72”	110
65	Marlborough Fire Headquarters	EOC	Low	No	48-72”	110
66	Adventure Club-Kane School	Daycare	Low	No	48-72”	110
67	Discovery Club – Boys & Girls Club	Daycare	Low	No	48-72”	110
68	Discovery Club-Richer School	Daycare	Low	No	48-72”	110
69	Happy Hours Preschool	Daycare	Low	No	48-72”	110
70	Kids' Quarters	Daycare	Low	No	48-72”	110
71	Meadowbrook Child Garden Preschool	Daycare	Low	No	48-72”	110
72	Our Lady Preschool of Learning Center	Daycare	Low	No	48-72”	110
73	Saint Anne Montessori School	Daycare	Low	No	48-72”	110
74	SMOC Family Child Care	Daycare	Low	No	48-72”	110
75	Marlborough Child Care & Head Start	Daycare	Low	No	48-72”	110

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
76	PS017-1	Sewer Pump Station	Low	No	48-72”	110
77	PS085-2	Sewer Pump Station	Low	No	48-72”	110
78	PS073-3	Sewer Pump Station	Low	No	48-72”	110
79	PS046-4	Sewer Pump Station	Low	No	48-72”	110
80	PS010-5	Sewer Pump Station	Low	No	48-72”	110
81	PS084-6	Sewer Pump Station	Low	No	48-72”	110
82	PS006-7	Sewer Pump Station	Low	No	48-72”	110
83	PS092-8	Sewer Pump Station	Low	No	48-72”	110
84	PS028-9	Sewer Pump Station	Low	No	48-72”	110
85	PS104-10	Sewer Pump Station	Low	No	48-72”	110
86	PS017-12	Sewer Pump Station	Low	No	48-72”	110
87	PS007-13	Sewer Pump Station	Low	No	48-72”	110
88	PS080-14	Sewer Pump Station	Low	No	48-72”	110
89	PS014-17	Sewer Pump Station	Low	No	48-72”	110
90	PS038-18	Sewer Pump Station	Low	No	48-72”	110
91	PS018-19	Sewer Pump Station	Low	No	48-72”	110
92	PS036-20	Sewer Pump Station	Low	No	48-72”	110
93	PS051-21	Sewer Pump Station	Low	No	48-72”	110
94	PS047-22	Sewer Pump Station	Low	No	48-72”	110
95	PS074-23	Sewer Pump Station	Low	No	48-72”	110
96	PS094-24	Sewer Pump Station	Low	No	48-72”	110
97	PS105-25	Sewer Pump Station	Low	No	48-72”	110
98	PS113-26	Sewer Pump Station	Low	No	48-72”	110
99	PS031-27	Sewer Pump Station	Low	No	48-72”	110
100	PS080-37	Sewer Pump Station	Low	No	48-72”	110

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
101	PS088-40	Sewer Pump Station	Low	No	48-72”	110
102	PS042-41	Sewer Pump Station	Low	No	48-72”	110
103	PS042-42	Sewer Pump Station	Low	No	48-72”	110
104	PS042-43	Sewer Pump Station	Low	No	48-72”	110
105	PS063-44	Sewer Pump Station	Low	No	48-72”	110
106	PS058-45	Sewer Pump Station	Low	No	48-72”	110
107	PS049-46	Sewer Pump Station	Low	No	48-72”	110
108	PS049-47	Sewer Pump Station	Low	No	48-72”	110
109	PS049-48	Sewer Pump Station	Low	No	48-72”	110
110	PS062-34	Sewer Pump Station	Low	No	48-72”	110
111	PS058-35	Sewer Pump Station	Low	No	48-72”	110
112	PS109-36	Sewer Pump Station	Low	No	48-72”	110
113	PS036-37	Sewer Pump Station	Low	No	48-72”	110
114	PS008-38	Pump Chamber	Low	No	48-72”	110
115	PS074-39	Pump Chamber	Low	No	48-72”	110
116	PS073-41	Sewer Pump Station	Low	No	48-72”	110
117	PS041-42	Pump Chamber	Low	No	48-72”	110
118	PS033-42	Pump Chamber	Low	No	48-72”	110
119	PS033-43	Pump Chamber	Low	No	48-72”	110
120	PS085-45	Sewer Pump Station	Low	No	48-72”	110
121	PS055-46	Pump Chamber	Low	No	48-72”	110
122	PS030-47	Sewer Pump Station	Low	No	48-72”	110
123	Substation	Substation	Low	No	48-72”	110
124	Substation	Substation	Low	No	48-72”	110
125	Substation	Substation	Low	No	48-72”	110

ID	Name	Type	Landslide Risk	Within FEMA Flood Zone	Average Annual Snow Fall	100-year wind speed (mph)
126	Substation	Substation	Low	No	48-72”	110
127	Spoonhill Tank	Storage Tank	Low	No	48-72”	110
128	Sligo Hilal (also Cell Tower on site)	Storage Tank-Cell Tower	Low	No	48-72”	110
129	Fairmont hill	Storage Tank	Low	No	48-72”	110
130	Carroll Water Treatment Plant	MWRA water Treatment	Low	No	48-72”	110
131	Gas Compressor	Gas Compressor	Low	No	48-72”	110
132	Hilton Garden Inn	Hotel	Low	No	48-72”	110
133	Quality Inn	Hotel	Low	No	48-72”	110
134	Residence Inn by Marriot	Hotel	Low	No	48-72”	110
135	Hyatt Place	Hotel	Low	No	48-72”	110
136	Fairfield Inn	Hotel	Low	No	48-72”	110
137	Goodnough Elementary School	School	Low	No	48-72”	110
138	Montessori School	School	Low	No	48-72”	110
139	Crossroads School	School	Low	No	48-72”	110
140	AFC Urgent Care	Urgent Care	Low	No	48-72”	110
141	Carewell Urgent Care	Urgent Care	Low	No	48-72”	110
142	Christopher Heights	Assisted Living	Low	No	48-72”	110
143	The Branches	Assisted Living	Low	No	48-72”	110
144	Learning Experience	Day Care	Low	No	48-72”	110
145	Hearthstone Alzheimer Care	Alzheimer Care	Low	No	48-72”	110
146	Alliance Health at Marie Esther	Nursing Home, Rehab,	Low	No	48-72”	110
147	Aging Well Adult Day Healthcare	Adult Day Healthcare	Low	No	48-72”	110
148	Fun Life Adult Day Care	Adult Day Healthcare	Low	No	48-72”	110
149	Meadows Retirement Apartments	Over 55 rental	Low	No	48-72”	110
150	Pleasant Hill Retirement Community	All Inclusive Rental units	Low	No	48-72”	110

VULNERABILITY ASSESSMENT

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software. The methodology for flooding was developed specifically to address the issue in many of the communities where flooding was not solely related to location within a floodplain.

Introduction to HAZUS-MH

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to http://www.fema.gov/plan/prevent/hazus/index.shtm

> "HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.
>
> HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations."

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed using Level 1 data. Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the City of Marlborough, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is "subject to a great deal of uncertainty."

However, for the purposes of this plan, the analysis is useful. This plan is attempting to generally indicate the possible extent of damages due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential damages from the hazards.

ESTIMATED DAMAGES FROM HURRICANES

The HAZUS software was used to model potential damages to the community from a 100 year and 500 year hurricane event; storms that are 1% and .0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the City, bringing the strongest winds and greatest damage potential.

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

Table 37 - Estimated Damages from Hurricanes

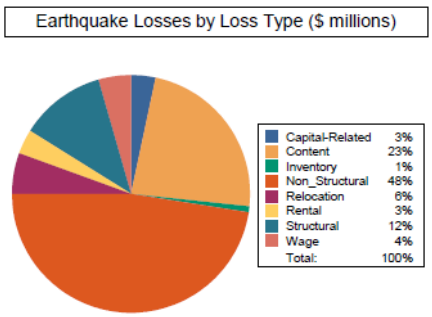
	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	12,017	
Estimated total building replacement value (2006 $)	6,407,000,000	
Building Damages		
# of buildings sustaining NO damage	11,706	9,988
# of buildings sustaining minor damage	276	1,658
# of buildings sustaining moderate damage	34	349
# of buildings sustaining severe damage	1	15
# of buildings destroyed	0	6
Population Needs		
# of households displaced	0	
# of people seeking public shelter	0	
Debris		
Building debris generated (tons)	1,718	8,501
Tree debris generated (tons)	5.594	14,443
Total debris generated (tons)	7,320	22,944
# of truckloads to clear building debris	69	340
Value of Damages		
Total property damage (buildings and content)	25,527,350	103,879,600
Losses due to business interruption	1,076,350	8,452,480
Total losses	26,603,700	112,332,080

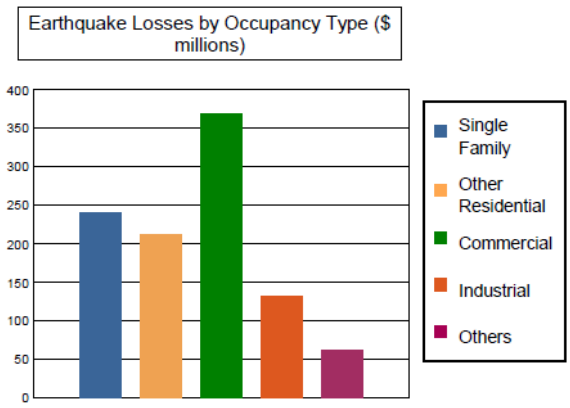
ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and magnitude 7.0. However, there was a technical problem with HAZUS running the 7.0 scenario. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 38 - Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	12,017	
Estimated total building replacement value	6,407,000,000	
Building Damages		
# of buildings sustaining NO damage	5,657	
# of buildings sustaining slight damage	3,405	
# of buildings sustaining moderate damage	2,072	
# of buildings sustaining extensive damage	698	
# of buildings completely damaged	185	
Population Needs		
# of households displaced	900	
# of people seeking public shelter	494	
Debris		
Building debris generated (tons)	204,000	
# of truckloads to clear debris (@ 25 tons/truck)	8,160	
Value of Damages (Millions of dollars)		
Total property damage	$846,565,300	
Total losses due to business interruption	$168,927,700	
Total Losses	$1,015,490,000	





ESTIMATED DAMAGES FROM FLOODING

The HAZUS flooding module allows users to model the potential damages caused by a 100-year flood event and a 500-year flood event.

Table 39: Estimated Damages from Flooding

	100-Year Flood	500-Year Flood
Building Characteristics		
Estimated total number of buildings	12,017	
Estimated total building replacement value	6,407,000,000	
Building Damages		
# of buildings sustaining limited damage	5	12
# of buildings sustaining moderate damage	5	3
# of buildings sustaining extensive damage	0	0
# of buildings substantially damaged	0	0
# Total building with damages	10	15
Population Needs		
# of households displaced	62	79
# of people seeking public shelter	2	5
Value of Damages		
Building Losses	$11,560,000	$14,840,000
Losses due to business interruption	$11,790,000	$14,140,000
Total of All Losses	$23,350,000	$28,980,000

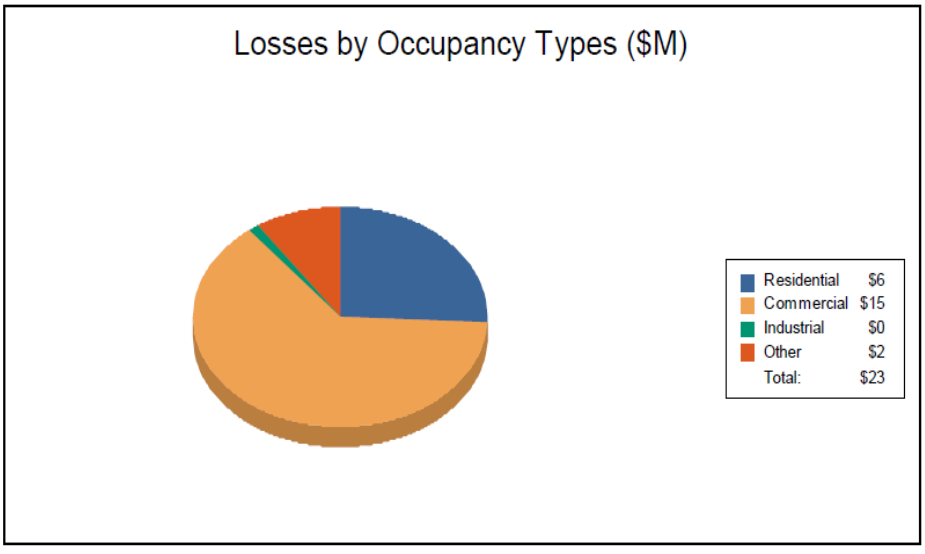


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Table 40: Summary of Hazard Risks for Society, Built Environmetn, and Natural Resources

CLIMATE CHANGE	NATURAL HAZARD	KEY CONCERNS SOCIETY	KEY CONCERNS BUILT ENVIRONMENT	KEY CONCERNS NATURAL RESOURCES
Changes in Precipitation 	Inland Flooding	Elderly residents and environmental justice populations; property damage. Impacts on businesses	Roadway closures, damage to buildings; impacts on infrastructure	Pollutants, erosion, scouring, damage to habitat
	Drought	Increases costs for irrigation, drinking water supply	Impacts on landscaped areas, parks, playing fields, etc.	Impacts on streams, wetlands, vegetation
	Landslide	Private property damage	Damage to buildings and infrastructure	Erosion, sedimentation
Sea Level Rise 	Coastal Flooding	Property damage, impacts on businesses	Roadway closures, damage to buildings; impacts on infrastructure	Damage to coastal habitat
Rising Temperatures 	Average and Extreme Temperatures	Elderly populations if no access to cooling or financial resources to buy an AC		Increasing invasives, stress on aquatic and terrestrial habitats
	Wildfires	Air Quality - Smoke	Damage to buildings	Damage to resources
	Invasive species	Potential health impacts of pests	Impaired use of park and open space	Loss of biodiversity
Extreme Weather 	Hurricanes / Tropical Storms	Power outages; property damage, impacts to businesses	Street closures, house flooding, emergency access, wind damage to buildings, power outages	Tree damage
	Severe Winter Storms	Power outages, elderly, or isolated residents	Damage to public buildings with snow loads, power outages that can affect municipal operations, road blockages.	Tree damage
	Tornadoes	Property damage, impacts on businesses	Damage to buildings and infrastructure	Tree damage
	Thunderstorms/ Microbursts)	Power outages, property damage	Power loss, road closures (same as above)	Tree damage
Non-Climate Hazard	Earthquake	Property damage, impacts on businesses	Damage to buildings and Infrastructure	Landslides

SECTION 5: HAZARD MITIGATION GOALS

The Marlborough Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2008 Hazard Mitigation Plan for the City of Marlborough. All of the goals are considered critical for the City and they are not listed in order of importance.

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

Goal 2: Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

Goal 3: Increase cooperation and coordination among private entities, City officials and Boards, State agencies and Federal agencies.

Goal 4: Increase awareness of the benefits of hazard mitigation through outreach and education.

Goal 5: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 6: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 7: Prevent and reduce the damage to public infrastructure resulting from all hazards.

Goal 8: Encourage the business community, major institutions and non-profits to work with the City to develop, review and implement the hazard mitigation plan.

Goal 9: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 10: Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

Goal 11: Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

Goal 12: Consider the impacts of climate change and incorporate climate sustainability and resilience into the City's planning and policies. (Added for this 2024 plan update)

SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the City of Marlborough are a combination of zoning, land use, and environmental regulations, infrastructure maintenance and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. The City's existing mitigation measures are listed by hazard type here and are summarized in Table 41.

Mitigation Measures Relating to Multiple Hazards

There are several mitigation measures that impact more than one hazard. These include the Comprehensive Emergency Management Plan (CEMP), the Massachusetts State Building Code and participation in a local Emergency Planning Committee.

Comprehensive Emergency Management Plan (CEMP)
Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. Marlborough's CEMP is currently being updated.

Massachusetts State Building Code
The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads. The City of Marlborough has adopted the "Stretch Code." For enhanced energy efficiency.

Participation in the Local Emergency Planning Committee (LEPC)
Marlborough has its own LEPC. The City is currently trying to fill a position to get certified.

Flood Related Hazards

Participation in the National Flood Insurance Program (NFIP)
Marlborough participates in the NFIP with 34 policies in force as of the July 9, 2022. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at http://www.fema.gov/nfip/pcstat.shtm. The reporting period covers from 1978 to the present day. The following information is provided for the City of Marlborough.

Flood insurance policies in force	34
Coverage amount of flood insurance policies	$11,260,000
Premiums paid	$16,052
Closed losses (Losses that have been paid)	13
Substantial Damages Paid since 1978	1
Total payments (Total amount paid on losses)	$36,845

Since the 2016 Hazard Mitigation Plan, the number of NFIP policies has decreased from 36 to 34, the amount of coverage has increased from to $9,255,000 to $11,260,000, and the total payments have increased from to $19,580 to $36,845. Despite these

increases, these are relatively low compared to many other communities in the greater Boston region.

Since 1978 there has been only one claims paid for substantial damage (see table above). The City implements the Substantial Improvements/Substantial Damages provisions of the floodplain management regulations as required per the NFIP (CFR Title 44, Parts 59 through 65) and Massachusetts State Building Code (780CMR). The Town will also coordinate with State Flood Hazard Management Program staff to assure that proper practices are followed and that a post-disaster plan will be in place to implement all Substantial Improvements/Substantial Damages provisions.

Street sweeping
Every street gets swept once a year in accordance with the provisions of the MS4 Stormwater Permit issued by EPA, with downtown streets cleaned twice per week in season. The work is performed by the city.

Catch basin cleaning
The city's 5000 catch basins are cleaned annually in accordance with the provisions of the MS4 Stormwater Permit issued by EPA.

Roadway treatments
The city uses a brine treatment of the roads for snow and ice control.

Drainage infrastructure and preventive practices to reduce clogging and ensure proper functioning. Some areas of downtown are prone to clogging and are checked by the Street Division regularly. Drainage projects have been incorporated into the city's Capital Improvement Program since 1990 and the city has replaced over 100 catch basins over the last decade using permitting mitigation funding

Subdivision Rules and Regulations
All subdivision drainage must be designed to meet the latest DEP Stormwater Management Regulations, and must create no adverse downstream impacts.

Zoning Regulations

- A stormwater and erosion control ordinance was adopted in 2011

- Wetlands Setback: In acting upon Notices of Intent and Determination of Applicability, the Conservation Commission will presume that any alteration or construction within 30 ft. of a wetland boundary would have a significant adverse impact on the wetlands, and such alteration or construction shall not be permitted unless the applicant demonstrates that (1) such activity would not have such an impact, or (2) public benefits, such as health or safety, outweighs any such impact, or (3) the activity involves the maintenance of existing structures, or (4) the activity is the installation of the stormwater outlet structure.

- Drainage standards are considered effective. Current city policy requires that all development and redevelopment projects must meet the state DEP Stormwater Regulations, regardless of its proximity to a wetland. Projects within the Millham

or Sudbury River watershed areas, which cover about 75% of the city, must treat the first one inch of runoff versus just 0.5 inches of runoff for other areas.

- The Site Plan Review ordinance requires the Site Plan to show adequate measures to prevent pollution of surface or ground water, to minimize erosion, sedimentation, increased rate of runoff and potential for flooding.

- Development in the Water Supply Protection District limits lot coverage by building type, requires previously developed lots to reduce impervious surface to meet lot coverage standards and establishes a 50-foot no-touch zone for wetland resource area projects. Since the previous plan the City has been 100% supplied by the Massachusetts Water Resources Authority due to elevated levels of sodium chloride in its local water sources. The local reservoirs are retained as emergency backup sources

- Shared parking in mixed use area is allowed, 3 % of parking lots over 50 spaces must be landscaped islands and 33% of lot spaces may be designed for compact cars

- The City has an MVP Action Grant to develop new climate resilient zoning, which is being prepared by a consultant and is expected later in 2023.

Updated Floodplain & Wetlands Ordinance
Passed by City Council.

Dam Failures

Comprehensive Emergency Management Plan (CEMP)
The CEMP addresses dam safety issues. Marlborough's CEMP is currently being updated.

State permits required for dam construction
State law requires a permit for the construction of any dam.

DCR dam safety regulations
The state has enacted dam safety regulations mandating inspections and emergency action plans.

Tyler Street Dam
This dam is owned by the Department of Conservation and Recreation and is classified as a high hazard dam. It is inspected annually and found to be in satisfactory condition. An Emergency Action Plan (EAP) for the dam was issued in July 2007 and updated in 2022.

Hager Street Dam This is a small privately owned dam. The dam is classified as being in poor condition but a breach would impact less than five households.

Fort Meadow Dam and Spillway
City owned, the Fort Meadow Dam was last inspected in 2006 and is considered to be in satisfactory condition. An Emergency Action Plan (EAP) for the dam was issued in September 2012 and updated in 2019.

Lake Williams Dam and Spillway
Owned by Division of Conservation and Recreation (DCR). An Emergency Action Plan (EAP) for the dam was issued in September 2012 and updated in 2019.

EAP's for Dams in Northborough and Berlin

Since the previous plan Emergency Action Plans have been prepared for three dams located in neighboring Northborough and one in Berlin which are upstream of Marlborough and could potentially impact the city in the event of a breach. The EAP's in Northborough include Cold Harbor Brook Dam, Hop Brook Dam, and Lester G Ross Floodwater Dam. The EAP in Berlin is for the Retarding Dam.

Wind-Related Hazards

Comprehensive Emergency Management Plan (CEMP)
The City has developed a CEMP that addresses hurricane/tornado concerns. Marlborough's CEMP is currently being updated.

The Massachusetts State Building Code
The City enforces the Massachusetts State Building Code, which has design requirements for wind impacts.

Tree trimming program
The City owns and uses equipment to trim or remove trees as needed, in addition to the work done by National Grid in power line corridors. National Grid recently conducted a large tree trimming effort.

Winter-Related Hazards

Snow Removal and Roadway Treatment
The Public Works Department conducts regular salting of the roads and local plowing. General snow removal by the city. MA Highway clears parts of Route 20 and Fitchburg Street. The snow dump location has been moved since the previous plan.

The Massachusetts State Building Code
The City enforces the Massachusetts State Building Code, which has design requirements for snow loads on roofs.

Brush Fire-Related Hazards

Permits required for outdoor burning
The Fire Department requires a written permit for outdoor burning. The permit issued by the Fire Dept. online.

Subdivision Review
The Fire Department is involved in reviewing all subdivision plans.

Prescribed Burn

The Fire Department recently oversaw a prescribed burn of a 25 acre site of Pitch Pine.

Geologic Hazards

The Massachusetts State Building Code

The City enforces the Massachusetts State Building Code, which has design requirements for earthquakes.

Table 41: Existing Mitigation Measures

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
MITIGATION MEASURES RELATING TO MULTIPLE HAZARDS				
Comprehensive Emergency Management Plan (CEMP)	Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies.	Citywide.	Emphasis is on emergency response.	The CEMP is currently being updated for 2023.
Massachusetts State Building Code	The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads.	Citywide.	Most effective for new construction. The City has adopted the "Stretch Code" for energy efficiency.	Updates to the State Building Code are pending.
Participation in the Local Emergency Planning Committee (LEPC)	Marlborough has its own LEPC.	Citywide.	Provides a forum for cooperation on issues related to natural and man-made disaster.	The City is trying to fill a position to get certified.
FLOOD RELATED HAZARDS				
Participation in the National Flood Insurance Program (NFIP)	Homeowners in the floodplain can purchase flood insurance.	Areas identified on the FIRM maps.	There are 34 policies in force.	Encourage all eligible homeowners to obtain insurance.

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
Street sweeping	Every street gets swept once a year with downtown streets cleaned twice per week in season. The work is performed by the city.	Citywide.	Effective.	None.
Catch basin cleaning	The city's 5000 catch basins are cleaned on a 2.5 year cycle, with approximately 175 basins cleaned yearly.	Citywide.	Effective.	None.
Roadway treatments	The city uses a brine solution to treat the roads.	City roads.	Effective	None.
Drainage infrastructure and preventive practices to reduce clogging and ensure proper functioning. Some areas of downtown are prone to clogging and are checked by the Street Division regularly.	Drainage projects have been incorporated into the city's Capital Improvement Program since 1990 and the city has replaced over 100 catch basins over the last decade using permitting mitigation funding.	Citywide.	Effective.	Additional resources to fund infrastructure maintenance and repair.
Subdivision Rules and Regulations	All subdivision drainage must be designed to meet the latest DEP Stormwater Management Regulations, and must create no adverse downstream impacts.	Citywide.	Effective.	None.
Zoning Regulations	• A stormwater and erosion control ordinance was adopted in 2011. • Wetlands Setback: In acting upon Notices of Intent and Determination of Applicability, the Conservation Commission will	Citywide or areas shown on the zoning and FIRM maps as floodplain.	Effective. Wetlands setback was increased from 20 to 30 feet.	The City has an MVP Action Grant to develop new climate resilient zoning, which is being prepared by a consultant and is expected later in 2023. Consider feasibility of creating a Stormwater Utility.

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
	presume that any alteration or construction within 30 ft. of a wetland boundary would have a significant adverse impact on the wetlands, and such alteration or construction shall not be permitted unless the applicant demonstrates that (1) such activity would not have such an impact, or (2) public benefits, such as health or safety, outweighs any such impact, or (3) the activity involves the maintenance of existing structures, or (4) the activity is the installation of the stormwater outlet structure. • Drainage standards are considered effective. Current city policy requires that all development and redevelopment projects must meet the state DEP Stormwater Regulations, regardless of its proximity to a wetland. Projects within the Millham or Sudbury River watershed areas, which cover about 75% of the city,			Consider adopting parking maximums.

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
	must treat the first one inch of runoff versus just 0.5 inches of runoff for other areas. • The Site Plan Review ordinance requires the Site Plan to show adequate measures to prevent pollution of surface or ground water, to minimize erosion, sedimentation, increased rate of runoff and potential for flooding. • Development in the Water Supply Protection District limits lot coverage by building type, requires previously developed lots to reduce impervious surface to meet lot coverage standards and establishes a 50-foot no-touch zone for wetland resource area projects. • Shared parking in mixed use area is allowed, 3 % of parking lots over 50 spaces must be landscaped islands and 33% of lot spaces may be designed for compact cars			

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
Updated Floodplain & Wetlands Ordinance	• Passed by City Council.	Citywide.	Effective	Updates will be included in the MVP Action grant project.
DAM FAILURES				
Comprehensive Emergency Management Plan (CEMP)	The CEMP addresses dam safety issues.	Citywide.	Emphasis is on emergency response.	None.
State permits required for dam construction	State law requires a permit for the construction of any dam.	State-wide.	Most effective for ensuring construction meets the code.	None
DCR dam safety regulations	The state has enacted dam safety regulations mandating inspections and emergency action plans.	State-wide.	Enforcement is an issue.	Staffing and budgeting needs to be addressed.
Tyler Street Dam	This dam is owned by the Department of Conservation and Recreation and is classified as a high hazard dam. It is inspected annually and found to be in satisfactory condition. An Emergency Action Plan (EAP) for the dam was issued in July 2007.	Normally impounds 650 acre-feet of water, with a maximum impoundment of 2,060 acre-feet of water.	Effective.	Emergency Action Plan (EAP) was updated in 2022. Establish regular inspection and maintenance program (DCR).
Hager Street Dam	This is a small privately owned dam. It is classified as being in poor condition but a breach would impact fewer than five households.	The dam has a normal impoundment of 144 acre-feet and a maximum impoundment of 400 acre-feet.	Somewhat effective.	Coordinate with owner(s) to make necessary repairs and establish a regular inspection and maintenance schedule. The dam could possibly be removed.
Fort Meadow Dam and Spillway	Fort Meadow Dam and Spillway: City owned, the Fort Meadow Dam was last inspected in	The Fort Meadow Reservoir has maximum	Effective.	Continue regular inspection and maintenance plan.

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
	2006 and is considered to be in satisfactory condition. An Emergency Action Plan (EAP) for the dam was issued in September 2012.	structural height of approximately 30 feet and a maximum storage capacity of 4,800 acre-feet.		
Lake Williams Dam and Spillway	Owned by Division of Conservation and Recreation (DCR). An Emergency Action Plan (EAP) for the dam was issued in September 2012.	Lake Williams The dam has a maximum structural height of approximately 11 feet and a maximum storage capacity of 500 acre-feet.	Effective.	Continue regular inspection and maintenance plan.
Dams in Northborough and Berlin	Emergency Action Plans have been prepared for three dams in Northborough and one in Berlin that are upstream of Marlborough and could potentially impact the city in the event of a breach.	Cold Harbor Brook Dam, Hop Brook Dam, and Lester G Ross Floodwater Dam in Northborough and Retarding Dam in Berlin.	Effective	Periodically update the EAPs
WIND-RELATED HAZARDS				
Comprehensive Emergency Management Plan (CEMP)	The City has developed a CEMP that addresses hurricane/tornado concerns.	Citywide.	Effective primarily for emergency response	The CEMP is currently being updated by the City..
The Massachusetts State Building Code	The City enforces the Massachusetts State Building Code.	Citywide.	Effective for most situations except severe storms	None.
Tree trimming program	The City owns and uses equipment to trim or remove trees as needed, in addition to the work done by National Grid in power line corridors.	Citywide.	Effective.	National Grid recently conducted a large tree trimming effort.

Type of Existing Protection	Description	Area Covered	Effectiveness /Enforcement	Improvements/ Changes Needed
WINTER-RELATED HAZARDS				
There are no specific measures beyond regular salting and sanding of the roads and local plowing.	General snow removal by the city. MA DOT clears parts of Route 20 and Fitchburg Street.	Citywide.	Effective.	Improvements to the DPW yard are in progress.
BRUSH FIRE RELATED HAZARDS				
Permits required for outdoor burning.	The Fire Department requires a written permit for outdoor burning.	Citywide.	Effective.	Permits may now be obtained online.
Subdivision Review	The Fire Department is involved in reviewing all subdivision plans.	Citywide.	Effective.	None.
Prescribed Burn	The Fire Department recently oversaw a prescribed burn of a 25 acre site of Pitch Pine.	One 25 acres site	Effective	None.
GEOLOGIC HAZARDS				
The Massachusetts State Building Code	The City enforces the Massachusetts State Building Code.	Citywide.	Effective for most situations.	None.

Local Capabilities for Implementation

The City of Marlborough has recognized several existing mitigation measures that require implementation, enforcement, or improvements, and has the capacity within its local boards and departments to address these. The Marlborough Department of Public Works has staff and resources available and will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure and oversight of the Emergency Action Plan for the Fort Meadow Dam. The City's Planning Board has resources available to address updates to the Master Plan and implementation of the Floodplain & Wetlands Ordinance and Subdivision Rules and Regulations. The Conservation Commission has a full time Conservation Officer who oversees implementation of the Wetlands Protection Act and the Open Space Plan. The City's Building Inspector has the resources and capacity to enforce the Massachusetts Building Code. The Fire Department has staff and resources to implement burning permits and address brushfire issues.

SECTION 7: MITIGATION MEASURES FROM THE 2016 PLAN

IMPLEMENTATION PROGRESS OF THE PREVIOUS PLAN

Since approval of the 2016 plan the City has integrated mitigation into City policies and processes and made progress with several mitigation measures. These include:

- City completed a Municipal Vulnerability Preparedness (MVP) planning process in 2018 and has been designated an MVP Community by the Executive Office of Energy and Environmental Affairs. Much of the critical data in the City's 2016 Hazard Mitigation Plan was utilized in the MVP planning process. The MVP project referred to the 2016 plan's assessment of critical infrastructure and local hazard vulnerability to inform the MVP project. When the MVP project was completed, it in turn contributed to this 2024 updated Hazard Mitigation Plan. Several mitigation actions put forward at the MVP workshop have been integrated into this Hazard Mitigation Plan update.

- Based on the MVP designation, the City secured an MVP Action Grant to conduct a climate resilience project to upgrade development guidelines. In 2023 the City completed Resilience Design Guidance to address flooding, heat, and other natural hazards for new developments.

- Implementation of capital projects such as completion of flood mitigation for the Boundary Street Bridge, replacement of a culvert on Route 85, and replacement of the Millham Brook culvert on Elm Street.

- Fire management activities included a 25-acre prescribed burn on the Desert Conservation Area, with plans for 30 additional acres on an adjacent site, and logging operations in the Millham Reservoir watershed area.

- Mitigation for winter hazards include the design and rehabilitation of the salt sheds and fuel depot, and implementation of pre-treatment of streets with a brine mixture for better management of snow and ice. Emergency backup generators were installed for City Hall and the Police Department.

The Local Team reviewed the recommended mitigation measures identified in the city's 2016 HMP and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this 2024 HMP update. The decision on whether to delete or retain a particular measure was based on the Local Team's assessment of the continued relevance or effectiveness of the measure. The table below summarizes the status of mitigation measures from the 2016 plan.

At a meeting of the Marlborough Hazard Mitigation Team, City staff reviewed the mitigation measures identified in the 2016 Marlborough Hazard Mitigation Plan and determined whether each measure had been completed, partially completed, or not completed. Of those measures that had not been completed, the local team evaluated if the measures are still relevant and whether they should be deleted or carried forward into this Hazard Mitigation Plan 2024 Update. For those measures carried forward to this plan, the local team also considered if any revisions to the mitigation is needed, and whether the priority assigned in the previous plan should be retained or changed for this plan update. Table 42 summarizes the current status of mitigation measures. The last column indicates if mitigation measures are being carried over into this 2024 plan update, and if so, if there are any revisions or change in priority.

Table 42: Status of Mitigation Measures from the 2016 Plan

Mitigation Measure	2016 Priority	Current Status 1. Completed 2. Partially Completed 3. Not Completed?	2024 Plan Update 1. Keep in 2024plan? 2. Revise for 2024? 3. Change Priority? 4. Delete 2024 Plan?
FLOODNG HAZARDS			
A. *Flooding--drainage repair:* Conduct a feasibility study to consider the adoption of a Stormwater Utility	Medium	**Not Completed**	**Delete from 2024 Plan:** No longer a priority for the City
B. *Flooding: land protection and acquisition*: Acquire Shoestring Hill parcel for open space, flood mitigation	Medium	**Not Completed** *(part of larger acquisition effort to be done in next phase)*	**Keep in 2024 Plan** Change priority to HIGH
C. *Flooding: Glen St./Millham Brook:* Install new drain lines on Ripley Street, reconfigure brook & inlet structure	High	**Partially completed:** Glen St. drainage work done, still needs inlet structure (design for this done, implementation will be the next phase)	**Keep in 2024 Plan**
D. *Flooding: Mowry Brook at Brook Village*: Modify culverts from East Main Street to Curtis Avenue & Cook Lane	High	**Partially completed:** Brook was cleaned; no calls reporting problems for several years	**Revise for 2024:** Monitor for flood potential; change priority to LOW
E. *Flooding: Culvert on Route 85:* Replace with larger culvert: at 50 % design	High	**Completed**	**Delete for 2024**
F. *Hager Street Dam*: Establish regular maintenance plan	High	**Not completed**	**Revise for 2024:** Plan to evaluate options to repair, replace, or remove dam and prepare designs. High cost, city does not own it

Mitigation Measure	2016 Priority	Current Status 1. Completed 2. Partially Completed 3. Not Completed?	2024 Plan Update 1. Keep in 2024plan? 2. Revise for 2024? 3. Change Priority? 4. Delete 2024 Plan?
G. Flooding--regulatory: Adopt a new flood zone map	Medium	**Partially Completed** City adopted 2014 FEMA flood hazard map, planning to amend Zoning Ordinance	**Revise for 2024** Adopt revisions to the Zoning Ordinance
H. *Flooding-Culvert on Elm Street*: Replace culvert on Elm Stret at Millham Brook	High	**Completed**	**Delete for 2024**
WINTER HAZARDS			
I. *Winter Storms*: Design & rehab of salt sheds, rehab gas/diesel fueling depot	High	**Completed**	**Revise for 2024:** Add snow storage facility
J. *Winter storms*: Apply pre-treatment brine before storms	High	**Completed**	**Delete for 2024**
GEOLOGIC HAZARDS			
K. E*arthquakes: Unreinforced Masonry Buildings*: Conduct an assessment of earthquake vulnerability of public safety buildings and feasibility of retrofits if needed	Medium	**Not completed** *(Funding was not secured after the 2016 plan; City will revisit options to implement this in the next phase)*	**Keep in 2024 Plan**
EXTREME TEMPERATURE HAZARDS			
L. *Extreme high temperatures:* Conduct a feasibility analysis of creating cooling centers in existing and new municipal facilities and implement any cost effective alternatives.	High	**Partially Completed**	**Revise for 2024:** Re-evaluate shelters (MVP Plan recommendation). Senior Center, High School, and Middle School
WIND HAZARDS			
M. *High winds:* Public education on mitigating against and preventing property damage and avoiding personal injury due to blowing or falling debris, tress or structures	Medium	**Not completed** *(Funding was not secured for this after the 2016 plan; the City will revisit options to implement this in the next phase, along with related MVP recommendations)*	**Keep in 2024 Plan**
WILDFIRE HAZARDS			
N. *Brush Fires*: Establish a new fire station in the western part of the city	High	**Partially Completed:** Land acquisition and planning for fire station	**Keep in 2024 Plan**
MULTI-HAZARDS			
O. *Multiple Hazards--Power Outages*: Acquire: 2 new 200	Medium	**Partially Completed:** New generators installed	**Revise for 2024:** Assess backup

Mitigation Measure	2016 Priority	Current Status 1. Completed 2. Partially Completed 3. Not Completed?	2024 Plan Update 1. Keep in 2024plan? 2. Revise for 2024? 3. Change Priority? 4. Delete 2024 Plan?
Kw, fixed generator for 2 schools		in City Hall, Police Station	power needs in remaining buildings--DPW, City Hall, Jared School, Middle School

SECTION 8: HAZARD MITIGATION STRATEGY

WHAT IS HAZARD MITIGATION?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Building Resilient Infrastructure and Communities (BRIC) grant, and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

- https://www.fema.gov/hazard-mitigation-grant-program
- https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities
- https://www.fema.gov/flood-mitigation-assistance-grant-program

According to FEMA Local Multi-Hazard Mitigation Planning Guidance, identified measures can generally be sorted into the following groups:

- Prevention: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- Property Protection: Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- Public Education & Awareness: Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- Natural Resource Protection: Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- Structural Projects: Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- Emergency Services Protection: Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-community and require cooperation between two or more municipalities. There is a third level of mitigation which is regional and may involve a state, regional or federal agency or three or more municipalities.

REGIONAL PARTNERS

In densely developed urban communities such as the metropolitan Boston area, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are complex systems of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including the City, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), and the Massachusetts Department of Transportation (MassDOT). The planning, construction, operation and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities' regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and they must make decisions about numerous competing priorities.

REGIONAL ISSUES

The Local Team did not identify site-specific regional issues impacting the city but did agree that all communities within the region share common concerns including the following:

- Maintenance and drainage from state highways, which include I-495 and State Routes 20 and 85.
- Inspection and maintenance of state- and privately-owned dams
- Coordinated response to wildfires on state- and privately-owned properties
- The regional impacts of drought, as many communities surrounding Marlborough rely on local groundwater and surface water sources for public drinking water.
- Emergency Planning and Community Right to Know (EPCRA) filers (Local Emergency Planning Committees (LEPC) would have a list and significant Hazardous Waste Sites that could impact a community during a disaster
- Transportation of hazardous materials through communities by rail or truck

NEW DEVELOPMENT AND INFRASTRUCTURE

As part of the process of developing recommendations for new mitigation measures for this plan update, the City considered the issues related to new development, redevelopment, and infrastructure needs in order to limit future risks. Taking into consideration the City's Floodplain Zoning District, the Stormwater Management bylaw enforced for new development, the Subdivision Rules and Regulations enforced for new development, and the Open Space and Recreation Plan, the city determined that existing regulatory measures are taking full advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development.

RECOMMENDED MITIGATION MEASURES FOR 2024 HMP UPDATE

Marlborough's 2024 mitigation strategy, which was developed by the local Hazard Mitigation Team, includes the following recommended mitigation measures to address multiple natural hazards in the City:

FLOOD HAZARDS

A. **Flooding: Glen St./Millham Brook:** Install new drain lines on Ripley Street, reconfigure brook & inlet structure. Since the 2016 plan, Glen St. work was done, and design for inlet structure was prepared.

B. **Flooding: Mowry Brook at Brook Village:** Drainage work partially completed since the 2016 plan (brook cleanout); no flooding for several years. Continue to monitor for any problems and need for further mitigation.

C. **Dam: Hager Street Dam:** Establish plan for evaluation and design to repair, replace, or remove the dam (unknown private owner, current state emergency maintenance, possible state dam removal).

D. **Dam maintenance**: Ensure maintenance of all existing public and private dams; incorporate projected increase in storms and precipitation intensity as part of maintenance schedule, updating every 5-10 years

E. **Flooding: land protection and acquisition**: Prioritize protection of open space areas in climate vulnerable areas; help limit impacts by increasing the use of open space as a buffer against flooding, extreme heat, and lack of wildlife habitat. Acquire Shoestring Hill parcel for open space, flood mitigation; along with other parcels noted in the city's Open Space and Recreation Plan

F. **Flooding: regulator:** Update Floodplain and Wetlands Protection District ordinance and map to include 2014 FIRM data as part of ordinance update underway in FY 2024.

WINTER HAZARDS

G. **Winter Storms:** Develop a new snow disposal area

GEOLOGIC HAZARDS

H. **Earthquake: Unreinforced Masonry:** Buildings Conduct an assessment of earthquake vulnerability of public safety buildings, IT, and City Hall and evaluate feasibility of retrofits if needed

EXTREME HEAT HAZARDS

I. Extreme high temperatures: Conduct a feasibility analysis of creating cooling centers in existing and new municipal facilities such as the Middle School and High School.

WIND HAZARDS

J. **Power Grid Resilience**: Work to improve power grid protection by increasing tree-trimming and dead tree removal from around electric power lines and other utility areas. Identify and prioritize the more vulnerable areas of the City.

K. **High winds:** Public education on mitigating against and preventing property damage and avoiding personal injury due to blowing or falling debris, tress or structures

FIRE HAZARDS

L. **Brush Fires**: Establish a new fire station in the western part of the city. Since the 2016 plan the City has been conducting planning and land acquisition for this facility.

DROUGHT HAZARDS

M. **Drought Mitigation:** Promote drought tolerant landscaping and site design measures: Adopt site development guidelines promoting drought-tolerant plantings and landscape design by using permeable pavement to reduce runoff and increase groundwater recharge

MULITI-HAZARDS

N. **Multiple Hazards: Power Outages:** Acquire backup generators for the Middle Schools, Elementary School, and the full Police facility, and assess backup power needs in remaining municipal buildings

O. **Tree Preservation and Urban Forestry:** Prepare a City tree preservation ordinance. Additional efforts should be directed towards City forestry management, tree planting, pest control and overall forest health maintenance. This would have benefits for multiple hazards, including flooding, extreme heat, and fire protection.

P. **Communications and outreach:** Increase overall communications between City departments and boards with non-English speaking residents, with a particular focus on Brazilian residents. Focus outreach on churches, social clubs and using social media; prioritize getting people signed up for Reverse 911.

PROCESS FOR SETTING PRIORITIES FOR MITIGATION MEASURES

The last step in developing the City's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the City's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Hazard Mitigation Team has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the team member's knowledge of the existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given measure.

Prioritization occurred through discussion at the meeting of the local team and through subsequent review by team members. Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events and the extent of the area impacted and the relation of a given mitigation measure to the City's identified goals. In addition, through the discussion, the local committee also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy, anticipated project costs, whether the City currently had the technical and administrative capability to carry out the mitigation measures, whether any environmental constraints existed, and whether the City would be able to justify the costs relative to the anticipated benefits.

The table below demonstrates the prioritization. For each mitigation measure, the geographic extent of the potential benefiting area is identified. The benefits, costs, and priority were evaluated in terms of the following factors:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event
Estimated Costs	
High	Estimated costs greater than $250,000
Medium	Estimated costs between $100,000 to $250,000
Low	Estimated costs less than $100,000 and/or staff time
Mitigation Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

Priorities for all mitigation measures are shown in Table 43, and the mitigation descriptions, priorities, lead agency, estimated cost, timeframe, and potential funding sources for each mitigation action are shown in Table 43.

Table 43: Mitigation Measure Prioritization

Mitigation Measure	Mitigation Action	Benefit	Estimated Cost	Priority
Flood Hazard Mitigation Measures				
A. *Flooding: Glen St. / Millham Brook*	Complete work on inlet structure (design completed)	High	High	High
B. *Flooding: Mowry Brook at Brook Village*	Monitor for any flooding problems requiring further drainage mitigation.	Low	Low	Low
C. *Dam: Hager Street Dam*	Establish plan for evaluation to repair, replace, or remove the dam.	High	High	High
D. *City-wide dam maintenance*	Ensure maintenance of all existing dams; incorporate projected increased storm intensity into maintenance	Medium	Medium	Medium
E. *Flooding: land protection and acquisition*	Prioritize protection of open space in climate vulnerable areas. Acquire Shoestring Hill and other parcels in the Open Space Recreation Plan	Medium	High	High
F. Flooding: regulatory	Update Floodplain and Wetlands Protection District ordinance and map to include 2014 FIRM data as part of ordinance update in FY 2024.	Medium	Low	High
Winter Storm Hazard Mitigation Measures				
G. *Winter Storms*	Develop a new snow storage facility	Medium	Medium	Medium
Geologic Hazard Mitigation Measures				

Table 43: Mitigation Measure Prioritization

Mitigation Measure	Mitigation Action	Benefit	Estimated Cost	Priority
H. *Earthquake: Unreinforced Masonry Buildings*	Conduct an assessment of earthquake vulnerability of public safety buildings and feasibility of retrofits if needed	Low	Low	Low
Extreme Temperature Mitigation Measures				
I. *Extreme high temperatures*	Conduct a feasibility analysis of creating cooling centers in existing and new municipal facilities such as the Middle School and High School.	Medium	Medium	High
Wind Mitigation Measures				
J. Power Grid Resilience	Improve power grid protection by increasing tree-trimming and dead tree removal around power lines and other utilities. Prioritize the more vulnerable areas of the City.	High	Medium	High
K. *High winds*	Public education on mitigating against and preventing property damage and avoiding personal injury due to blowing or falling debris, tress or structures	Medium	Low	Medium
Fire Hazards				
L. *Brush Fires*	Establish a new fire station in the western part of the city	High	High	High
Drought Hazards				
M. *Drought Mitigation*	Adopt site development guidelines promoting drought-tolerant plantings and landscape design by using permeable pavement	Medium	Low	Medium

Table 43: Mitigation Measure Prioritization

Mitigation Measure	Mitigation Action	Benefit	Estimated Cost	Priority
	to reduce runoff and increase groundwater recharge			
Other Hazards / Mitigation Measures				
N. *Multiple Hazards: Power Outages*	Acquire backup generators for the Middle Schools, Elementary School, and the full Police facility, and assess backup power needs in remaining municipal buildings	Medium	Medium	Medium
O. Tree Preservation and Urban Forestry	Prepare a City tree preservation ordinance. Additional efforts should be directed towards City forestry management, tree planting, pest control and overall forest health maintenance.	Medium	Medium	Medium
P. Communications and outreach	Increase overall communications between City departments and boards with non-English speaking residents. Focus outreach on churches, social clubs and using social media; prioritize getting people signed up for Reverse 911.	Medium	Medium	Medium

RECOMMENDED MITIGATION TABLE

INTRODUCTION TO MITIGATION MEASURES TABLE (Table 44)

Mitigation Type/Location – name, location, or category of the action item.

Mitigation Description– Each mitigation measure is provided with a brief description.

Priority – As described above, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs.

Lead Implementation– based on a general knowledge of what each municipal department is responsible for. Most mitigation measures may require coordination of multiple departments, and assigning staff is the sole responsibility of the governing body of each community. Coordination with state agencies should also be considered.

Estimated Cost – The Local Hazard Mitigation Team assigned a cost category as follows:

Low:	<$100,000 and/or staff time
Medium:	$$100,000 to $250,000
High:	>$250,000

Time Frame – The timeframe was based on a combination of the priority for that measure, the complexity of the measure and whether the measure is conceptual, in design, or already designed and awaiting funding. The timing for all mitigation measures has also been kept within the typical five-year HMP framework. The identification of a likely timeframe is not meant to constrain a community from taking advantage of funding opportunities as they arise. In some cases, target dates are listed. In other cases, the estimated time ranges are used.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for each recommended mitigation measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for or selected for funding. The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. Upon adoption of this plan, the local committee responsible for its implementation should begin to explore the funding sources in more detail.

Abbreviations used in the Table below include:

- DCR: MA Department of Conservation and Recreation
- BRIC: Building Resilient Infrastructure and Communities
- EEA: Massachusetts Executive Office of Energy and Environmental Affairs

- MassDOT: Massachusetts Department of Transportation
- DEP: Department of Environmental Protection
- TAP: Technical Assistance Program (MAPC Grant)
- EMPG: MEMA Emergency Management Performance Grant
- MET: Massachusetts Environmental Trust

Table 44: Recommended Mitigation Strategies						
Mitigation Action/Location	**Mitigation Description**	**Priority**	**Lead Agency Implementation**	**Estimated Cost***	**Estimated Timeframe 2024-28**	**Potential Funding Sources**
FLOOD HAZARDS						
A. *Flooding mitigation: Glen St./Millham Brook*	Reconfigure brook & inlet structure. Since the 2016 plan, Glen St. work was done, and design for inlet structure was prepared.	High	Engineering/DPW	High	2024-25	Marlborough General Fund; FEMA BRIC
B. *Flooding mitigation: Mowry Brook at Brook Village*	Drainage work partially completed since the 2016 plan (brook cleanout); no flooding for several years. Monitor for any problems and need for further drainage mitigation.	Low	Engineering/DPW	Low	2024-28	Private Funds (Condo Association)
C. *Hager Street Dam mitigation*	Establish plan for evaluation and design to repair, replace, or remove the dam (unknown private owner, current state emergency maintenance, possible state dam removal).	High	Engineering/DPW	High	2024-26	Private Funds (Dam privately owned)/
D. *City-wide dam maintenance*	Ensure maintenance of all existing public and private dams; incorporate projected increase in storms and precipitation intensity as part of maintenance schedule, updating every 5-10 years	Medium	Engineering/DPW	Medium	2025-28	Marlborough General Fund
E. *Flooding mitigation: land protection and acquisition*	Prioritize protection of open space areas in climate vulnerable areas; help limit impacts by increasing the use of open space as a buffer against flooding, extreme heat, and lack of wildlife habitat. Acquire Shoestring	High	Conservation Commission	High ($2m)	2024-28	Marlborough General Fund

Table 44: Recommended Mitigation Strategies						
Mitigation Action/Location	**Mitigation Description**	**Priority**	**Lead Agency Implementation**	**Estimated Cost***	**Estimated Timeframe 2024-28**	**Potential Funding Sources**
	Hill parcel for open space, flood mitigation; along with other parcels noted in the city's Open Space and Recreation Plan					
F. *Flooding mitigation: regulatory*	Update Floodplain and Wetlands Protection District ordinance and map to include 2014 FIRM data as part of ordinance update underway in FY 2024.	High	Planning/Conservation	Low	2024-24	Marlborough General Fund
WINTER HAZARDS						
G. *Winter Storms mitigation*	Develop a new snow disposal area	Medium	DPW	Medium	2024-24	Marlborough General Fund
GEOLOGIC HAZARDS						
H. *Earthquake mitigation: Unreinforced Masonry Buildings*	Conduct an assessment of earthquake vulnerability of public safety buildings, IT, and City Hall and evaluate feasibility of retrofits if needed	Low	Facilities Director	Medium	2025-26	Marlborough General Fund /FEMA BRIC
EXTREME HEAT HAZARDS						
I. *Extreme high temperatures mitigation*	Conduct a feasibility analysis of creating cooling centers in existing and new municipal facilities such as the Middle School and High School.	High	Facilities Director	Medium	2024-26	Marlborough General Fund /FEMA BRIC

Table 44: Recommended Mitigation Strategies						
Mitigation Action/Location	**Mitigation Description**	**Priority**	**Lead Agency Implementation**	**Estimated Cost***	**Estimated Timeframe 2024-28**	**Potential Funding Sources**
WIND/EXTREME WEATHER HAZARDS						
J. *Power Grid Resilience*	Improve power grid protection from severe weather such as high winds and hail by increasing tree-trimming and dead tree removal around power lines and other utilities. Prioritize the more vulnerable areas of the City.	High	DPW	Medium	2024-28	Marlborough General Fund
K. *High winds mitigation*	Public education on mitigating against and preventing property damage and avoiding personal injury due severe weather such as high winds, hail, and blowing or falling debris, tress or structures	Medium	Marlborough Emergency Management	Low	2025-28	Marlborough General Fund
FIRE HAZARDS						
L. *Brush Fire mitigation*	Establish a new fire station in the western part of the city. Since the 2016 plan the City has been conducting planning and land acquisition for this facility.	High	Fire Department	High	2024-26	Marlborough General Fund, DHS/EOPS
DROUGHT HAZARDS						
M. *Drought Mitigation*	Promote drought tolerant landscaping and site design measures: Adopt site development guidelines promoting drought-tolerant plantings and landscape design by using permeable pavement to reduce runoff and increase groundwater recharge	Medium	Conservation Commission	Low	2024-25	Marlborough General Fund

Table 44: Recommended Mitigation Strategies						
Mitigation Action/Location	**Mitigation Description**	**Priority**	**Lead Agency Implementation**	**Estimated Cost***	**Estimated Timeframe 2024-28**	**Potential Funding Sources**
MULITI-HAZARDS						
N. *Multiple Hazards mitigation: Power Outages*	Acquire backup generators for the Middle Schools, Elementary School, and the full Police facility, and assess backup power needs in remaining municipal buildings	Medium	Facilities Department	High	2024-27	Marlborough General Fund/FEMA BRIC
O. *Tree Preservation and Urban Forestry*	Prepare a City tree preservation ordinance. Additional efforts should be directed towards City forestry management, tree planting, pest control and overall forest health maintenance. This would have benefits for multiple hazards, including flooding, extreme heat, and fire protection.	Medium	Conservation Commission	Medium	2025-28	Marlborough General Fund / MVP Action Grant
P. *Communications and outreach*	Increase overall communications between City departments and boards with non-English speaking residents. Focus outreach on churches, social clubs and using social media; prioritize getting people signed up for Reverse 911.	Medium	Human Services Dept./ Emergency Management	Low	2024-28	Marlborough General Fund / MVP Action Grant

KEY TO COSTS

High	Estimated costs greater than $250,000.
Medium	Estimated costs between $100,000 and $250,000.
Low	Estimated costs less than $100,000, or staff time.

SECTION 9: PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Marlborough Hazard Mitigation Plan was adopted by the City Council on [ADD DATE]. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

Plan Maintenance

MAPC worked with the Marlborough Hazard Mitigation Team to prepare this plan. After approval of the plan by FEMA, the local Team will meet on a regular basis to oversee implementation of the plan and prepare for the next plan update. The Emergency Management Director is designated as the local team coordinator. Additional members could be added to the local implementation team from other City departments, local businesses, non-profits, and institutions.

The City will encourage public participation during the next 5-year planning cycle. As updates and a review of the plan are conducted by the local Team, these will be placed on the project's website, and any meetings of the Local Team will be publicly noticed in accordance with city and state open meeting laws. The posting will include a mechanism for citizen feedback such as an e-mail address to send comments.

Implementation Schedule

Mid-Term Survey on Progress – The coordinator of the Hazard Mitigation Team will prepare and distribute a survey during year three of the plan. The survey will be distributed to the local Hazard Mitigation Team members and other interested local stakeholders. The survey will poll the members on progress and accomplishments for implementation, any new hazards or problem areas that have been identified, and any changes or revisions to the plan that may be needed.

Evaluation criteria--In reviewing progress on implementing the plan, the local team will consider factors that may be barriers or constraints to implementation of the mitigation strategies, including capital costs, operating costs, staff capacity, training, or expertise, legal and regulatory barriers, public support or opposition (such as NIMBY objections), and planning and coordination among multiple municipal departments.

This information will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team will have primary responsibility for tracking progress and updating the plan.

Begin to Prepare for the next Plan Update – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the City's approved plan status and its eligibility for FEMA mitigation grants. Because of the time required to secure a planning grant, prepare an updated plan, and complete the approval and adoption of an updated plan, the local Hazard Mitigation Planning Team should begin the process in Year 3. This will help the City avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

The Hazard Mitigation Team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan –Once the resources have been secured to update the plan, the Hazard Mitigation Team may decide to undertake the update themselves or procure the services of a consultant or the Metropolitan Area Planning Council to update the plan, following FEMA procurement requirements. However, the Hazard Mitigation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. Once the next draft plan

update is prepared, the City will submit it to MEMA and FEMA for review and approval and adopt the plan update to obtain formal FEMA approval of the plan.

Integration of the Plans with Other Planning Initiatives

Upon approval of the Marlborough Hazard Mitigation Plan 2024 Update by FEMA, the coordinator of the Hazard Mitigation 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 ongoing work.

At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire
- Emergency Management
- Police
- Public Works
- Engineering
- Community Development
- Energy and Environment
- Forestry
- Health
- Building

Other stakeholders that will be coordinated will include land conservation organizations, watershed groups, business groups, and nonprofit institutions.

Moving forward, the Hazard Mitigation Plan 2024 Update will be integrated into other city plans and policies as they are updated and renewed, including the Master Plan, Open Space and Recreation Plan, Capital Investment Program and Comprehensive Emergency Management Plan.

SECTION 10: LIST OF REFERENCES

City of Marlborough Comprehensive Emergency Management Plan
City of Marlborough Draft Open Space Plan 2011-2018
City of Marlborough General Code
City of Marlborough Subdivision Regulations
Blue Hill Observatory
Boston HIRA
FEMA, *Disaster Declarations for States and Counties*. Retrieved from Data Visualizations: https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties
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FEMA, Hazards U.S. Multi-Hazard
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Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
MA Emergency Management Agency, State *Hazard Mitigation Plan*, 2013
MA EEA, *Massachusetts Climate Change Adaptation Report*, 2011
MA EEA and MEMA, *Massachusetts Drought Management Plan, 2019*
MA Geographic Information System, *McConnell Land Use Statistics*
Metropolitan Area Planning Council. *MassBuilds* development database
Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
Nevada Seismological Library
Northeast Climate Adaptation Science Center
New England Seismic Network, Weston Observatory
Northeast States Emergency Consortium
Tornado History Project
US Census, 2020 and American Community Survey 2020
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NWCG. (2023). *Size Class of Fire*. Retrieved from National Wildfire Coordinating Group:
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U. S. Census, 2020, and American Community Survey, 2017
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University of Massachusetts Boston, "Climate Change Impacts and Projections for the Greater Boston Area: Findings of the Greater Boston Research Advisory Group Report," 2022

APPDENCIX A: HAZARD MAP SERIES

The MAPC GIS (Geographic Information Systems) Lab produced this series of hazard maps for Marlborough's Hazard Mitigation Plan. Some of the data came from the Northeast States Emergency Consortium (NESEC). More information on NESEC can be found at http://www.serve.com/NESEC/. Due to the various sources for the data and varying levels of accuracy, the identification of an area as being in one of the hazard categories must be considered as a general classification that should always be supplemented with more local knowledge.

The map series consists of twelve panels displaying the following information:

Map 1.	Population Density
Map 1b.	Environmental Justice
Map 2.	Land Use
Map 3.	Flood Zones
Map 3b.	Flood Claims from March 2010 Disaster Declaration
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Local Hazard Areas
Map 10	Extreme Heat
Map 11	Wildfires

Map 1: Population Density – This map uses the US Census block data for 2020 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 1b: Environmental Justice – This map shows Environmental Justice (EJ) populations using 2020 data. EJ designations from the State include English isolation, income, and minority residents.

Map 2: Land Use – This map shows land cover and land use from MassGIS' 2016 Land Cover/Land Use dataset.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones for Middlesex County as its source. For more information, refer to the FEMA Map Service Center website http://www.msc.fema.gov. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and municipally owned and protected open space.

Map3b: Flood Claims – This map shows flood insurance and disaster claim records from March 2010. The March 29, 2010 federal disaster declaration associated with severe rainfall and flooding triggered the launch of the Federal Emergency Management Agency's (FEMA's) Individual Assistance Program through which residential property owners, businesses, and institutions without flood insurance were eligible to apply for relief to pay for storm-related expenditures and repairs. In the MAPC region, 18,400 claims were approved for $30 million dollars in disaster assistance.

Map 4: Earthquakes and Landslides (Regional) – This map depicts landslide risk and recorded earthquake epicenters in the community and surrounding region. This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

Map 5: Hurricanes and Tornadoes (Regional) – This map shows the spatial characteristics of several different meteorological properties and past events in the community and surrounding region. The map includes the storm tracks for both hurricanes and tropical

storms. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100-year wind speed and areas that could be inundated by storm surge during a hurricane, if any.

Map 6: Average Snowfall (Regional) **-** This map shows the average snowfall in the community and the surrounding region.

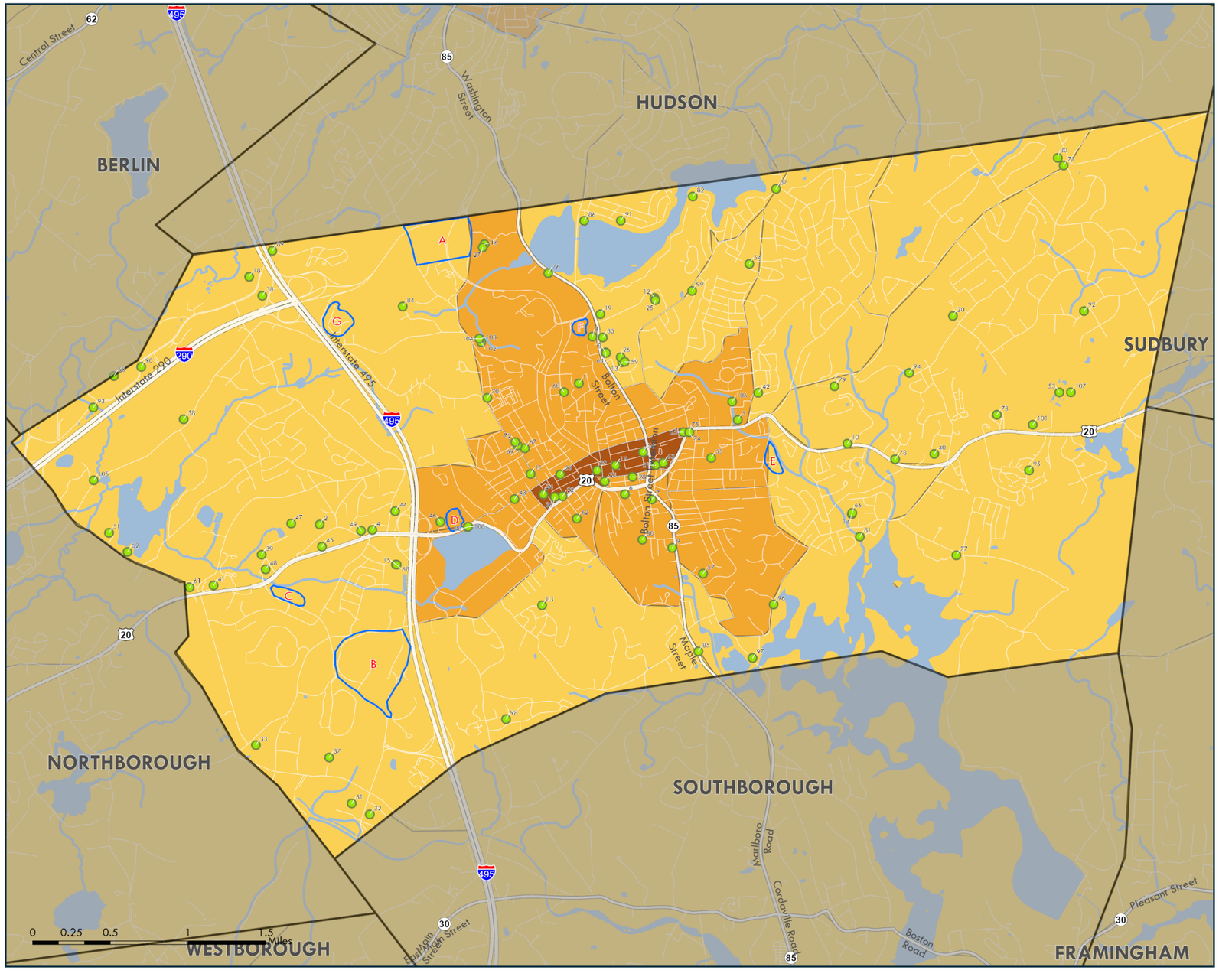
Map 7: Composite Natural Hazards (Regional) **-** This map shows four categories of composite natural hazards. The hazards included in this map are 100-year wind speeds of 110 mph or higher, low, and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane surge inundation areas. Areas with only one hazard were considered to be low hazard areas. Moderate areas have two of the hazards present. High hazard areas have three hazards present and severe hazard areas have four hazards present.

Map 8: Local Hazard Areas **–** For each community, locally identified hazard areas are overlaid on an aerial photograph. The critical infrastructure sites and planned development areas are also shown. The source of the aerial photograph is Mass GIS.

Map 10: Extreme Heat **–** MAPC's Statewide Land Surface Temperature (LST) Index was created by combining estimates of surface temperature from days in 2018, 2019, and 2020 where the daily air temperature maximum exceeded 70 degrees Fahrenheit. The Statewide LST Index "Hot Spots" data depicts the 5% highest LST index areas in each Regional Planning Agency (RPA) region. The data was generated by identifying pixels whose LST index values are equal to or greater than 95% of LST index values in the region, and then delineating cohesive regions where pixels meet this criterion as polygons. Map 9 represents the "Hot Spots" relative to the MAPC region, mapped on top of the National Land Cover Database's 2016 30-m tree canopy data.

Map 11: Wildfires **–** This map shows wildfire risk to the community using USDA data. Wildfire risk is classified as very low, low, moderate, high, and very high.

The map set described above is included on the subsequent pages.



Map 1: Population Density

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

- Critical Infrastructure*
- Development Areas

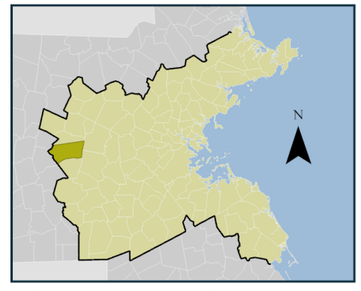
* See details in separate table

- Water Bodies
- Commuter Rail

Census 2020 Block Groups

Population Density: People per acre

- 0 or No Data
- 0.1 - 5.0
- 5.1 - 15.0
- 15.1 - 30.0
- More than 30



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Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census

MARLBOROUGH, MA

Date: 5/9/2023

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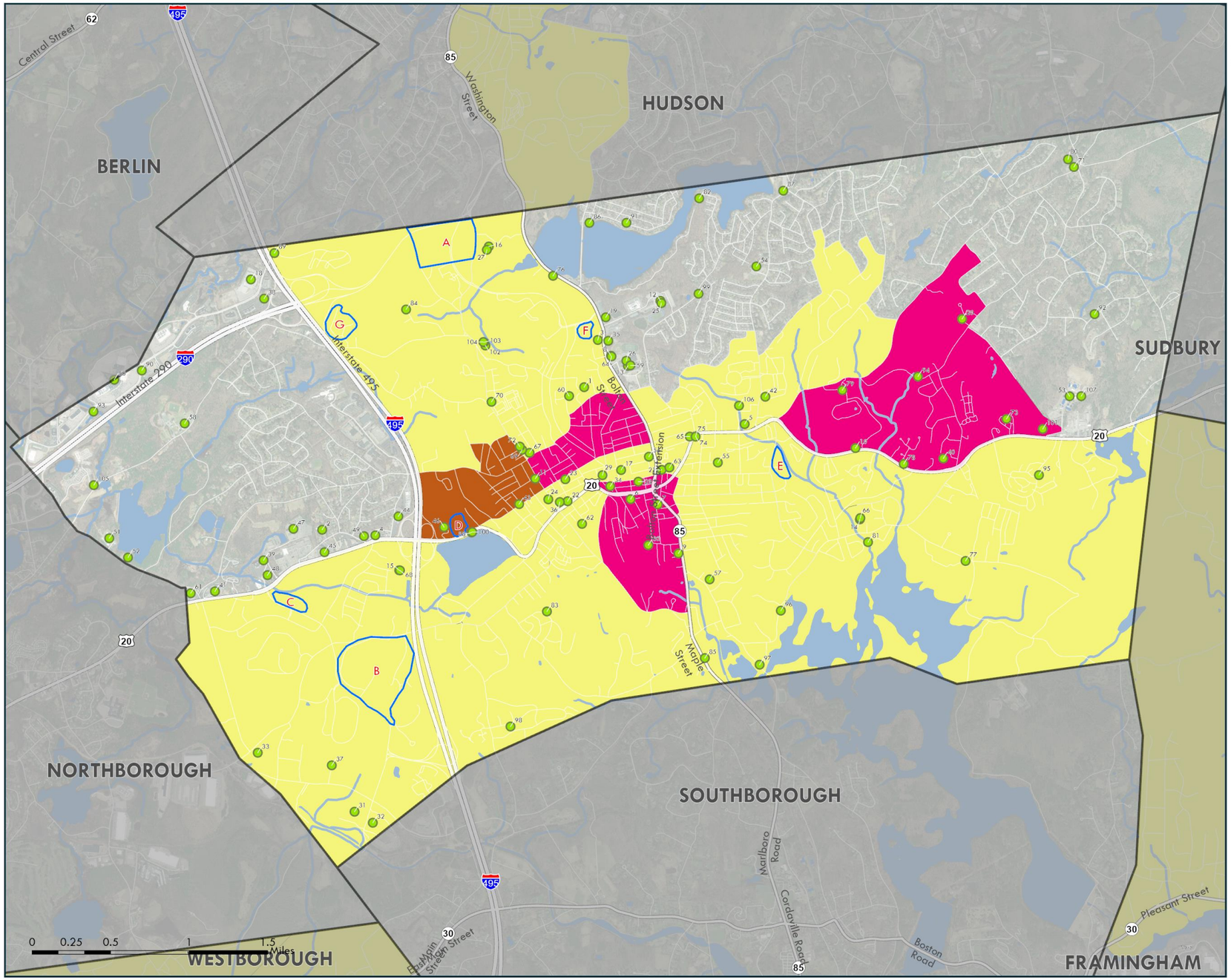


Map 1a: Environmental Justice

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

- Critical Infrastructure*
- Development Areas

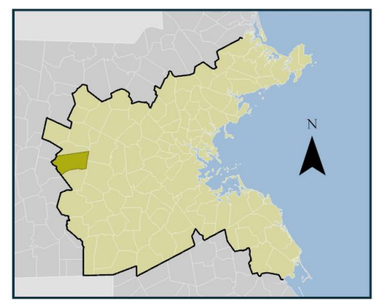
* See details in separate table

- Water Bodies
- Commuter Rail

Environmental Justice Populations 2020

EJ Criteria Description

- English isolation
- Income
- Income and English isolation
- Minority
- Minority and English isolation
- Minority and income
- Minority, income and English isolation



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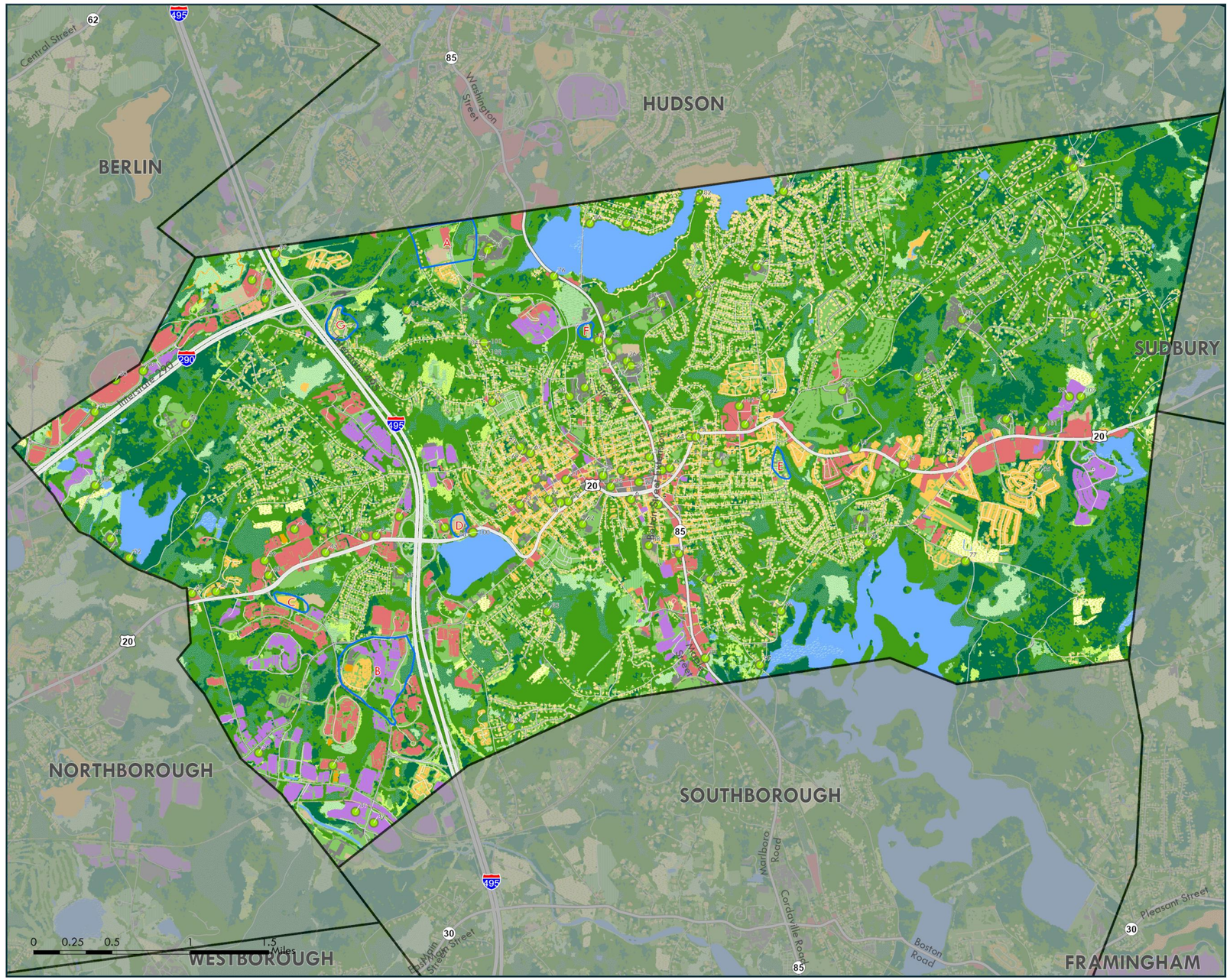


Map 2: Land Use

MAPC dcr

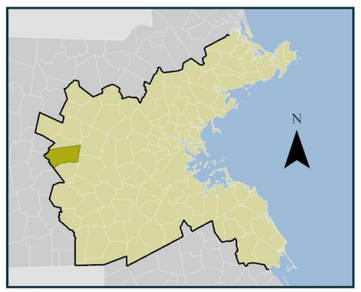
FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

- Critical Infrastructure*
- Development Areas
  * See details in separate table
- Commuter Rail

Land Cover-Land Use (2016)

- Residential - Single Family
- Residential - Multi-Family
- Residential - Other
- Commercial
- Industrial
- Mixed Use - Primarily Residential
- Mixed Use - Primarily Commercial
- Mixed Use - Other
- Other Impervious
- Right-of-way
- Cultivated
- Pasture/Hay
- Developed Open Space
- Deciduous Forest
- Evergreen Forest
- Grassland
- Scrub/Shrub
- Bare Land
- Forested Wetland
- Non-forested Wetland
- Saltwater Wetland
- Water
- Unconsolidated Shore
- Aquatic Bed



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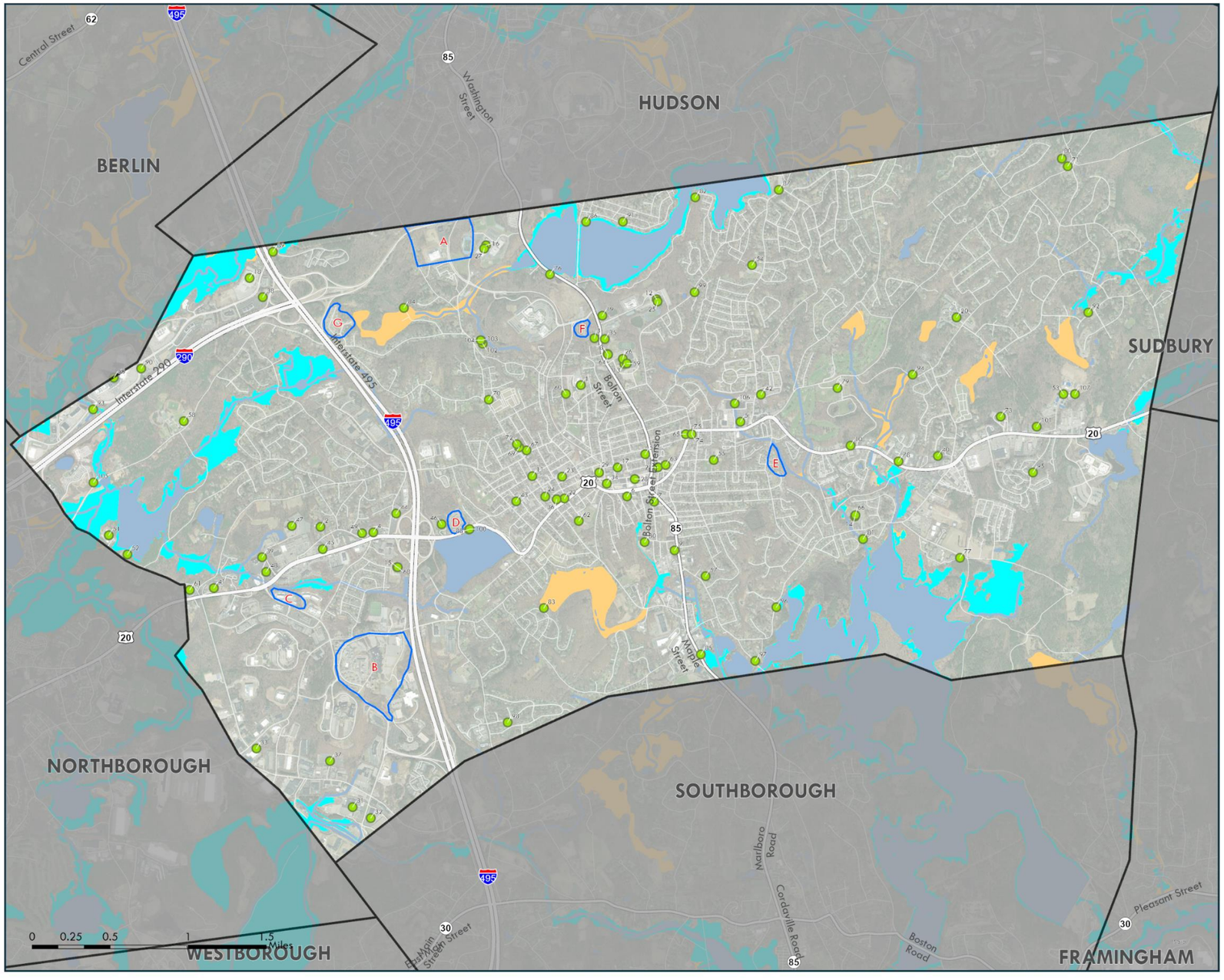


Map 3: Flood Zones

MAPC dcr

FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

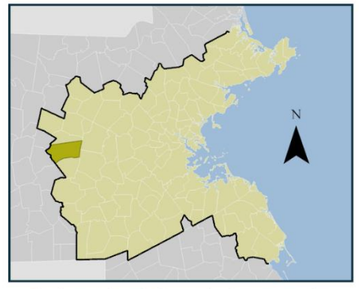
- Critical Infrastructure*
- Development Areas

* See details in separate table

- Water Bodies
- Commuter Rail

FEMA Flood Zones, 2017
(Annual Chance)

- Zone A: 1%
- Zone AE: 1%
- Zone AH: 1%
- Zone AO: 1%
- Zone VE: 1% with Velocity Hazard
- 0.2% Annual Chance



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U.S. Decennial Census

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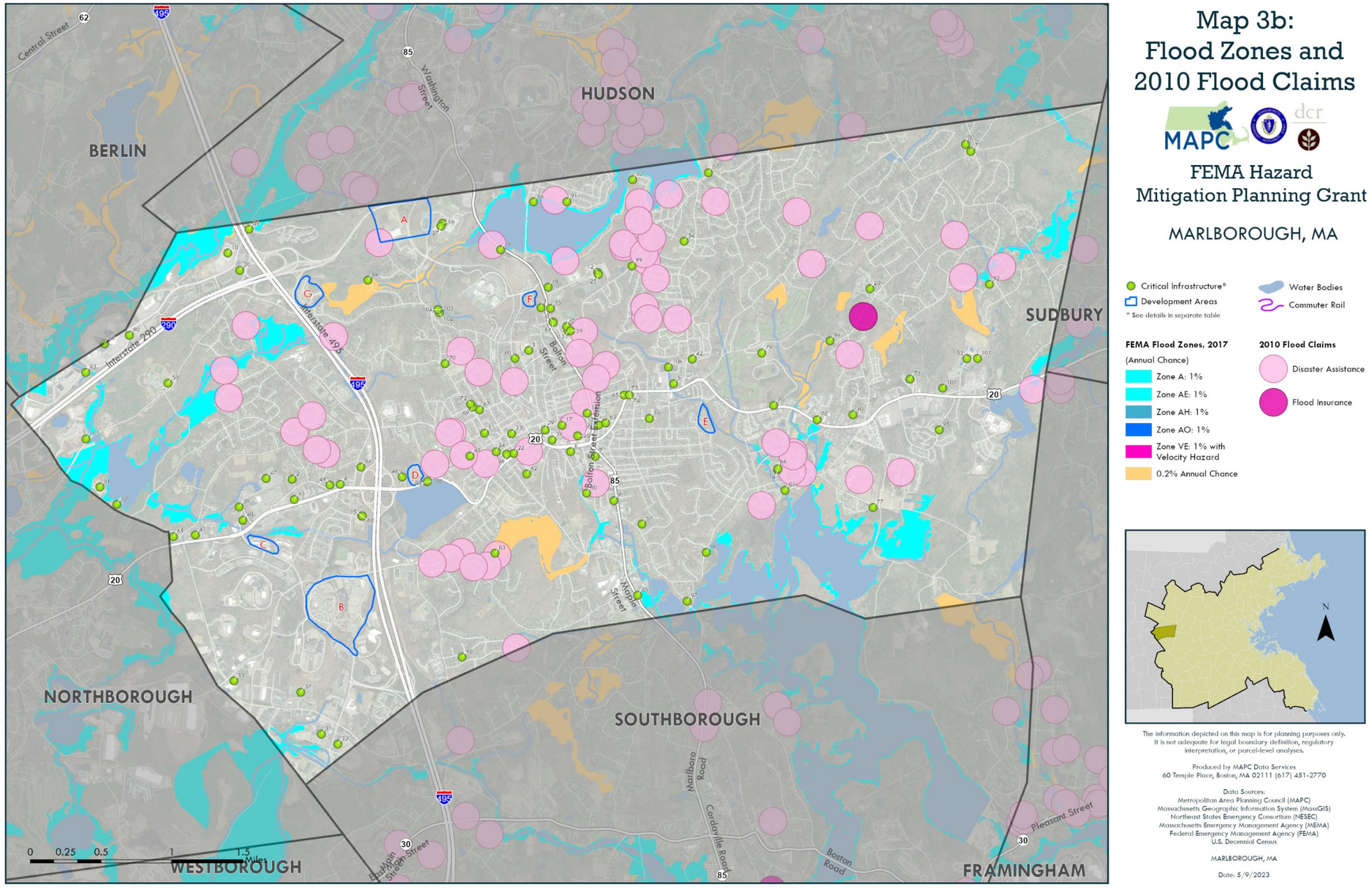

Map 3b: Flood Zones and 2010 Flood Claims

MAPC

FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

- Critical Infrastructure*
- Development Areas

* See details in separate table

- Water Bodies
- Commuter Rail

FEMA Flood Zones, 2017
(Annual Chance)

- Zone A: 1%
- Zone AE: 1%
- Zone AH: 1%
- Zone AO: 1%
- Zone VE: 1% with Velocity Hazard
- 0.2% Annual Chance

2010 Flood Claims

- Disaster Assistance
- Flood Insurance

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Federal Emergency Management Agency (FEMA)
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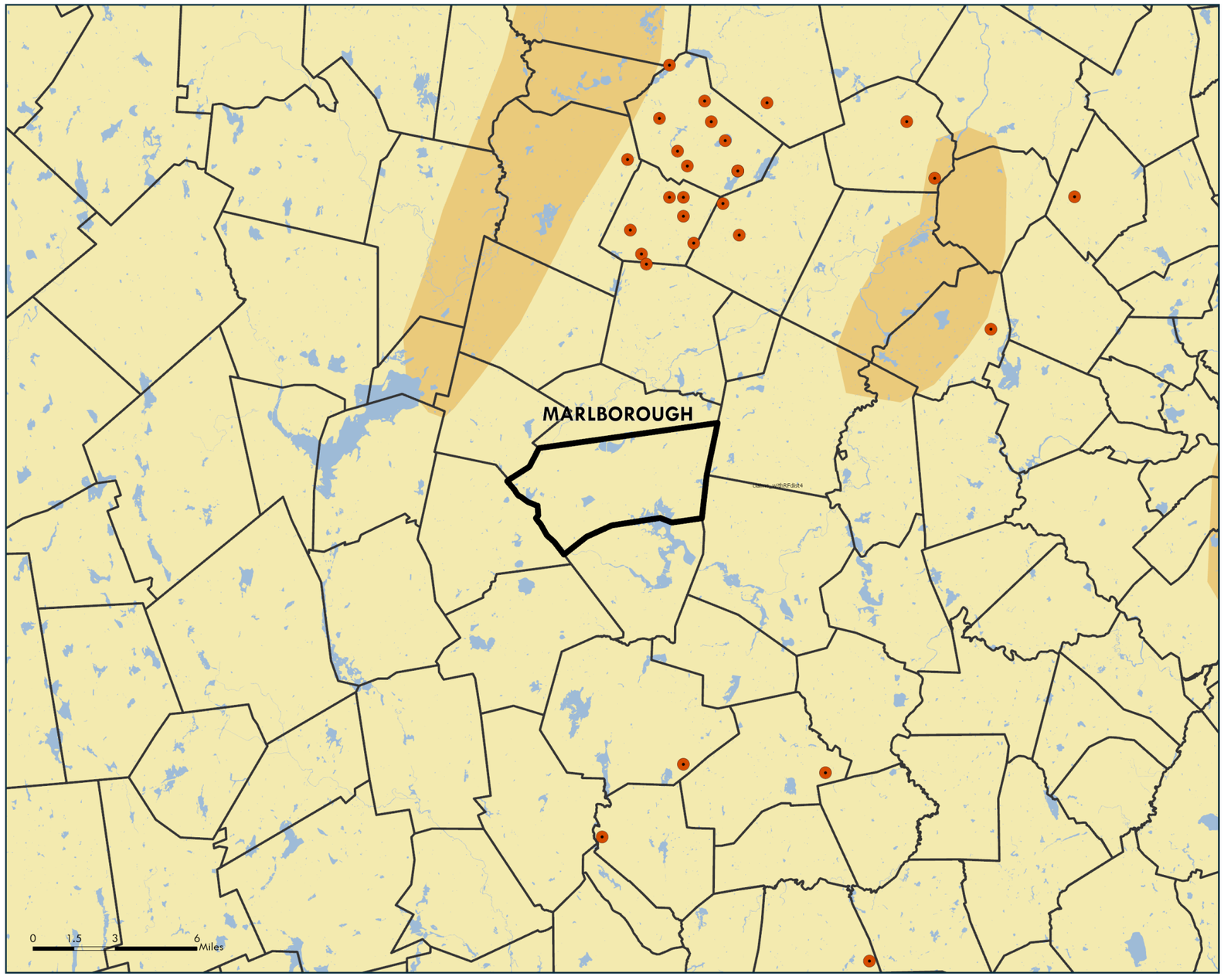


Map 4: Earthquakes and Landslides

MAPC

dcr

FEMA Hazard Mitigation Planning Grant

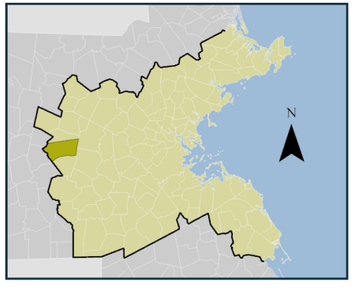
MARLBOROUGH, MA

Landslides

- High landslide incidence (greater than 15% of the area is involved in landsliding)
- High susceptibility to landsliding and moderate incidence
- High susceptibility to landsliding and low incidence
- Moderate susceptibility to landsliding and low incidence
- Low landslide incidence (less than 1.5 % of the area is involved in landsliding

Earthquakes

- Epicenters



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Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census

MARLBOROUGH, MA

Date: 5/9/2023

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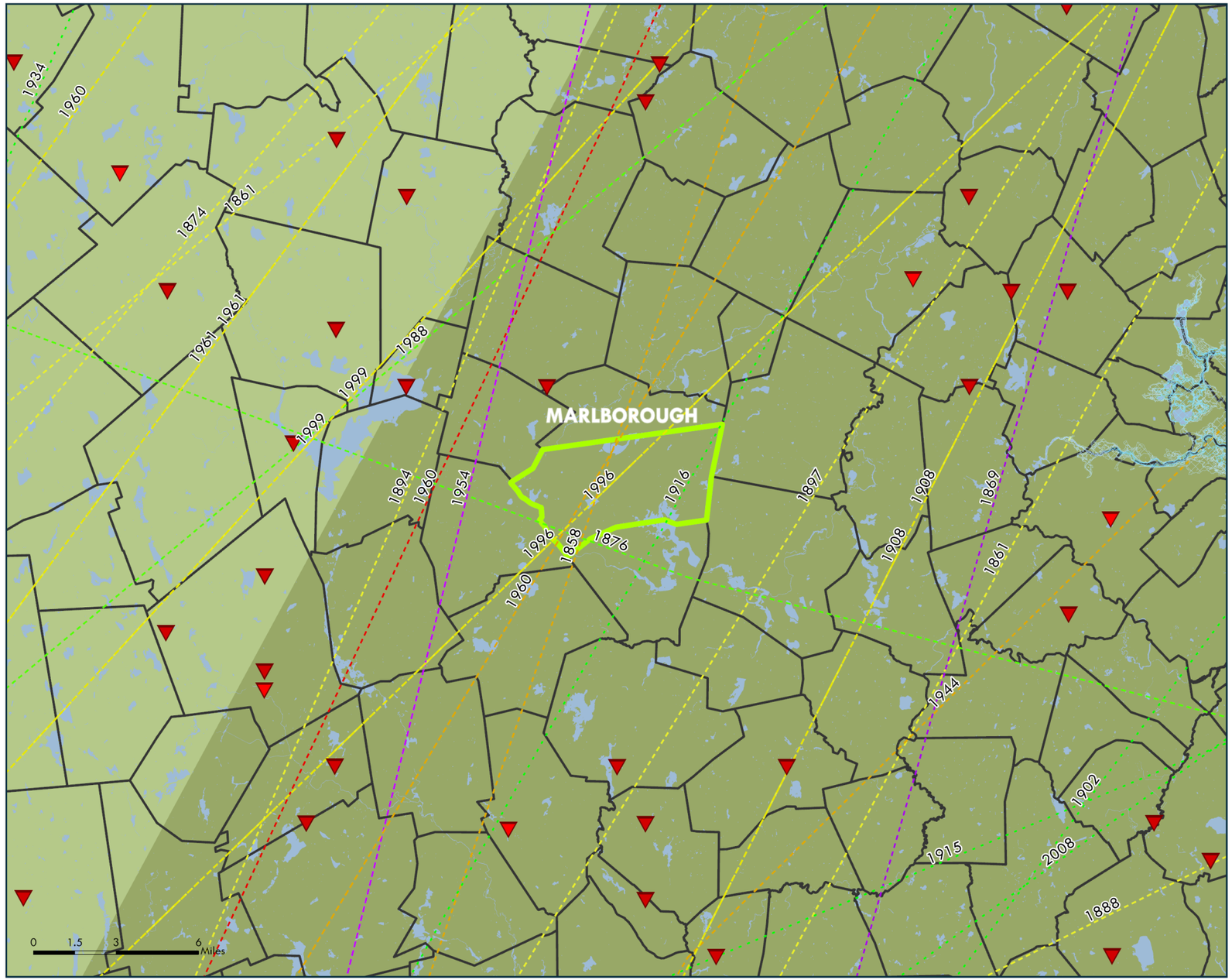


Map 5: Hurricanes and Tornadoes

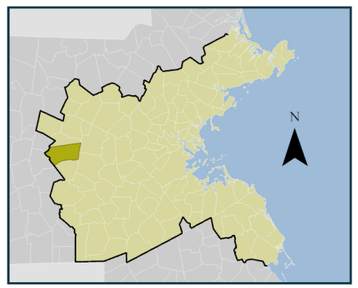
MAPC dcr

FEMA Hazard Mitigation Planning Grant
MARLBOROUGH, MA

Hurricane Surge Inundation Area
Tornado

Storm Tracks
- Tropical Depression
- Tropical Storm
- Category 1 Hurricane
- Category 2 Hurricane
- Category 3 Hurricane

100 Year Wind Speeds
Miles Per Hour
- 90 MPH
- 100 MPH
- 110 MPH
- 120 MPH
- 130 MPH



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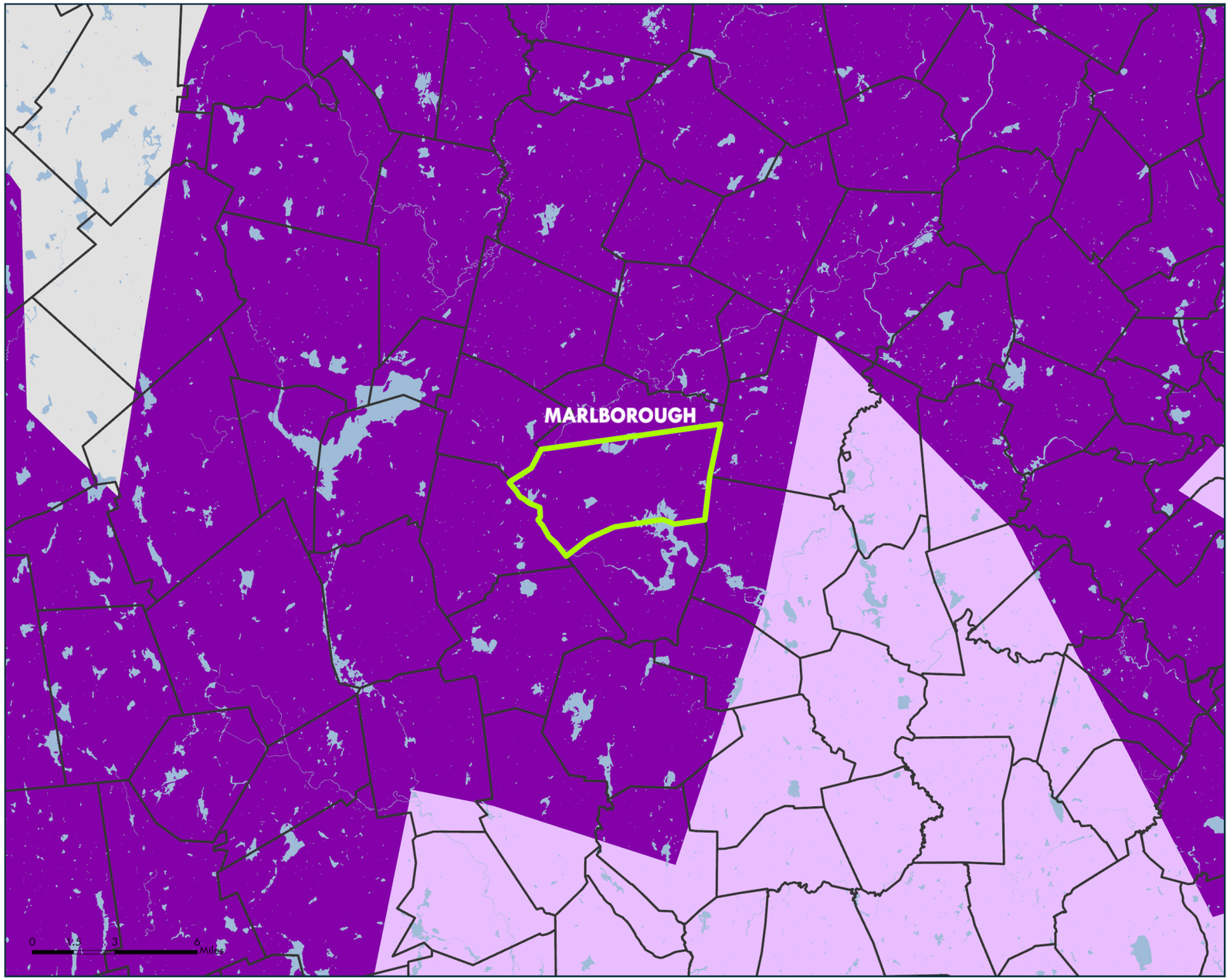
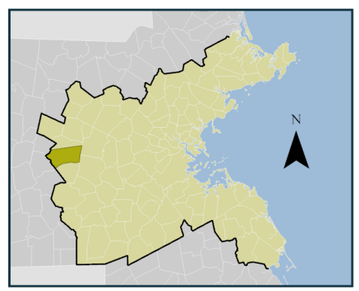


Map 6: Average Snowfall

FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

Average Annual Snowfall
Inches
G 36.1 - 48.0
H 48.1 - 72.0



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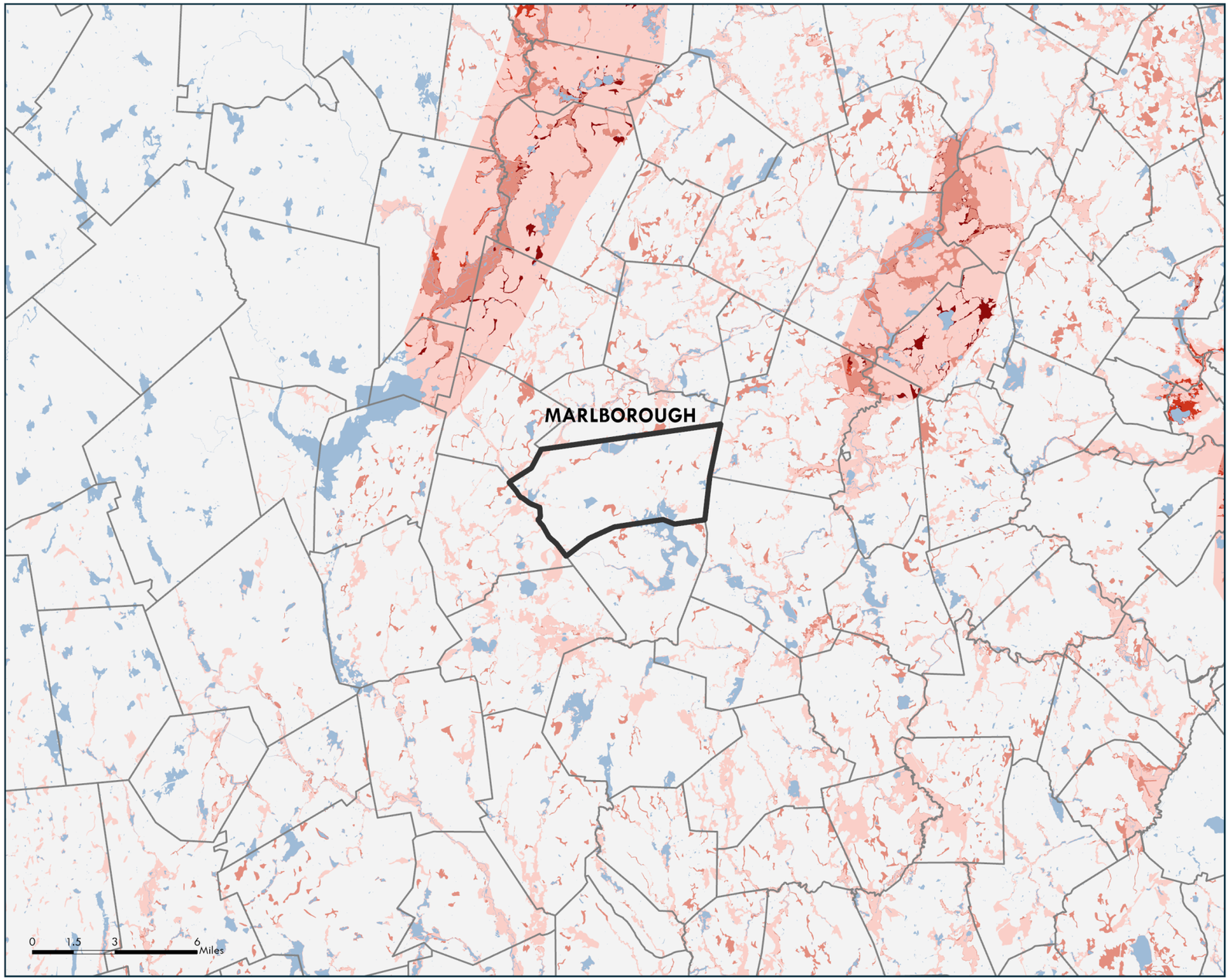


Map 7: Composite Natural Hazards

FEMA Hazard Mitigation Planning Grant

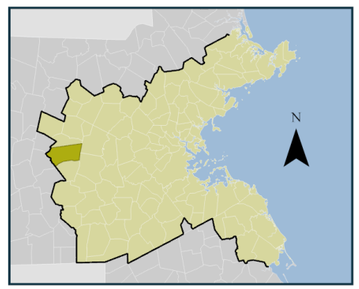
MARLBOROUGH, MA

Composite Natural Hazards

- Low (2 Hazards)
- Moderate (3 Hazards)
- High (4 Hazards)
- Very High (5 Hazards)

Composite natural hazards shown for areas of existing development. Hazards include:

- 100 year wind speed of 110 MPH or higher
- Moderate landslide risk
- FEMA flood zones (100 year and 500 year)
- Average snowfall of 36.1" or more
- Hurricane surge inundation areas



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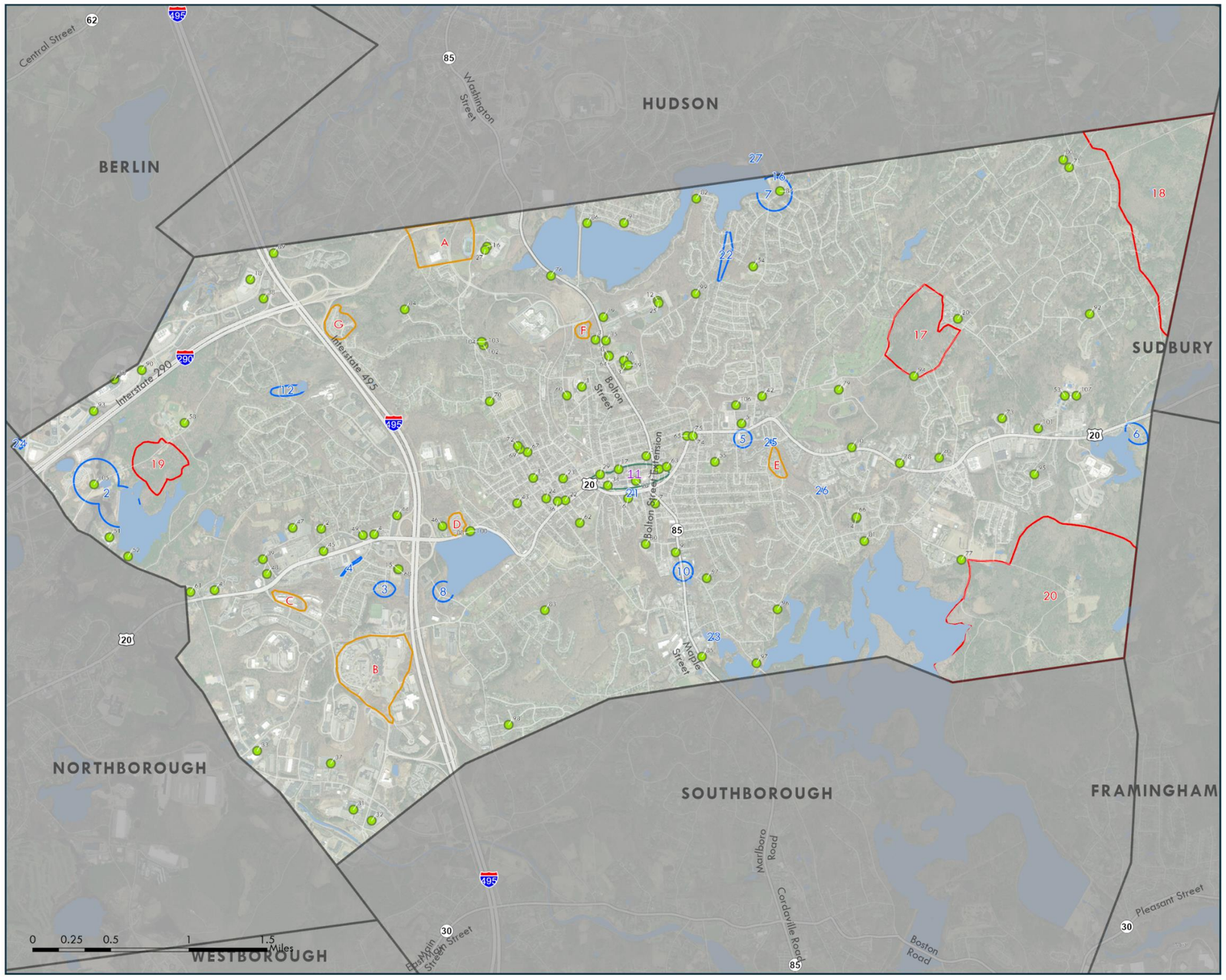


Map 8: Local Hazard Areas

MAPC dcr

FEMA Hazard Mitigation Planning Grant

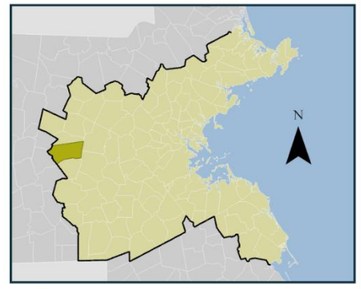
MARLBOROUGH, MA

- Critical Infrastructure*
- Development Areas

* See details in separate table

- Water Bodies
- Commuter Rail

Hazard Areas
Type
- Brush Fire
- Flooding
- Other



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MARLBOROUGH, MA

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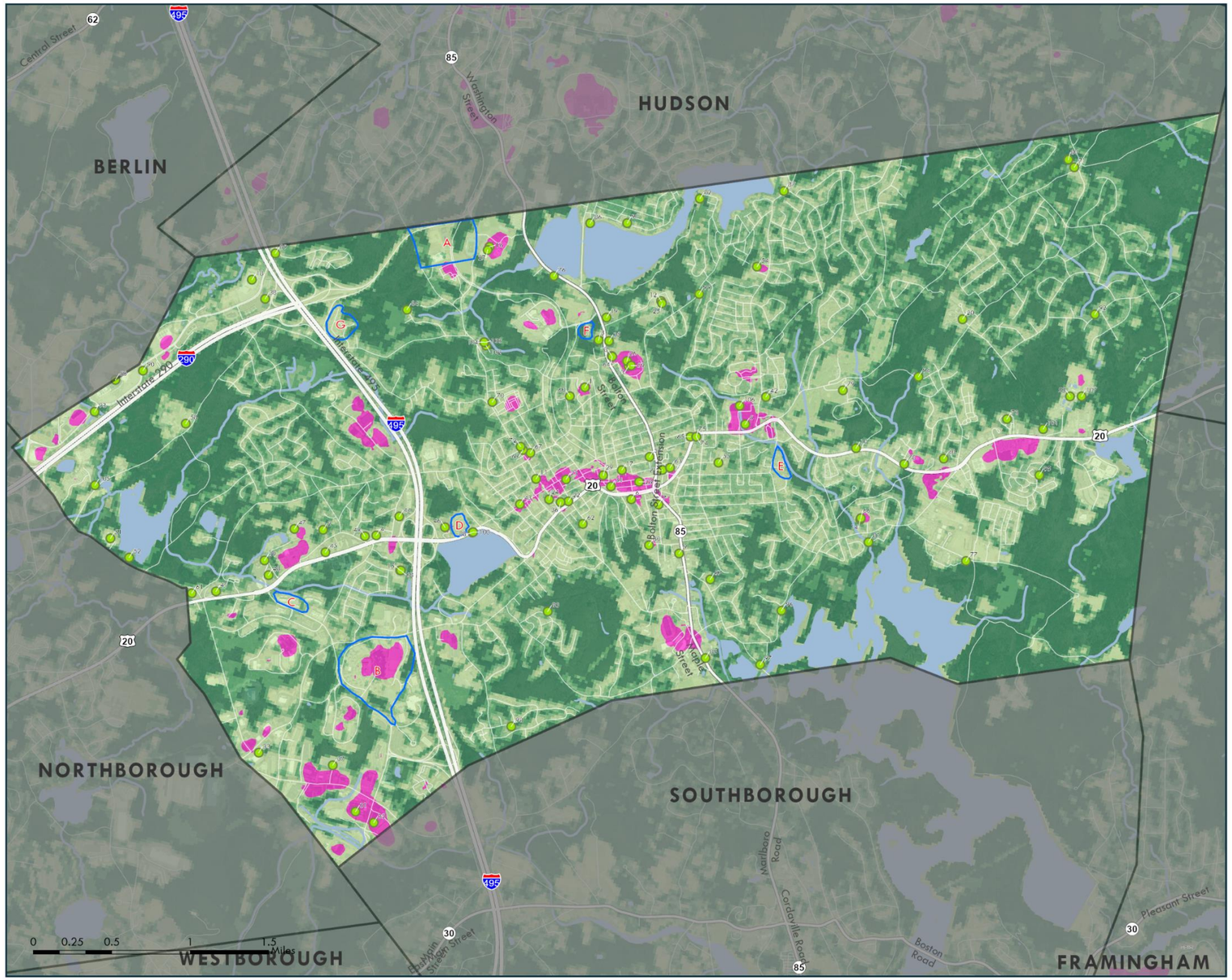


Map 9: Land Surface Temperature

MAPC dcr

FEMA Hazard Mitigation Planning Grant
MARLBOROUGH, MA

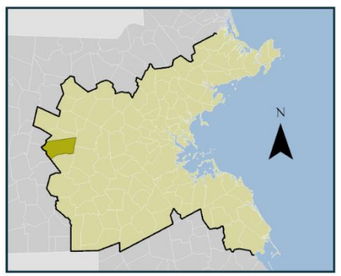
- Critical Infrastructure*
- Development Areas
- * See details in separate table
- Water Bodies
- Commuter Rail

Tree Canopy Coverage (2016 - 30m)

- Hottest 5% of region's land area

% Canopy Coverage

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%



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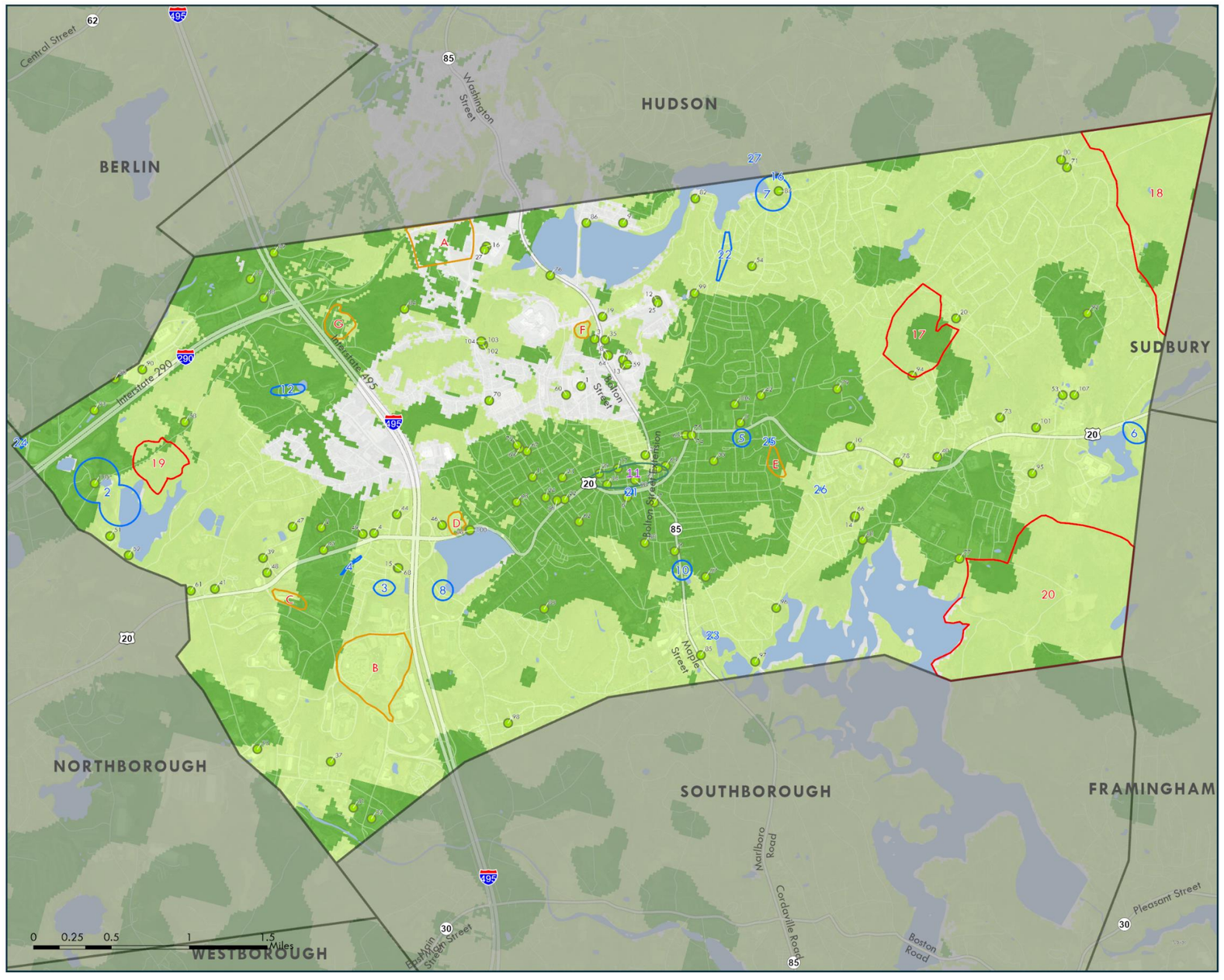


Map 11: Wildfire Risk

MAPC dcr

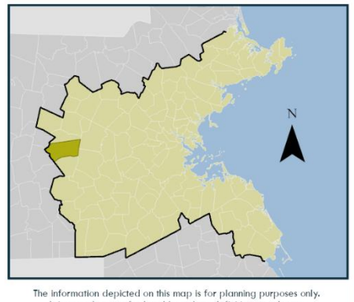
FEMA Hazard Mitigation Planning Grant

MARLBOROUGH, MA

Critical Infrastructure*
Development Areas
* See details in separate table

Hazard Areas
Type
Brush Fire
Flooding
Other

USDA Wildfire Risk to Communities
Wildfire Hazard Potential
N/A
Very Low
Low
Moderate
High
Very High



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APPDENCIX B: HAZARD MITIGATION TEAM

Marlborough Hazard Mitigation Plan Update 2022
Local Team Meeting #1

Tuesday, August 16, 2022
10:00 – 11:30 AM

AGENDA

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1. Welcome and Introductions

2. Overview of the HMP Project

- Overview of the FEMA Hazard Mitigation Plans
- Project tasks and schedule (see attached Summary of the Process)

3. Getting Started: Local Data Updates from the 2016 Plan

- *We will update the following 3 types of local data from the 2016 plan (see attached worksheets for updating each of the 3 data types):*
  - Local Hazard Areas of Concern (Flooding & Wildfire)
  - Critical Facilities
  - New Development sites
- *MAPC's GIS Planner will join via Zoom to map new or revised sites using the online platform Google MyMaps*

4. Next steps: Prepare for Public Meetings and Outreach

- Two Public Meetings: during planning process, and review draft plan
- Identify local stakeholders to invite (review MVP Workshop invitees)

APPDENCIX B: HAZARD MITIGATION TEAM

WORKSHEET #1 – MARLBOROUGH HAZARD AREAS FROM 2016 PLAN UPDATED BY THE LOCAL TEAM 8-16-22

FLOODING POTENTIAL HAZARD AREAS	UPDATES, REVISIONS, ADDITIONAL SITES, OR DELETIONS?
~~1. Boundary Street Bridge (1); Road floods during 25-year storm event; road needs to be raised; being planned~~	1. Delete for 2022 plan—road has been raised
3. Culvert at Ripley & McGee Avenue drainage at intersection is under-sized and needs to be replaced *(d*rainage from Lake Williams/I-495 Industrial Park*)*	3. Keep for 2022 plan
4. Glen Brook neighborhood, Millham Brook: Outlet culvert into downstream wetland from brook backs up and floods Glen Brook neighborhood in large rain storms despite some city upgrades	4. Keep & Revise for 2022 plan – Marlborough DPW did some upgrades; need to address inlet configuration which takes a 90 degree turn; leave linear section and swale.
5. Mowry Brook at Brook Village: Culverts from East Main Street to Curtis Avenue need to be enlarged as brook floods apartments	5. Keep & Revise for 2022 plan: Add Mowry Brook culverts under Cook Lane (25) and Phelps Street (26) (see below)
9. ~~Culvert at Route 85 (9); In design for replacement with a larger culvert~~	9. Delete for 2022 plan
10. Culvert at Maple Street (Rt. 85) and Framingham Road (10); Culvert catches debris so needs to be replaced with a larger culvert	10. Keep for 2022 plan
12. Bigelow Street: Flooding due to beavers (12)	12. Keep & Revise for 2022 plan: Change to "Need to upgrade culvert"
~~13. Stow Road and Concord Road: Flooding due to beavers (13)~~	13. Delete for 2022 plan

APPDENCIX B: HAZARD MITIGATION TEAM

Marlborough Hazard Mitigation Plan Update 2022
Local Team Meeting #2

Wednesday, October 19, 2022
10:00 – 11:30 AM

Department of Public Works
Teams Room
135 Neil Street

AGENDA

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1. **Welcome and Project Update**

2. **Review and Update of Mitigation Goals for the Plan**
   See Mitigation Goals from the 2016 plan attached

3. **Review Status of Existing Mitigation Measures**
   See table of Existing Mitigation from the 2016 Plan attached

   - Note any **Changes for 2022**
   - Update any **Improvements Needed**
   - Add any **New Measures** adopted since 2016

4. **Prepare for First Public Meeting**

   - Date and hosting board/commission
   - *Meeting Invitation and outreach:*
     - *Identify local stakeholders to invite* (refer to MVP invitees?)
   - Public outreach on City website, social media?

APPDENCIX B: HAZARD MITIGATION TEAM

EXISTING MARLBOROUGH MITIGATION MEASURES FROM 2016 FOR 2022 UPDATE

Please update as needed any Changes since 2016 Plan and Improvements Needed

Mitigation Measure	Description	Effectiveness	Changes since 2016 Plan?	Improvements Needed?
MULTIPLE HAZARDS				
Comprehensive Emergency Management Plan (CEMP)	Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies.	Emphasis is on emergency response.		
Massachusetts State Building Code	The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads.	Effective for new construction and reconstruction.		
Participation in the Local Emergency Planning Committee (LEPC)	Marlborough has its own LEPC.	Provides a forum for cooperation on issues related to natural and man-made disaster.		

Page 1 of 7

APPDENCIX B: HAZARD MITIGATION TEAM

MARLBOROUGH HAZARD MITIGATION GOALS—2016 PLAN

The Marlborough Local Hazard Mitigation Team reviewed and endorsed the following goals for the 2016 Hazard Mitigation Plan. All of the goals are considered critical for the City and they are not listed in order of importance.

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards.

Goal 2: Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.

Goal 3: Increase cooperation and coordination among private entities, City officials and Boards, State agencies and Federal agencies.

Goal 4: Increase awareness of the benefits of hazard mitigation through outreach and education.

Goal 5: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 6: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees, and boards.

Goal 7: Prevent and reduce the damage to public infrastructure resulting from all hazards.

Goal 8: Encourage the business community, major institutions, and non-profits to work with the City to develop, review and implement the hazard mitigation plan.

Goal 9: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 10: Ensure that future development meets federal, state, and local standards for preventing and reducing the impacts of natural hazards.

Goal 11: Take maximum advantage of resources from FEMA and MEMA to educate City staff and the public about hazard mitigation.

POTENTIAL ADDITIONAL GOAL TO CONSIDER FOR 2022 PLAN UPDTTE:

Goal 12. Consider the impacts of climate change and incorporate climate sustainability and resiliency into the City’s planning and policies.

APPDENCIX B: HAZARD MITIGATION TEAM

Marlborough Hazard Mitigation Plan Update 2022
Local Team Meeting #3

Wednesday, December 14, 2022
10:00 – 11:30 AM

Department of Public Works
Teams Room
135 Neil Street

AGENDA

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1. Welcome and Introductions

2. Review and Update Status of Mitigation from the 2016 Plan

See Worksheet showing 2016 Mitigation Recommendations to be updated

- Identify 2016 mitigation measures that have been **COMPLETED** or **PARTIALLY COMPLETED**
- Review 2016 mitigation that has **NOT BEEN COMPLETED:**
    - Determine which 2016 measures should be **RETAINED** "as is" in the 2022 plan
    - Determine if any 2016 mitigation should be **REVISED** for the 2022 plan
    - Decide if any **PRIORITIES** should be changed for 2022
- Decide if any 2016 measures should be **DELETED** for the 2022 plan

3. Prepare for the Public Meeting

- MAPC to present an overview of the plan update project
- Select date and identify host agency
- MAPC will conduct outreach/invitations and media advisory

  Team: please identify local stakeholder contacts (Business groups, major employers, community organizations, service providers, etc.)

APPDENCIX B: HAZARD MITIGATION TEAM

Worksheet 2: Mitigation measures recommended in the 2016 plan, to be updated for the 2022 plan

- The Team will note which of these have been (1) Completed, (2) Partially Completed, or (3) Not Completed in the CURRENT STATUS COLUMN
- Mitigation not completed may be (1) Retained in the 2022 Plan, (2) Revised for 2022, (3) Deleted, or (4) changed priority under 2022 PLAN UPDATE

Status of Recommended Mitigation Measures from the 2016 Marlborough Hazard Mitigation Plan					
Mitigation Measure	**Description**	**Estimated Cost*** (see key below)	**Priority**	**CURRENT STATUS** 1. Completed 2. Partially Completed 3. Not Completed	**2022 PLAN UPDATE** 1. Retain in 2022 Plan? 2. Revise for 2022? 3. Changed Priority for 2022? 4. Delete in 2022 Plan?
FLOODNG HAZARDS					
A. *Flooding: drainage infrastructure maintenance and repair*	Feasibility study to consider the adoption of a Stormwater Utility	Medium ($15k)	Medium		
B. *Flooding: land protection and acquisition*	Acquire Shoestring Hill parcel for open space, flood mitigation	High ($2m)	Medium		
C. *Flooding: Glen St./Millham Brook*	Install new drain lines on Ripley Street, reconfigure brook & inlet structure	High ($75k design)	High		
D. *Flooding: Mowry Brook at Brook Village*	Modify culverts from East Main Street to Curtis Avenue & Cook Lane	High ($125k+)	High		
E. *Flooding: Culvert on Route 85*	Replace with larger culvert: at 50 % design	High ($300k)	High		
F. *Dam: Hager Street Dam*	Establish regular maintenance plan	Low	High		
G. *Flooding: regulatory*	Adopt a new flood zone map s	Low	Med		d
H. *Flooding-Culvert on Elm Street*	Replace culvert on Elm Stret at Millham Brook	High ($450k)	High		

1 of 3

APPDENCIX B: HAZARD MITIGATION TEAM

Marlborough Hazard Mitigation Plan
Local Team Meeting #4

Monday, March 27, 2023
2:00 – 3:30 PM

Department of Public Works
Teams Room
135 Neil Street

AGENDA

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1. Welcome and brief update

2. Recommended Mitigation Strategies for the 2023 Plan
See table showing recommended mitigation for 2023

- Confirm mitigation carried over from the 2017 plan
- Consider new/additional mitigation measures (MVP examples attached)
- For each mitigation measure, confirm priority, cost, lead agency, funding source

3. Prepare for the final Public Meeting

- Early May time frame, depending on City meeting schedules
- Need to decide on host for the meeting
    - (Planning Board already held the first public meeting)
- MAPC will prepare a presentation on the draft plan
- MAPC will prepare the meeting notice and media advisory, and notify neighboring municipalities.

APPDENCIX B: HAZARD MITIGATION TEAM

Draft Mitigation Strategies to be recommended in the 2023 updated plan

1. The Team will update the information in the yellow columns, which is carried over from the 2017 plan.
2. Also consider adding new mitigation recommendations. Please see the MVP summary below for potential ideas.

DRAFT Mitigation Strategies for the Malden 2022 Hazard Mitigation Plan

Mitigation Action	Description Green text updates from 2017 plan-please confirm accuracy of edits	Priority	Lead Agency	Estimated Cost*	Estimated Timeframe 2023-28	Potential Funding Sources
FLOOD HAZARDS						
A. *Flooding: Glen St./Millham Brook*	Install new drain lines on Ripley Street, reconfigure brook & inlet structure. Since the 2017 plan, Glen St. work was done, and design for inlet structure was prepared.	High	Engineering/DPW	High ($75k design)		Marlborough General Fund
B. *Flooding: Mowry Brook at Brook Village*	Drainage work partially completed since the 2017 plan--brook cleanout; no flooding for several years. Continue to monitor for any problems and potential further mitigation.	Low	Engineering/DPW	High ($125k+)		Marlborough General Fund / FEMA
C. *Dam: Hager Street Dam*	Establish plan for evaluation and design to repair, replace, or remove the dam.	High	Engineering/DPW	High		Marlborough General Fund / FEMA
D. *Flooding: land protection and acquisition*	Acquire Shoestring Hill parcel for open space, flood mitigation	High	Conservation Commission	High ($2m)		Marlborough General Fund
E. *Flooding: regulatory*	Update Floodplain and Wetlands Protection District map as needed (for new FIRM maps).	High	Planning/Conservation	Low		Marlborough General Fund
WINTER HAZARDS						
F. *Winter Storms*	Develop snow disposal area (New for 2023 Plan)					

APPDENCIX C: PUBLIC MEETINGS

Public Meeting on the Marlborough Hazard Mitigation Plan

Natural hazards can have serious impacts on the City of Marlborough and its residents and businesses



The City of Marlborough is preparing an updated Hazard Mitigation Plan to reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. The plan will also enable the City to apply for mitigatioin grants from FEMA. Please join the City for a presentation about the plan at a public meeting hosted by the Marlborough Planning Board on Monday, February 13 at 7:00 PM. A presentation will be made by the Metropolitan Area Planning Council, which is assisting the City in preparing this plan.

Marlborough Planning Board

Monday, February 13, 2023, 7:00 pm
Memorial Hall, 3rd Floor
City Hall
140 Main Street, Marlborough MA

Questions and suggestions for the plan are welcome at the meeting, and may also be sent by email to MarlboroughHazardPlan@mapc.org

APPDENCIX C: PUBLIC MEETINGS

Home

Marlborough Hazard Mitigation Plan

Public Meeting

POSTED ON: FEBRUARY 1, 2023 - 9:58AM

Natural hazards can have serious impacts on the City of Marlborough and it's residents and businesses.

The City of Marlborough is preparing an updated Hazard Mitigation Plan to reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. The plan will also enable the City to apply for mitigation grants from FEMA. Please join the City for a presentation about the plan at a public meeting hosted by the Marlborough Planning Board on **Monday, February 13 at 7:00 PM**. A presentation will be made by the Metropolitan Area Planning Council, which is assisting the City in preparing this plan.

Questions and suggestions for the plan are welcome at the meeting, and may also be sent by email to *MarlboroughHazardPlan@mapc.org*

Attachment	Size
marlborough_hazard_mitigation_meeting_notice_02-13-2023.pdf	250.13 KB

APPDENCIX C: PUBLIC MEETINGS

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

MARLBOROUGH'S HAZARD MITIGATION PLAN TO BE DISCUSSED ON FEBRUARY 13 PUBLIC MEETING

Who: Marlborough residents, business owners, institutions, and non-profit organizations, and others interested in preventing and reducing damage from natural hazards.

What: At a public meeting on Monday, February 13 at 7:00 PM, a presentation on the Marlborough Hazard Mitigation Plan 2023 Update will be given at the Marlborough Planning Board meeting. The presentation will be given by the Metropolitan Area Planning Council, which is assisting the city's Hazard Mitigation Team in the preparation of the plan. There will be an opportunity for questions following the presentation.

The City of Marlborough is preparing the updated 2023 Hazard Mitigation Plan to evaluate natural hazards that affect the City, such as floods, hurricanes, and severe winter storms. The plan will develop recommended actions the city can take to reduce its vulnerability to these hazards.

When: Monday, February 13, 2023, 7:00 PM

Where: Memorial Hall, 3rd Floor
City Hall, 140 Main Street, Marlborough MA

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

##

APPDENCIX C: PUBLIC MEETINGS

MINUTES
MARLBOROUGH PLANNING BOARD
MARLBOROUGH, MA 01752

1A

Call to Order **February 13, 2023**

The Meeting of the Marlborough Planning Board was called to order at 7:00 pm in Memorial Hall, 3rd Floor City Hall, 140 Main Street, Marlborough, MA. Members present: Sean Fay, Phil Hodge, George LaVenture, and Chris Russ. Meeting support provided by City Engineer, Thomas DiPersio, City Solicitor, Jason Grossfield, and Assistant City Solicitor, Jeremy McManus. Members Absent: Barbara Fenby and William Fowler.

1. **Draft Meeting Minutes**
   A. January 23, 2023
      On a motion by Mr. LaVenture, seconded by Mr. Russ, the Board voted to accept and file the January 23, 2023, meeting minutes with minor typo edits. Yea: Fay, Hodge, and Russ. Nay: 0. Motion carried. 3-0. Abstain: LaVenture.

2. **Chair's Business**
   A. Unaccepted Streets – ***No Updates***

   On a motion by Mr. Russ, seconded by Mr. LaVenture the Board voted to move up item 2.C. 215 Simarano Drive. Yea: Fay, Hodge, LaVenture, and Russ. Nay: 0. Motion carried. 4-0.

   C. 215 Simarano Drive
      i. Correspondence from Assistant City Solicitor, Jeremy McManus
         Mr. LaVenture read a portion of the February 8, 2023, correspondence into the record.
         On a motion by Mr. Russ, seconded by Mr. LaVenture, the Board voted to accept and file the correspondence. Yea: Fay, Hodge, LaVenture, and Russ. Nay: 0. Motion carried. 4-0.

      ii. Statutory Covenant

         City Solicitor, Jason Grossfield, and Assistant City Solicitor, Jeremy McManus discussed 215 Simarano Drive with the Board and Mr. McManus went over the statutory covenant. He explained the definitive plan that was approved in 2018 but was never endorsed. The legal department was approached by the developer about the idea of security, which is a requirement under general law Chapter 41, section 81U that requires security to be in place for the construction of ways and the installation of services. The unique part about this subdivision is that there was never any intention of constructing it, it was sought only for the zoning freeze that is provided for under Chapter 48 Section 6.

         Mr. McManus explained the covenant before the Board meets all the requirements under Chapter 40 Section 81U, it provides for the fact that, if there ever was going to be a construction of the subdivision that none of the lots would be conveyed until the infrastructure shown on the plan was constructed. It satisfies the legal requirements for a covenant. It differs from the normal covenant that the board encounters because there is no intention of constructing the subdivision, there for paragraphs about construction meetings and items pertaining to construction have been removed.

         Mr. McManus explained the statute states that when the plan is endorsed, that's when the eight-year zoning freeze starts. With this subdivision, we have an approval but not an endorsement. There is an argument that if the Board endorses the covenant now, then the freeze starts now. Mr. McManus explained the legal department worked with the developer to back date the zoning freeze to September 10, 2018.

APPDENCIX C: PUBLIC MEETINGS

MINUTES
MARLBOROUGH PLANNING BOARD
MARLBOROUGH, MA 01752

Mr. LaVenture asked about holding the developers to the standards of the current rules and regulations. Specifically, the requirement for two guarantees: one, the completion guarantee and two, the street acceptance guarantee. Mr. McManus explained these guarantees were changes to the rules and regulations that were made after this plan was filed. The plan is being held in compliance with the previous rules and regulations.

The Board decided to vote to endorse the covenant and the plan at the February 27, 2023, meeting.

B. Marlborough Hazardous Mitigation Plan 2022 Update Presentation
Fred Flynn and Martin Pillsbury of Metropolitan Area Planning Concil (MAPC) spoke on behalf of the Marlborough Hazardous Mitigation Plan (MHMP) Updates and Mr. Flynn explained MAPC was awarded the grant to rewrite the MHMP. Mr. Pillsbury went over the presentation within the February 13, 2023, Planning Board agenda packet.

The presentation went over the following items.

Techniques for Hazard Mitigation:

1. Prevention
2. Property Protection
3. Public Education
4. Natural Resources Protection
5. Structural Projects
6. Emergency Services Protection

Plan Development Steps:

1. Update Hazard Identification and Mapping
2. Update and Map Critical Facilities
3. Update Risks and Vulnerabilities
4. Review Existing Mitigation
5. 1st Public Meeting (February 13, 2023 Planning Board Meeting)
6. Update Mitigation Strategies
7. Prepare Draft Plan
8. 2nd Public Meeting
9. MEMA/FEMA Review and Approval, City Adoption

Mr. Russ asked, what is Marlborough's biggest risk? Mr. Pillsbury said its probably flooding. He explained the flooding in Marlborough is likely to be localized flooding but that there are over a dozen sites that have been identified. Followed by wind and fallen trees resulting in power outages.

Mr. Russ asked about what other communities are doing to strengthen their power grids. Mr. Pillsbury explained the most effective thing that can be done is enhanced/targeted tree trimming, specifically by identifying areas within the power grid with the highest risk and hiring an arborist to review the trees in those areas. He also mentioned underground utilities but explained how this change would not only be expensive but went over the potential difficulties underground utilities can face, like groundwater and freezing.

City Council President, Michael Ossing asked, how does the MHMP work with the Municipal Vulnerability Preparedness MVP? Mr. Pillsbury explained they do overlap, but the MHMP is created to meet Federal Emergency Management Agency (FEMA) requirements and would result in a set of specific action recommendations.


Marlborough Hazard Mitigation Plan
2022 Update
Marlborough Planning Board
February 13, 2023
Martin Pillsbury
Metropolitan Area Planning Council

APPDENCIX C: PUBLIC MEETINGS

Public Presentation of the *Marlborough Hazard Mitigation Plan*

Natural hazards can have serious impacts on the City of Marlborough and its residents and businesses



The City of Marlborough has prepared a draft updated *Hazard Mitigation Plan* to help reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. The plan will also enable the City to apply for grants from FEMA to fund mitigation projects. Please join the City for a presentation of the draft plan at a meeting of the City Council on Monday, May 22 at 8:00 PM. The presentation will be made by the Metropolitan Area Planning Council, which is assisting the City in preparing the plan. After the meeting the draft plan will be available online for public review, and questions and comments are welcome.

Marlborough City Council
Monday, May 22, 2023, 8:00 pm
City Council Chambers, 2nd Floor, City Hall
140 Main Street, Marlborough MA

The meeting will be televised on WMCT-TV (Comcast Channel 8 or Verizon/Fios Channel 34) and can be viewed online using the link under the Meeting Videos tab on the city website www.marlborough-ma.gov

For any questions. please send an email to MarlboroughHazardPlan@mapc.org

APPDENCIX C: PUBLIC MEETINGS

Apresentação Pública do Plano de Mitigação de Riscos Naturais de Marlborough

Os perigos naturais podem ter sérios impactos sobre a Cidade de Marlborough e seus residentes e empresas



A cidade de Marlborough preparou um Plano de Mitigação de Riscos Naturais atualizado para ajudar a reduzir sua vulnerabilidade a riscos naturais, como enchentes, furacões e tempestades de inverno. O plano também permitirá que a cidade solicite subsídios da FEMA para financiar projetos de mitigação. Assistir a uma apresentação pública do projeto de plano em uma reunião da Câmara Municipal na segunda-feira, 22 de maio, às 20h. A apresentação será feita pelo Metropolitan Area Planning Council, que está auxiliando a Prefeitura na elaboração do plano. Após a reunião, o rascunho do plano estará disponível on-line para revisão pública. Perguntas e comentários são bem-vindos.

Câmara Municipal de Marlborough
Segunda-feira, 22 de maio de 2023, 20:00 hs
Câmaras de Vereadores, 2º Andar da Prefeitura de Marlborough
140 Main Street, Marlborough MA

A reunião será transmitida pela WMCT-TV (Comcast Channel 8 ou Verizon/Fios Channel 34) e pode ser assistida online usando o link na guia Meeting Videos no site da cidade
www.marlborough-ma.gov

Para qualquer dúvida por favor envie um e-mail para
MarlboroughHazardPlan@mapc.org

APPDENCIX C: PUBLIC MEETINGS

Presentación Pública de la Plan de Mitigación de Riesgos Naturales de Marlborough

Los peligros naturales pueden tener graves impactos en la Ciudad de Marlborough y sus residentes y negocios



La Ciudad de Marlborough ha preparado un borrador actualizado del Plan de Mitigación de Riesgos para ayudar a reducir su vulnerabilidad a los peligros naturales como inundaciones, huracanes y tormentas de invierno. El plan también permitirá que la Ciudad solicite subvenciones de FEMA para financiar proyectos de mitigación. Asistir a una presentación pública del borrador del plan en una reunión del Concejo Municipal el lunes 22 de mayo a las 8:00 p. m. La presentación estará a cargo del Consejo de Planificación del Área Metropolitana, que está asistiendo a la Ciudad en la preparación del plan. Después de la reunión, el borrador del plan estará disponible en línea para revisión pública, y las preguntas y los comentarios son bienvenidos.

Consejo Municipal de Marlborough
Lunes, 22 de mayo de 2023, 20:00
Salas del Concejo Municipal, 2.° Piso
140 Main Street, Marlborough MA

La reunión será televisada en WMCT-TV (Comcast Channel 8 o Verizon/Fios Channel 34) y se puede ver en línea utilizando el enlace en la pestaña Videos de la reunión en el sitio web de la ciudad. www.marlborough-ma.gov

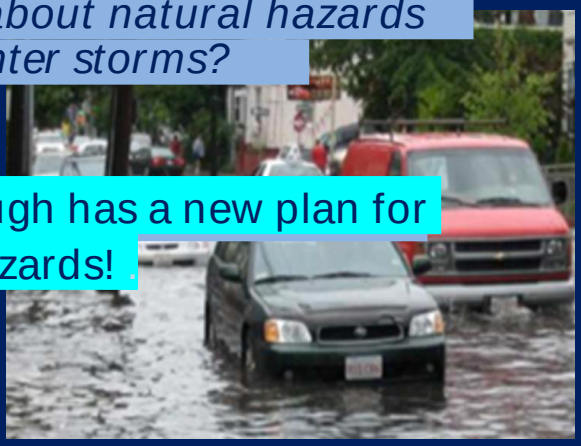
Para cualquier pregunta. por favor envíe un correo electrónico a
MarlboroughHazardPlan@mapc.org

APPDENCIX C: PUBLIC MEETINGS

Public Meeting #2
Social Media Card

Floods? Blizzards? Hurricanes?

Are you concerned about natural hazards like flooding and winter storms?



The City of Marlborough has a new plan for Mitigating Natural Hazards!

Please Join us for a presentation at City Council on May 22, 2023 at 8:00 PM

Marlborough City Council
City Hall, Council Chambers
140 Main St, Marlborough

APPDENCIX C: PUBLIC MEETINGS

APPDENCIX C: PUBLIC MEETINGS

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

MARLBOROUGH'S *HAZARD MITIGATION PLAN 2023 UPDATE* TO BE PRESENTED AT MAY 22 CITY COUNCIL MEETING

Who:	Marlborough residents, business owners, institutions, and non-profit organizations, and others interested in preventing and reducing damage from natural hazards.
What:	A presentation of the draft *Marlborough Hazard Mitigation Plan 2023 Update* will be given at a meeting of the Marlborough City Council on Monday, May 22 at 8:00 PM. The presentation will be given by the Metropolitan Area Planning Council, which has assisted the city's Hazard Mitigation Team in the preparation of the plan. The City of Marlborough has prepared the draft *Marlborough Hazard Mitigation Plan 2023 Update* to evaluate natural hazards that affect the Town, such as floods, hurricanes, and severe winter storms. The draft plan provides recommended mitigation actions the city can take to reduce its vulnerability to those hazards. The plan will also enable the City to apply for grants from FEMA to fund mitigation projects. The draft plan will be available online for public review after the meeting, and the public's questions and comments are welcome.
When:	Monday, May 22, 2023, 8:00 PM
Where:	City Council Chambers, 2nd Floor City Hall, 140 Main Street, Marlborough MA
Remote Access	The meeting will be televised on WMCT-TV (Comcast Channel 8 or Verizon/Fios Channel 34) and can be viewed online using the link under the Meeting Videos tab on the city website www.marlborough-ma.gov
	MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

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APPDENCIX C: PUBLIC MEETINGS

NOTICE OF PUBLIC MEETING
TO MARLBOROUGH'S NEIGHBORING COMMUNITIES

TO: City and Town Clerks in Berlin, Framingham, Hudson, Northborough, Southborough, and Sudbury,

RE: Notification of Public Presentation on the Marlborough Hazard Mitigation Plan

The City of Marlborough has prepared the 2023 update of the *Marlborough Hazard Mitigation Plan*, which is intended to reduce the City's vulnerability to natural hazards such as flooding, drought, hurricanes, and winter storms. The plan identifies recommended hazard mitigation measures, including infrastructure improvements, regulatory measures, and educational and outreach efforts related to natural hazards.

As part of the planning process, as required by FEMA, Marlborough's neighboring municipalities are being notified of a public presentation on the draft plan to be hosted by the Marlborough City Council. The meeting will be held as follows:

Monday, May 22, 8:00 PM
Marlborough City Council
Council Chambers, 2nd Floor
City Hall, Main Street
Marlborough, MA

Remote Access:
The meeting can be viewed online using the link under the Meeting Videos tab on the city website
www.marlborough-ma.gov

A flyer announcing the meeting with the above information is also attached.

After the City Council meeting the draft plan will be available online on the City's website for public review, and questions and comments are welcome.

Thank you,

Martin Pillsbury
Environmental Planning Director
Metropolitan Area Planning Council
60 Temple Place, Boston, MA 02111
617-933-0747
mpillsbury@mapc.org
www.mapc.org

APPDENCIX D: PLAN ADOPTION CERTIFICATE

<CITY LETTERHEAD>

CERTIFICATE OF ADOPTION
CITY COUNCIL

CITY OF MARLBOROUGH, MASSACHUSETTS

A RESOLUTION ADOPTING THE
CITY OF MARLBOROUGH HAZARD MITIGATION PLAN 2024 UPDATE

WHEREAS, the City of Marlborough established a Hazard Mitigation Planning Team, coordinated by the Emergency Management Director, to prepare the *City of Marlborough Hazard Mitigation Plan 2024 Update*; and

WHEREAS, the *City of Marlborough Hazard Mitigation Plan 2024 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the City of Marlborough, and

WHEREAS, duly-noticed public meetings were held by the PLANNING BOARD ON FEBRUARY 13, 2023, and by the City Council on May 22, 2023

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

NOW, THEREFORE BE IT RESOLVED that the Marlborough CITY COUNCIL adopts the *City of Marlborough Hazard Mitigation Plan 2024 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the City of Marlborough.

ADOPTED AND SIGNED this Date. _____

Name(s)

Title(s)

Signature(s)

ATTEST